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[1] *Ecole Superieure Sainte Felicite University*
03 BP 4050, Godomey Houedonou Cotonou, Abomey-Calavi, Benin Republic

[2] *Joel Olaifa & Partners*
78 Ralph Sodeinde Street, Abuja, Nigeria

[3] *Mai Idris Alooma Polytechnic*
P. M. B. 1020, Geidam, Yobe State, Nigeria

[4] *Abubakar Tafawa Balewa University*
Dass road, P. M. B. 0248, Bauchi, Nigeria

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Corresponding Author:
Ojeniyi Sulaiman Adekunle
kunleoje@yahoo.com

Abstract. It is well known that housing demands ranked second in the hierarchy of human necessities after food. This study examined inhabitants' choices and satisfaction with housing provided by private developers and public-private partnerships in Abuja. Participants were given questionnaires at the public-private partnership and private developer estates; at the public estate, 300 questionnaires were distributed, of which 227 were retrieved. Of the 24 questionnaires served for the Private Developer development Ologunloye Estate, 11 were retrieved. According to the analysis. T-test analysis was also used to determine the difference between inhabitants' choices and contentment with dwellings provided by the government and PPP in the research area. At 0.06 and 0.011, which is smaller than the 0.05 significance level, the ANOVA findings likewise showed a significant difference in residence satisfaction between public housing estates and PPP. Building a bridge between residents' preferences and their own should be a goal of developers in both the public and private housing sectors. To boost resident appreciation and satisfaction, it would be best if the drainage systems, waste management, and sewage disposal were improved. The survey's findings indicate that respondents' contentment and preference for inhabitants are incredibly high, high, and moderate.

Keywords: housing; public-private partnership; private housing; Abuja; Nigeria.

INTRODUCTION

Housing was considered crucial to one's health and well-being and a sign of personal fulfilment [18]. One of the three basic requirements of humanity is housing. Its effectiveness should align with both general user expectations and technological requirements. The role of the home in supplying human comfort through humans and the environment is crucial since it has a significant impact on people's lives as well as the lives of the country [28]. Making sure that particular housing or other necessities are fulfilled at a price or rent that does not subject people to excessive financial hardship is referred to as affordability in housing [39]. Housing is one of the three basic requirements of humanity. Its effectiveness should meet all general technical requirements and those set by users [39]. Residents' opinions of their surroundings and area impact how satisfied they are with their homes. The satisfaction of renters' basic housing needs is shown by the low degree of dissatisfaction and the high level of agreement between planned and actual circumstances [1]. Housing satisfaction is a

subjective assessment based on what a person perceives as the primary component of their current living situation [37].

Providing livable and satisfactory residential housing in terms of standards, quality, user needs, assumptions, and wishes is one of private and public real estate developers [25]. In developing nations like Nigeria, resident satisfaction remains a significant concern despite efforts from both corporate and state housing developers [26]. In the extended term, residents' satisfaction is related to a range of elements, including physical, social, and neighbourhood features, as well as psychological and socio-economic characteristics of the residents [7]. Maximizing citizens' well-being is the ultimate goal of a city's improvement [34].

Private involvement is necessary to control spatial growth connected to housing, especially in emerging nations like Nigeria. Maximizing citizens' well-being is the ultimate goal of a city's improvement [9]. To analyze and evaluate the significance and impact of investments in housing construction, inhabitants' preferences are necessary [3]. Housing preferences have been the subject of numerous studies because planners and other housing industry stakeholders are concerned about the influence of citizens. Authors [39] investigated housing provision and soldier housing preferences at Shadawanka Barrack in Bauchi to satisfy the housing needs of military soldiers in the research area. Data were gathered using a questionnaire instrument, a descriptive and exploratory research design, a quantitative technique, and a survey strategy. The barracks' overall or typical level of housing conditions was assessed as fair. In his work, [21] employed ordered probit analysis to investigate the relationship between some individual-related characteristics and the residential satisfaction of households. The main conclusions of this investigation indicate a complex relationship between house qualities, especially neighbourhood aspects, and residential satisfaction. Once housing and neighbourhood factors were considered, socio-demographic characteristics of individuals and households (including age, gender, and education) only had a minor impact. This study concentrated primarily on private estates. Authors [26] investigated how to deal with the difficulties of public-private partnerships (PPPs) for housing delivery in Nigeria; nevertheless, the author neglected to look at users' contentment and housing calibre. The quality of PPP housing, resident happiness and choice in FCT Abuja were not the focus of any of the studies above. As a result of the arguments above, there is a gap in the body of literature about the performance of residential properties offered by private and public-private partnerships in the Federal Capital Territory of Abuja. To suggest strategies to increase inhabitants' satisfaction and preferences in the FCT Abuja, this research compares residential properties offered by public-private partnerships and private developers. The following are the study's goals:

1. To evaluate residents' satisfaction with housing provision by the Public Private Partnership and Private Developer in FCT Abuja.

2. To investigate the significant areas of residents' preferences in housing provision by the Public Private Partnership and Private Developer in the study area.

3. To assess the differences in residents' satisfaction and preferences in housing provision by the Public Private Partnership and Private Developer in the study area.

Literature review

Concept of Housing. Housing can be viewed as an economic good, a social good, or a fundamental human right, and it is evident that it has a profound impact on every single person [8]. According to [11], the term "housing" has been interpreted variously by different professions. However, each definition places equal emphasis on the function of housing in providing security and comfort to its occupants. The economy of the person, the local community, and the country are all significantly impacted by housing investments. It often represents a person's first significant financial commitment and life goal [23]. Housing costs a substantial percentage of a family's or business's budget, yet in terms of private and public investment, the built environment is a person's most tangible material asset [36]. Housing is also a crucial component of human settlement that satisfies a fundamental need. It significantly impacts a person's quality of life, health, welfare, and productivity [6]. Housing is more than just a place to live or utilize domestic utilities; it also incorporates environmental features like waste management, water supply, road access, and the user's socio-cultural and behavioural traits [15]. To meet the basic and social needs of the population and to ensure safety, sol-

ace, and easiness for the users, the process of providing a significant number of residential buildings permanently with adequate physical infrastructure and social services in planned, decent, safe, and sanitary neighbourhoods is known as housing [2]. It is impossible to overstate how important housing is to man, particularly regarding psychological happiness and socio-economic well-being. Housing thus promotes modern existence and morality in addition to individuals' mental and bodily well-being [16].

Concept of Satisfaction. "The satisfaction one feels comes from having one's wants and desires met." In Rai's opinion, satisfaction can be categorized as either cognitive or affective. Based on what is received in comparison to expectations, the experience is evaluated [35]. Customer satisfaction and customer delight are commonly linked. Customers receive desirable value from the goods or services that give them satisfaction, at least to a certain amount. According to ISO 10004, customer judgment and opinion constitute satisfaction. The degree of satisfaction is defined as the discrepancy between the customer's impression of the supplied goods and their expectations.

Residential Satisfaction. Residential contentment is the feeling of well-being one experiences when their requirements or wants are satisfied at home. Several studies have investigated it, and the findings are recognized as a significant factor in determining a person's assessment of the quality of a home and an indicator of how well government and non-governmental housing programs are working [24]. The idea of residential pleasure has therefore changed throughout time. The notion of residential happiness has evolved in recent years to encompass the complete fulfilment of tenants' fundamental housing needs, including structural and physical defects, in addition to the delivery of necessary facilities, tools, and installations, as well as access to sources of income, to make the area a secure and comfortable location for human settlement [25].

Concept of Public Private Partnership. Public Private Partnership (PPP) is a strategy for delivering governmental services and projects in conjunction with the private sector [32]. PFI (Private Finance Initiative), which is where the idea of PPP started in the United Kingdom in the 1960s, may be summed up as the general idea and comprehension of responsibility, sharing guidelines between the public and private sectors. Public-Private Partnership was further defined by [32] as a relatively new idea that originated in the United Kingdom in the 1960s and involves carrying out public projects and services through "partnership arrangements with the private sector, particularly in the areas of facilities called PFI (Private Finance Initiative). PPP is described as a range of various contributions from both public and private arrangements. PPPs are a viable option for firms managed nearly exclusively by the public sector on one side of the spectrum to those controlled almost entirely by the private sector.

In Nigeria, PPPs have been used to increase the supply of urban housing whilst resolving difficulties with residential accessibility and affordability [14]. PPP is described by [20] as a group of joint ventures involving the public and private sectors. Private parties join the government to fund infrastructure in a public-private partnership (PPP). It describes a government program or for-profit enterprise that was created and is run as a result of an alliance between the government and one or more businesses from the private sector [4]. Public and private sector partnerships are essential to motivate the private sector to take a proactive role in tackling Nigeria's escalating urban housing issue. PPP is not the purchase of an item but rather the payment for a stream of services provided by rules and regulations. Public-Private Partnerships (PPPs), which take on various forms, are institutions where the private and public sectors share duties, benefits and risks in housing, infrastructure and service provision [14]. Urban infrastructure delivery through the private sector is anticipated to ease the financial strain on the public sector while assuring accountability, monitoring, and management [30]. The Public-Private Partnership (PPP) program was implemented in Nigeria to increase the supply of urban housing while solving housing accessibility and affordability [14].

Private Housing: Issues and Factors. Poor access to housing as barriers to land rights, high costs of building materials, planning restrictions and codes and issues with residential infrastructure are the main issues limiting the private sector's ability to provide housing [22]. The optimum way to enable private housing in Nigeria is by determining the dynamics of these issues and how they affect different kinds of private developers.

Access to finance. The private housing sector depends heavily on finance, and it faces severe challenges due to limited access to capital. Due to the country's deteriorating economic situation during the past one to two decades, over 70% of Nigerians are likely below the international poverty threshold [29]. The obvious consequence is that the self-help developers, responsible for most of the housing units in both urban and rural areas, have limited capacity. Additionally, this influential group of private housing developers typically lacks access to institutional financing and cannot obtain loans. Most funding for building homes comes from individual savings [5].

Building sites for residential development. In the process of developing dwellings, the land is crucial. However, it is difficult to obtain land for homes in Nigerian cities [27]. In many cities around the country, prospective homebuilders can find at least three land sources. The first is by buying construction sites from locations the government has already purchased. The potential developer often foots the bill for the crucial infrastructure the government supplies to these areas after negotiating the bureaucratic procedure of acquiring a Certificate of Occupancy. Traditional land holdings are a part of the second strategy. For instance, in conventional towns like Benin City, Ibadan, and Kano, the metropolitan areas are divided into quarters with chiefs or community heads appointed by traditional authorities. There may be land distribution committees in the quarters. The third includes purchasing land from individuals who have individual land pieces. These people are typically land speculators who buy property under the traditional land allocation process and then sell it for astronomical sums. It also includes the purchase or use of peri-urban land for homes, which helps explain suburban ad hoc unplanned communities. The city later starts to have these towns. The availability of land is frequently significantly impacted by this category. For instance, in the suburbs around Abuja, the federal capital, landowners provide 40% of the sources of land for small-scale house developers [38].

Planning and institutional issues. Planning regulations and building laws can restrict the nation's private sector's capacity to create housing [17]. Most Nigerian cities' building and planning regulations are derived from the Town and Country Planning Law documents. These laws were based on the Town Planning Act of 1959 and the Town and Country Ordinance of 1946. These were primarily constructed using planning methods used during British colonial rule. Even while the Urban and Regional Planning Law 1992, which went into effect around three years ago and has yet to have the expected result, reflects an attempt to harmonize planning regulations among cities, it has not yet had the anticipated effect.

Residential infrastructure development. Infrastructure for residential use can promote the construction and supply of dwellings. It not only raises property values, which attracts home builders to a location but also assures orderly growth, preventing unfavourable environmental conditions brought on by a lack of ecological infrastructure services. Many Nigerian cities have few environmental facilities, especially in the suburbs. Although town planning law outlines the procedure for developing infrastructure, they are frequently executed exclusively in government-acquired areas [13]. Potential plot purchasers in government-owned lands are obligated to cover the costs of extending the areas' roads, drains, and water supply. Before a Certificate of Occupancy is granted, this is paid as a planning rate. In the regions around Abuja, this category of residential land supply makes up roughly 20%, whereas traditional lands and private land supplies make up 80% [30].

The discussion above provides an introductory lesson: many migrant households are not committed to metropolitan life and may have plans to move back to their hometowns. As a result, many like constructing their first homes close to where they live. Many Nigerian homes may never make it to the city because it is an expensive lifetime investment, at least in terms of income.

METHODOLOGY

Quantitative research techniques were applied in this investigation. The Abuja @ 30 housing estates (PPP) with 300 housing units, out of which 227 questionnaires were retrieved, and Olugunloye (private), which contains 24 housing units, were the study's target populations. Of the 24 questionnaires that were distributed, 11 were returned. Therefore, all residents of the two Estates are included in the study's population. After careful data collection, the field data was analyzed using SPSS Version 22 using descriptive, mean ranking, and multiple linear regressions.

RESULTS AND DISCUSSION

In the Ministerial housing estate, respondents provided background data such as gender, age, household size, monthly income, and educational background. It was found that 63.6 % of the respondents were men and 36.4 % were women. This reveals that most people surveyed in the research region are male responders. The table shows that respondents under 30 make up 45.5 % of the total, and respondents between the ages of 31 and 60 make up 54.5 %.

Table 1 – Demographic information of respondents (Abuja @ 30 housing estate, PPP)

Variables	Options	Frequency	%
Gender	Male	132	58.1
	Female	95	41.9
Age	Under 30 years	24	10.6
	31 to 60 years	179	78.8
	Above 60 years	24	10.6
Household size	Below four people	101	44.5
	5 to 8 people	123	54.2
	9 to 12 people	2	0.9
	Above 13 people	1	0.4
Monthly income	Less than 50,000	23	10.1
	N51,000–100,000	23	10.1
	N101,000–150,000	69	30.5
	N151,000–200,000	55	24.2
	Above N20,000	57	25.1
Education qualification	Informal education	6	2.6
	Primary/Secondary	16	7
	Diploma/NCE	18	8
	Degree/HND	113	49.8
	Master's Degree and above	74	32.6

This indicates that the age range of most respondents in the study area is between 31 and 60. Table further showed that households with four or fewer members make up 9.1 % of all households, followed by those with five to eight members at 72.7 % and those with nine to twelve members at 18.2 %. This suggests that 5 to 8 persons make up the majority of households in the research area. Informal education makes up 9.1 % of the total education, with 9.1 % of respondents possessing a first leaving/secondary certificate, 18.2 % possessing a diploma/NCE, 45.5% possessing a first degree/HND certificate, and 18.2 % possessing a Master's degree or higher. This shows that degree/HND holders outweigh non-degree holders in the study region.

According to the table's depiction of the respondents' age distribution, 54.5% of respondents were aged 31 to 60, and 45.5% were under 30. This shows that respondents in the research region are primarily between the ages of 31 and 60.

Table 2 – Demographic information of Respondents (Olugunloye Housing Estate, Private Developer)

Variables	Options	Frequency	%
Gender	Male	7	63.6
	Female	4	36.4
Age	Under 30 years	5	45.5
	31 to 60 years	6	54.5
Household size	Below four people	1	9.1
	5 to 8 people	8	72.7
	9 to 12 people	2	18.2
Monthly income	Less than 50,000	1	9
	N51,000–100,000	4	36.4
	N101,000–150,000	3	27.3
	N151,000–200,000	3	27.3
Education qualification	Informal education	1	9.1
	Primary/Secondary	1	9.1
	Diploma/NCE	2	18.2
	Degree/HND	5	45.5
	Master's Degree and above	2	18.2

Table further showed that households with four or fewer members had a 9.1% rate, while those with 5 to 8 members had 72.7%, and those with 9 to 12 members had 18.2%. This demonstrates that most households in the study area have between 5 and 8 members. Informal education makes up 9.1% of respondents' educational backgrounds. Of those, 9.1% had their first leaving or secondary certificate, followed by 18.2% who had their diploma or NCE, 45.5% had their first degree or HND, and 18.2% had their master's degree or above. This shows that most people in the studied area have a degree or HND.

Text below describes and analyses the respondents' responses to questions about Abuja's residents' preferences and housing quality. A 5-point Likert scale was employed throughout the study, with several components having unique scale descriptors.

Research Question 1 – the level of Residents' Satisfaction with housing Provision by Public Private Partnership and Private Developer (Tables 3–4).

With mean scores of 4.08, 4.04, 4.01, 3.92 and standard deviations of 1.139, .859, .806 and .830, privacy, floor quality, window and wall conditions, respectively, ranked first, second, third,

and fourth in Table 3, while ventilation, toilets facilities, drainage system, and sewage disposal ranked eleventh, twelfth, thirteenth, and fourteenth, respectively.

Table 3 – level of Residents' Satisfaction in Abuja @ 30 Housing Estate (PPP)

Variables	Mean	Std. Deviation	Ranking	Remarks
Privacy	4.52	.796	1st	Extremely satisfied
Floor quality	4.19	.781	2nd	Very satisfied
Conditions of windows	4.17	.569	3rd	Very satisfied
Toilets facilities	4.16	.576	4th	Very satisfied
Roof	4.14	.603	5th	Very satisfied
Walls	4.10	.646	6th	Very satisfied
Doors	4.08	.661	7th	Very satisfied
Ceiling	3.87	1.284	8th	Very satisfied
Parking space	3.86	.739	9th	Very satisfied
Paintings of the walls	3.77	.892	10th	Very satisfied
Sewage disposal	3.55	.944	11th	Very satisfied
Drainage system	3.31	1.037	12th	Moderately satisfied
Ventilation	3.29	1.059	13th	Moderately satisfied
Waste management	3.19	.987	14th	Moderately satisfied

According to the rank ordering of the fourteen type constructs used to measure resident satisfaction with private housing developers, privacy, floor quality, window and wall conditions, and security received the highest rankings. Ventilation, restroom amenities, and privacy received the lowest orders. The sewage disposal and drainage system came in last. This result is in line with [16] study on the post-occupancy assessment of residential satisfaction in Lagos' Oniru Estate. Along with external visual quality, quality of maintenance, structural quality, quality of services, quality of estate roads, quality of the landscape and open spaces, environmental layout, and location, other factors are evaluated, including road accessibility, functionality, spatial efficacy and efficiency, aesthetics, safety, and confidentiality.

Table 4 – Level of Resident's Satisfaction in Olugunloye Housing Estate (Private Developer)

Variables	Mean	Std. Deviation	Ranking	Remarks
Privacy	4.08	1.139	1st	Very satisfied
Floor quality	4.04	.859	2nd	Very satisfied
Conditions of windows	4.01	.806	3rd	Very satisfied
Walls	3.92	.830	4th	Very satisfied
Parking space	3.75	.794	5th	Very satisfied
Roof	3.67	.868	6th	Very satisfied
Ceiling	3.65	1.167	7th	Very satisfied
Paintings of the walls	3.63	1.096	8th	Very satisfied
Doors	3.50	.933	9th	Very satisfied
Waste management	3.04	1.042	10th	Moderately satisfied
Ventilation	3.01	1.197	11th	Moderately satisfied
Toilets facilities	2.92	1.248	12th	Moderately satisfied
Drainage system	2.89	1.100	13th	Moderately satisfied
Sewage disposal	2.83	1.090	14th	Moderately satisfied

Table 4 showed that ventilation, sewage disposal, drainage system, and waste management were ranked 11-14th, respectively. In contrast, privacy, floor quality, conditions of windows, and walls were ranked first-fourth, respectively, with mean scores of 4.4203, 4.3188, 4.2174, and 4.2003 and standard deviations of .79346, .46944, .41549, and .40449. The fourteen type constructs on residents' preferences in the ministerial housing estate were ranked, and the results showed that privacy, floor quality, window and wall conditions, and ventilation received the highest rankings. In contrast, sewage disposal, drainage systems, and waste management received the lowest orders. The conclusions concur with [10]. The Changing Structure of Preferences and Housing-Related Attributes also show that residents favoured their privacy, a good waste disposal system, and appropriate ventilation.

Research Question 2 – Major Areas of Residents' Preference in housing Provision by Public Private Partnership and Private Developers (Table 5–6).

Table 5 – Major Areas of Residents' Preference in Abuja @ 30 Housing Estate (PPP)

Variables	Mean	Std. Deviation	Ranking	Remarks
Privacy	4.4026	.80097	1st	Highly preferred
Floor quality	4.2987	.45868	2nd	Highly preferred
Conditions of windows	4.1991	.40022	3rd	Preferred
Walls	4.1983	.40007	4th	Preferred
Doors	4.0998	.37683	5th	Preferred
Parking space	4.0996	.30007	6th	Preferred
Roof	4.0779	.56182	7th	Preferred
Ceiling	3.7922	1.08352	8th	Preferred
Paintings of the walls	3.7576	.79242	9th	Preferred
Toilets facilities	3.7143	.98498	10th	Preferred
Sewage disposal	3.2944	1.00862	11th	Moderately preferred
Ventilation	3.2597	1.01813	12th	Moderately preferred
Drainage system	3.1948	.98297	13th	Moderately preferred
Waste management	3.0048	.98007	14th	Moderately preferred

With mean scores of 4.3750, 4.3333, 4.2083, 4.2013 and standard deviations of .82423, .48154, .41485 and .41243, privacy, floor quality, conditions of windows, and walls were ranked first, second, third, and fourth respectively. According to Table 5, sewage disposal, ventilation, drainage system and waste management were ranked eleventh, twelve, thirteenth, and fourteenth, respectively. The ranking of the fourteen types of constructions on residents' preferences for private housing developers showed that the most significant orders were for privacy, floor quality, windows and wall conditions and privacy. While waste management, ventilation, drainage, and sewage disposal received the lowest rankings. This result is consistent with [12], which showed that residents of low-cost housing schemes typically favour homes with good floor qualities, good drainage systems, proper waste management, parking space and privacy.

Difference between Residents' Satisfaction and Residents' Preferences in the Housing Provision by Public Private Partnership (PPP) and Private Developer in the Study Area. According to Table 7, the test for homogeneity of variance found that all significant levels are above 0.05, indicating that the outcome is consistent across the two constructs.

Table 6 – Major Areas of Residents' Preference in Olugunloye Housing Estate (Private Developer)

Variables	Mean	Std. Deviation	Ranking	Remarks
Privacy	4.3750	.82423	1st	Highly preferred
Floor quality	4.3333	.48154	2nd	Highly preferred
Conditions of windows	4.2083	.41485	3rd	Preferred
Walls	4.2013	.41243	4th	Preferred
Doors	4.1982	.41135	5th	Preferred
Roof	4.1250	.53670	6th	Preferred
parking space	4.0833	.28233	7th	Preferred
Ceiling	3.7917	1.02062	8th	Preferred
Paintings of the walls	3.7197	.72106	9th	Preferred
Toilets facilities	3.7083	1.04170	10th	Preferred
Sewage disposal	3.2500	.98907	11th	Moderately preferred
Ventilation	3.2083	1.02062	12th	Moderately preferred
Drainage system	3.1667	.96309	13th	Moderately preferred
Waste management	3.0017	.96301	14th	Moderately preferred

Table 7 – Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Residents' satisfaction	2.849	2	319	.059
Residents Preferences	.060	2	321	.942

Table 7's significance of ANOVA reveals a significant difference between residents' preferences and resident satisfaction at 0.00, below 0.05.

Table 8 shows the degree of individual type comparison for private and PPP. There is no discernible difference between private and PPP housing options regarding resident preferences. Residents' satisfaction shows a substantial difference between private and PPP at 0.011, below the suggested 0.05.

According to the study's findings, respondents at the Olugunloye and Abuja @ 30 housing estates (private). The respondents said they were delighted with their living situation in the study locations.

Table 8 – ANOVA

Dependent Variable		Sum of Squares	Df	Mean Square	F	Sig.
Residents' satisfaction	Between Groups	4.889	2	2.445	7.797	.000
	Within Groups	100.017	319	.314		
	Total	104.906	321			
Residents Preferences	Between Groups	.061	2	.030	.109	.896
	Within Groups	88.990	321	.277		
	Total	89.051	323			

Table 9 – Tukey HSD Multiple Comparisons

Dependent Variable	(I) Type	(J) Type	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval
						Lower Bound
Residents' satisfaction	Private	PPP	-.22517*	.07770	.011	-.4081
	PPP	Private	.22517*	.07770	.011	.0422
	Private	PPP	.03292	.07224	.892	-.1372
Residents Preference	PPP	Private	-.03292	.07224	.892	-.2030

According to the survey, residents of Abuja @ 30 Housing Estate (PPP) and Olugunloye Housing Estate (private) favoured resident preference in the studied regions.

The difference in residents' tastes and satisfaction with the homes offered by the PPP and Private Developers in the study region was also determined using t-test analysis. According to the ANOVA results, there is a significant difference in residence satisfaction between PPP and public housing estates at 0.06 and 0.011, below the 0.05 level.

CONCLUSIONS

The study was conducted at a period when the need for shelter among humans has always been a problem for both those in need of housing and those in charge of building or planning it. It is well known that housing needs come in second to food in the hierarchy of human needs. According to the results of the poll, replies about resident satisfaction and preference are very high, high and moderate, respectively. The study showed no discernible difference between homeowners' preferences and their satisfaction with the homes offered by private and public developers in the study area.

The study makes the following recommendations to help improve residents' satisfaction and preferences in FCT Abuja in light of the findings and inferences from the study. Since waste management and drainage are essentially the least popular services in the two selected estates, it is urgently necessary for developers in public and private sectors to significantly enhance them. Developers should narrow the gap between resident preferences and those in public and private housing sectors.

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Testing the Validity of the Inflation-Unemployment Nexus within the West African Monetary Zone

Ubong Edem Effiong [1], **Ekomabasi Akpan** [1], **John Polycarp Ekpe** [2]

[1] *University of Uyo*
Ikpa Road, PMB 1017, Akwa Ibom State, Nigeria

[2] *University of Nigeria, Nsukka*
Nsukka Road, 410001, Nsukka, Enugu State, Nigeria

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Corresponding Author:
Ubong Edem Effiong
ubongeffiong3@gmail.com

Abstract. This study aimed to ascertain the validity of the Phillips Curve in six countries of Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone within the West African Monetary Zone (WAMZ). The study utilised panel data from these countries varying from 2000 to 2021, which were obtained from the World Bank database. The data were analysed using the Panel unit root test, Johansen Fisher Panel (JFP) co-integration test, Pairwise Dumitrescu Hurlin Panel (PDHP) Causality Tests, and the Panel Autoregressive Distributed Lag (ARDL) approach. The PDHP Causality Test revealed a one-way causality from unemployment to inflation; hence, unemployment causes inflation. The JFP co-integration test conducted since the variables were not all stationary at levels revealed that the two variables are cointegrated, which portrayed some degree of long-run relationship. The significant findings of this study, as presented by the panel ARDL result, indicated that the inverse relationship between inflation and unemployment is only valid in the short run within the WAMZ. This finding supports the argument that there is no trade-off between inflation and unemployment in the long run and the Phillips Curve is a vertical line at the natural unemployment rate.

Keywords: Phillips Curve; Natural Rate of Unemployment; Inflation; Monetary Policy; Labour Market.

INTRODUCTION

Government macroeconomic policies of any country are aimed at achieving economic stability. Among the objectives of such policies are the promotion of economic growth and the reduction of inflation and unemployment. Both inflation and unemployment rates should be maintained to a minimum, making financial management a top priority. However, trade-offs inevitably exist, particularly in the short run, making it impossible to simultaneously achieve targets to decrease inflation and unemployment rates [32]. The short-run link between unemployment and inflation is inverse, i.e., if unemployment is high, inflation will be low, and vice versa [32].

The two most significant issues facing many nations currently are inflation and unemployment [49]. These factors affect economic activities, including saving, investment, export, poverty, economic development, and so on [9, 50]. Such factors as persistently high inflation rates reduce people's living standards. In contrast, low inflation may result in lower economic growth rates, increasing poverty, reducing employment opportunities, and eventually leading to recession. If appropriately managed, inflation has been shown to benefit GDP, as noted by [9]. On the other hand, high unemployment rates have a ripple impact in many areas of society and the economy, including slowing growth, increased crime, and so on [49].

Historically, unemployment has been a problem throughout West Africa [39], particularly in the West African Monetary Zone (WAMZ). The West African Monetary Zone (WAMZ) is a group of six ECOWAS member countries founded in 2000. The Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone are all members. The organisation intended to launch a unified currency, the Eco, by 2015. Nigeria dominates the WAMZ, reflecting its role as Africa's largest oil producer and most populated country. Except for Guinea, all of the group's members are English-speaking. Since the early 2000, unemployment has reached crisis proportions, with millions of non-disabled peo-

ple unable to get work while being ready to accept salary rates at or below the market average [16] in the WAMZ. As argued by [39], policymakers in the West African bloc have long recognised unemployment as a significant threat to the region's economic growth. West Africa's monetary zone has seen serious inflation problems [19]. In most countries of the WAMZ, rising inflation has become more common than any other macroeconomic concept [16]. Low-income families lament the depreciation of their income since they cannot purchase as much as they formerly did.

Unemployment and inflation in the West Africa Monetary Zone (WAMZ) have risen to new heights due to the 2019 coronavirus pandemic [16] and the current Russia-Ukraine war that has disrupted global supply chains. As a result, achieving a middle ground between unemployment and inflation is a primary economic objective for all nations in the WAMZ. Authors [32] pointed out that all economics would benefit more from achieving price stability and full employment. Without peace, economic growth will be meaningless. According to [30], inflation and unemployment are essential economic growth and development drivers.

Although unavoidable in a market economy, inflation and unemployment have socioeconomic effects on the people who live in the nations where these processes occur. However, the primary issue is, "Does inflation cause unemployment, or are they unrelated?" This subject is becoming essential due to the observed pattern in inflation and unemployment movements among countries in the West African monetary zones, such as Nigeria, Gambia and Ghana.

Recent empirical researches have, in one way or another, refuted Phillips's posited trade-off between inflation and unemployment. For example, authors [29, 32, 49] discovered a positive relationship between inflation and unemployment in Indonesia. In contrast, authors [18, 26] found a significant negative relationship between inflation and unemployment rates in Nigeria. High inflation and high unemployment rates have been shown to coexist, particularly among countries in the WAMZ (such as Nigeria, Gambia, Ghana etc.), indicating a condition known as stagflation. Stagflation is the co-existence of low productivity or decreasing GDP with inflation. In other words, the economy is in a slump, yet inflation is on the rise.

In most countries in the WAMZ, unemployment has continued to rise at an alarming pace. The increase in the unemployment rate has paralleled the rise in inflation rates. For example, in 2019, the inflation rate in Nigeria climbed to 11.40%, with the unemployment rate increasing to 8.53%. In the Gambia, inflation went from 5.93% in 2020 to 7.12% in 2021, with the unemployment rate rising from 11.08% to 11.21%.

In Ghana, inflation rose from 7.14% in 2019 to 9.97% in 2021, while the unemployment rate rose from 4,32% in 2019 to 4.7% in 2021 [47], invalidating Philip's argument of the existence of a trade-off between inflation and unemployment. According to [16], like other WAMZ nations, the Nigerian economy is dealing with threatening inflation and a sluggish growth rate, with an astronomical unemployment rate. Authors [] concluded that the Nigerian economy is at a crossroads. Nonetheless, there are countervailing viewpoints presented by researchers such as [5], whose study validated the presence of Philip's Curve in Nigeria. The inconsistency between the conclusions of empirical research has prompted the need for more research on the topic.

It, therefore, becomes pertinent to explore the behaviour of the rate of inflation and the rate of unemployment in countries within the West African Monetary Zone (WAMZ). This behaviour is captured in Figure 1.

It can be observed from Figure 1 that the Gambia maintained a somewhat stable rate of unemployment up to 2018 before a slight upsurge set in. Meanwhile, the country's inflation rate has been a bit volatile over the years. Ghana exhibits a similar trend in inflation and unemployment as the country has been recording a continuous decline over the years, with some form of inflation rate oscillating. For Guinea, the inflation rate has been highly volatile, while the country experienced a stable unemployment rate below 8% over the years. Liberia has been experiencing a rising trend in the rate of inflation in recent years, going above 20%, while the rate of unemployment maintained a stable trend over the years. Although Nigeria's inflation rate has been highly volatile, the unemployment rate has been challenging up to 2017 before maintaining an upward trend. Finally, Sierra Leone experienced a steady rise in unemployment over the years, holding a single digit. The inflation rate in the country declined steadily up to 2014 before taking a sharply rising trend of double-digit and reaching its peak in 2017 before a deterioration set in.

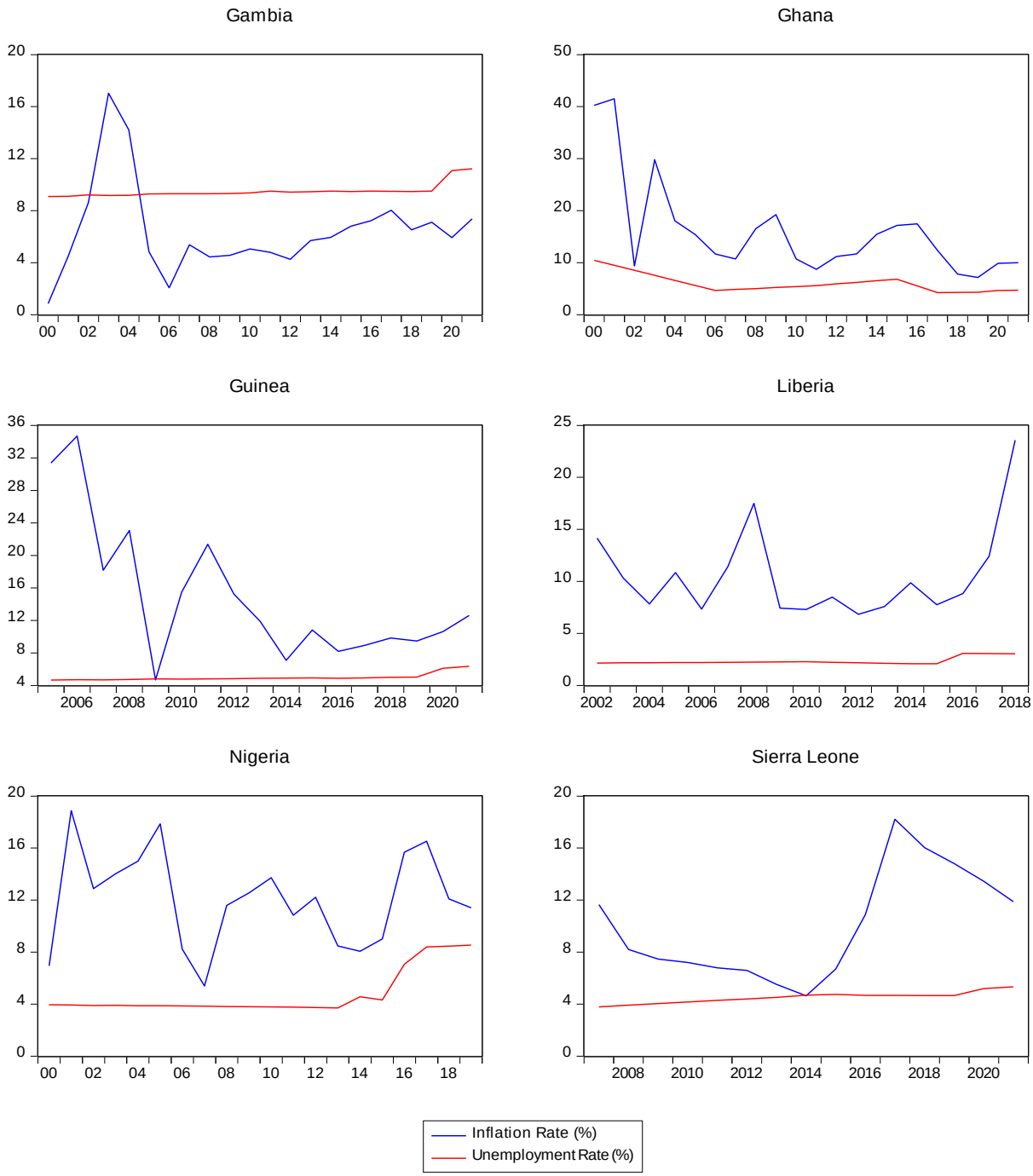

Figure 1 – Trend of Inflation and Unemployment for Countries within the WAMZ

Given the dynamics of inflation and unemployment within the WAMZ, could it be that a relationship exists between the two variables? In this regard, this study seeks to validate/invalidate the Phillips Curve postulations within the WAMZ. The study aims to ascertain an inverse relationship between the inflation rate and unemployment within the West African Monetary Zone. The study will explore whether the Phillips Curve is valid within the WAMZ in the short and long run. The paper utilises panel data of the six countries (Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone) for the period 2000 to 2021, which is analysed using the causality test, co-integration test, and the panel autoregressive distributed lag (PARL) approach of estimation.

Literature review

Theoretical Framework. As mentioned earlier, there are three dominant ideas on the causes of inflation proposed by three different schools of thought; the classical (Keynesian), the monetarist and the neoclassical.

The Philips Curve (The Keynesian / Classical Approach). The Phillips Curve, as propounded by

[41] in 1958, is the early or traditional incarnation of inflation theories constructed by plotting the United Kingdom's inflation rate against the unemployment rate from 1861-1957. Phillips discovered an inverse relationship (trade-off) between inflation and unemployment, i.e., when inflation is low, it automatically implies a high unemployment rate and vice versa. According to Solow and Samuelson, this relationship between inflation and unemployment is known as the Phillips Curve after carrying out the same experiment in the United States. The Phillips Curve quickly became an essential tool in macroeconomics and for policymakers as the curve illustrates that countries could choose between different combinations of unemployment and inflation that they find desirable on the Phillips Curve [1]. This implies that a country can achieve low inflation if it's willing to accept higher levels of unemployment and vice versa and is strictly static.

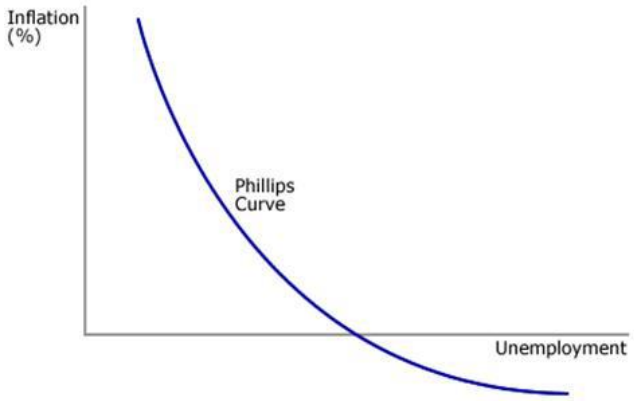

Figure 2 – Phillips Curve Showing the Trade-off between Inflation and Unemployment

However, the Phillips Curve met its shortcoming in the 1970 as the inflation-unemployment relationship broke down, and a new situation known as stagflation emerged when the United States and other countries experienced a simultaneous increase in inflation and unemployment, clearly contradicting the traditional Phillips Curve. During the 1970, "the inverse relationship between inflation and unemployment, however, broke apart, and most of the OECD member states observed stagflation which means high inflation as well as high unemployment" [39]. But although the Phillips Curve could not elucidate stagflation, a new relation between unemployment and inflation was revealed, viz. "the inverse relation of unemployment and changes in inflation" [39]. This bond was the basis for the modified Phillips Curve and is still binding and relevant for numerous developed countries.

The Monetarist Theory of Inflation. Milton Freidman and Edmund Phelps engendered the monetarist theory of inflation as a criticism of the classical approach. The authors believed that the classical system was based on static expectations of inflation among individuals; in reality, people's expectations are not fixed but rather dynamic as people tend to change their expectations about inflation over time. They named this dynamic behaviour of people's expectations 'the expectations-augmented Phillips Curve' and further introduced the concept of the natural rate of unemployment [1]. According to Edmund and Friedman, the natural rate of unemployment is the unemployment rate at which the actual inflation rate is equal to the expected inflation rate. It is the rate of unemployment required to keep the inflation rate constant. This is why the natural rate is also called the Non-Accelerating Inflation Rate of Unemployment (NAIRU) [1].

The Neo-Classical Theory. The Neo-classical theory introduced the term rational expectation to criticise the augmented-expectations idea of the monetarist school. They assert that inflation occurs due to people's reasonable expectations based on the information they have concerning the price of goods and services in the present and future [43]. For instance, if people expect the prices of commodities to increase in the future, they will opt to buy more items in the present, leading to their expectations becoming evident.

Empirical Review. Inflation and unemployment were two issues that [12] investigated in Ghana. The study's secondary objective was to use the updated Keynesian Philips Curve model to look for evidence of the Philips curve in annual time series data from Ghana, covering the years 1970 through 2013. To determine whether or not the Economic Recovery Programme affected the correlation between inflation and unemployment, the researcher split the data into two groups covering different periods (1970–1982 and 1983–2013). The data was analysed using OLS. According to the empirical estimate, there is no relationship between unemployment and inflation in either subsample time. The research also debunks the existence of a Philips curve in Ghana.

To determine whether the original Phillips Curve argument holds for Nigeria, authors [39] ana-

lysed the correlation between inflation and unemployment in the country. Using information collected from 1970 to 2011, the researchers used an ordinary least squares regression model. The findings show that unemployment is a significant factor in determining the inflation rate in Nigeria and that there is a positive correlation between the two variables. This study disproves the Phillips Curve hypothesis's fundamental premise in Nigeria. Therefore, the research suggests that Nigeria's government and monetary authorities diversify the economy and implement suitable measures to lower the threat of inflation and unemployment and alleviate the stagflation situation in Nigeria.

Authors [26] studied the relationship between inflation and unemployment in Nigeria between 1980 and 2015. The causality test, VECM and Johansen co-integration tests were used to analyse the time series data set. The study's findings indicate that inflation significantly impacted unemployment in Nigeria in the short and long run. The results further revealed that fiscal policy, like increasing government expenditure, reduces unemployment by creating employment and stabilising inflation.

Authors [29] investigated the Nigerian economy's asymmetry between unemployment and price expectation (Phillips Curve). The study found a positive relationship between unemployment and inflation, thus rejecting the presence of a Phillips Curve in the Nigerian economy.

Using the Generalised Method of Moments (GMM) technique to analyse the range from the first quarter of 1990 to the fourth quarter of 2012, the author [44] estimated a New Keynesian Phillips Curve model for the Nigerian economy. The study shows a negative relationship between inflation and unemployment, thus validating that the Phillips Curve holds in Nigeria.

Authors [13] looked at inflation and unemployment in Nigeria using the ARDL model approach. In their analysis, the study used annual time series data covering the period between 1977 and 2011. The result of the co-integration development indicates that there is a long-run relationship between the variables of inflation and unemployment in Nigeria. Their finding supports the applicability of the Philips curve hypothesis in Nigeria and, as such, contradicts the popular idea of the co-existence of unemployment and inflation in the country.

Also, the study of [17] empirically investigated the Non-Accelerating Inflation Rate of Unemployment (NAIRU) in Nigeria by using annual time series data from 1972-2015 and Ordinary Least Square (OLS) method for data analysis to ascertain if Phillips Curve postulates held in Nigeria. The study's findings discovered a negative but insignificant relationship between inflation and unemployment in the short run and the long run in Nigeria.

From 1980 to 2016, authors [28] investigated the presence and validity of the Phillips Curve in Nigeria. The study employed the Vector Autoregression model and Impulse Response Function on inflation and unemployment data. The results showed an inverse relationship between the variables in the period under investigation, thus validating the presence of the Phillips Curve in Nigeria.

Authors [45] examined Nigeria's relationship between unemployment and inflation from 1961-2015. The ARDL-bound testing approach was used to capture the study's short- and long-run relationship between inflation and unemployment. The result of the study reported a positive relationship between inflation and unemployment, thereby refuting the Phillips Curve proposition of an inflation-unemployment trade-off in Nigeria.

Furthermore, using quarterly data from the 1986-2016 period and adopting the Autoregressive Distribution Lag Model (ARDL), the study [8] showed a negative relationship between the variables both in the long and short -run.

Authors [24] investigated the nexus between unemployment, inflation, and economic growth in Nigeria using the OLS technique and the Johansen co-integration and the Granger causality tests to establish the long-run relationship and direction of causality. Empirical results refuted the presence of a Phillips Curve in Nigeria's data from 1986 to 2015.

Employing the Ordinary Least Square technique (OLS), the author [20] tested for the validation of the presence of the Phillips Curve in Nigeria using annual data for the 1986-2014 period. The study showed a significant negative relationship between inflation and unemployment, implying that the Phillips Curve holds in Nigeria.

The author [3] examined the inflation and unemployment trade-off (Phillips Curve) and its stability from 1980 to 2016 in Nigeria. The following

techniques were used for the study: The Autoregressive Distributed Lag (ARDL) bounds testing approach, Canonical Cointegrating Regression (CCR), Dynamic Ordinary Least Squares (DOLS), Fully Modified Ordinary Least Squares (FMOLS) and the Static Ordinary Least Squares (OLS). The study's findings showed a long-run relationship between inflation and unemployment and that the Phillips Curve hypothesis is fully validated.

Authors [31] explored Nigeria's trade-off amid inflation and unemployment using data from 1980 to 2018 by employing the OLS and ARDL approaches. The OLS and ARDL bounds testing results reported no trade-off between inflation and unemployment. However, the ARDL short-run and long-run effects validated the existence of a negative bond between inflation and unemployment, but such a bond was insignificant.

The works of [21] looked at the relationship between inflation and unemployment in Nigeria using data from 1981 to 2017 and the Fully Modified Least Square Regression (FMOLS) for analysing data. Empirical findings of the study showed that the Phillips Curve is applicable in the Nigerian case since a 1 % reduction in unemployment will be achieved if the economy sacrifices a 49 % increase in inflation and vice versa.

The author [2] examined the Phillips Curve hypothesis (inflation and unemployment trade-off) and its stability in Nigeria from 1980 to 2016 using the Autoregressive Distributed Lag (ARDL) bounds testing approach. Other estimation techniques, including the Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), Static Ordinary Least Squares (OLS), and Canonical Cointegrating Regression (CCR), was employed to ascertain the consistency and robustness of the results that were generated using the ARDL bounds testing method. The results of the co-integration test revealed the existence of a long-run relationship between inflation and unemployment. The results of the ARDL bounds testing, FMOLS, DOLS, static OLS and CCR estimations indicate a trade-off relationship between the variables, and higher unemployment leads to lower inflation in the long run. The plots of the cumulative sum of squares of recursive residuals (CUSUMQ) conform to the stability of the long-run parameters. The causality test results using the standard Granger causality test and the Toda and Yamamoto approach demonstrate unidirectional causality from inflation to unemployment.

Authors [18] examined Nigeria's validity of the Phillips Curve hypothesis. The study was based on quarterly data, using the following: Generalised Method of Moments (GMM), Canonical Cointegrating Regression (CCR), and the KPSS (Kwiatkowski–Phillips–Schmidt–Shin) test as techniques for data analysis. The findings of the result confirm the existence of a long-run relationship between inflation and unemployment, thus validating the Phillips Curve hypothesis in Nigeria.

The inflation and unemployment nexus in Indonesia were studied by [32] in 2020. This research sought to re-evaluate whether or not the Phillips hypothesis, as it was first formulated, was held in Indonesia between 1988 and 2017. Data were evaluated using an error correction model (ECM) to determine the short-term and long-term link between inflation and unemployment. According to the results, Indonesia has no trade-off between unemployment and inflation in the short run. Unemployment positively influences inflation, but the effect is not statistically significant. But unemployment has a negative and considerable impact on inflation over the long term, so there is a trade-off between the two: if unemployment rises, it will have the effect of lowering the rate of inflation, and if it declines, it will have the effect of raising the rate of inflation.

Authors [40] estimated Iran’s time-varying Non-Accelerating Inflation Rate of Unemployment (NAIRU) over the period 1986–2018 for constant NAIRU (HP filter) and time-varying NAIRU (using Kalman filter). "Results show that the NAIRU has been raised during the period. According to the econometric results, there is a structural unemployment gap in the long run, and the actual unemployment rate is approaching full employment". It shows that the high unemployment rate is linked to structural elements and cannot be reduced by applying monetary policies in the long run. Nevertheless, what these policies do in the short term is reduce the unemployment rate temporarily and, in the long run, increase inflation.

Authors [16] studied the Inflation-Unemployment Link and tested the Philips Curve Hypotheses using secondary data from the Central Bank of Nigeria and the World Bank. The study made use of Vector Autoregressive and Error Correction techniques. According to the find-

ings, inflation and unemployment in Nigeria were found to have no discernible link.

Authors [42] explored the inflation-unemployment dilemma for G7 countries. With the use of Granger, Granger-Wald and Johansen tests, the findings maintained the Phillips model in the short run, demonstrating an inverse link between the inflation rate and the unemployment rate in the G7 countries. Still, in the long run, the results indicated that a cointegrating relationship between inflation and unemployment could coexist, which permits the study to agree with the monetarist theories.

The literature examined for this study's purpose was explicitly based on the Nigerian economy. During the review, some studies revealed that the Phillips Curve hypothesis/theory holds in Nigeria [2, 8, 17, 18, 20, 21, 28, 3, 44, 13]. On the other hand, some studies' findings contradict the authors' studies listed above [24, 29, 45]. The present study will contribute to the existing works of literature in this domain by taking a deeper dive to test the Validity of the Inflation-Unemployment Nexus within the West African Monetary Zone. Most empirical studies were country-specific, regional and cross-sectional studies, but none focused on the West African Monetary Zone (WAMZ) as a whole. This study seeks to fill this gap by exploring the WAMZ's short-run and long-run inflation-unemployment nexus.

METHODOLOGY

The Model. Going by the Phillips Curve, our model is specified by [42] to capture the relationship between the inflation rate and unemployment rate within the WAMZ. The model is specified as follows:

$$INFR_{i,t} = f(UNMR_{i,t}) \quad (1)$$

Equation (1) states that the rate of inflation (INFR) in country *i* at time *t* is a function of the rate of unemployment (UNMR) in country *i* at time *t*. In equation (1), INFR is the rate of inflation (measured in percentages), UNMR is the unemployment rate (measured in percentages), *i* is the country (i = 1, 2, …, 6) comprising the six countries of Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone within the West African Monetary Zone (WAMZ), and *t* is the time.

In a form conformable to estimation, equation (1) is transformed as follows:

$$INFR_{i,t} = \xi_0 + \xi_1 UNMR_{i,t} + \nu_t \quad (2)$$

In which the variables are as earlier defined, is the constant, which is expected to be non-zero ($\xi_0 \neq 0$), is the slope coefficient of UNMR, which is expected to be negative ($\xi_1 < 0$) to align with the Phillips Curve postulation of an inverse relationship between the rate of inflation and the rate of unemployment ($^{\partial INFR}/_{\partial UNMP} < 0$), and is the error term which is assumed to be normally distributed.

Nature and Sources of Data. The data utilised in this study is a panel data set obtained from six cross-sections (Gambia, Ghana, Guinea, Liberia, Nigeria, Sierra Leone) spanning from 2000 through 2021. The dependent variable is the rate of inflation (INFR), while the independent variable is the rate of unemployment (UNMR). These two variables were obtained from the [47] database. The variables are both measured in percentages, with the unemployment rate being the consumer price index, and the unemployment rate is calculated based on the International Labour Organization (ILO) estimates.

Technique of Analysis. The technique of analysis so employed in the study is sequential in order. First, we ascertain the variables' unit root properties using the individual unit root test developed by [27] and the typical unit root test developed by [33]. Further, our analysis proceeds to ascertain the causal relationship between the rate of inflation and unemployment using the Pairwise Dumitrescu Hurlin Panel Causality Test. The test for co-integration is conducted using the Johansen Fisher Panel Cointegration Test. At the same time, we estimate both the short-run and long-run effects of unemployment on inflation. We utilise the panel autoregressive distributed lag (PARDL) and error correction Models. This approach aids in the estimation of both the short-run and long-run estimates of the model at the same time and with ease.

Causality Test. The causality test is conducted using the Pairwise Dumitrescu Hurlin Panel Causality Test. The test captures the direction of the

causal relationship between the two variables of interest: inflation and unemployment. The test offers a comprehensive test designed to spot causality in panel data [34]. The test equation is specified as follows:

$$\begin{cases} INFR_{i,t} = \emptyset_{1i} + \sum_{k=1}^{k} \beta_{i,k} INFR_{i,t-k} + \sum_{k=1}^{k} \gamma_{i,k} UNMR_{i,t-k} + \varepsilon_{1t} \\ UNMR_{i,t} = \emptyset_{2i} + \sum_{j=1}^{j} \beta_{i,j} INFR_{i,t-j} + \sum_{j=1}^{j} \gamma_{i,j} UNMR_{i,t-j} + \varepsilon_{2t} \end{cases} \quad (4)$$

The lag order, k and j, are assumed to be identical (*k=j*) for all individuals, and the panel must be balanced [34]. The null hypothesis is defined as:

$$\begin{cases} H_0: \gamma_{i,1} = \gamma_{i,2} = \cdots = \gamma_{i,k} = 0 & \forall_i = 1, 2, \dots, N \\ H_0: \gamma_{i,1} = \gamma_{i,2} = \cdots \gamma_{i,j} = 0 & \forall_i = 1, 2, \dots, N \end{cases}$$

Which in reality posits the absence of causality. The alternative hypothesis is given as follows:

$$\begin{cases} H_a: \gamma_{i,1} \neq \gamma_{i,2} \neq \cdots \neq \gamma_{i,k} \neq 0 & \forall_i = 1, 2, \dots, N_1 \\ \gamma_{i,1} \neq 0 \; or \dots or \; \gamma_{i,k} \neq 0 & \forall_i = N_1 + 1, \dots, N \end{cases}$$

And

$$\begin{cases} H_a: \gamma_{i,1} \neq \gamma_{i,2} \neq \cdots \gamma_{i,j} \neq 0 & \forall_i = 1, 2, \dots, N \\ \gamma_{i,1} \neq 0 \; or \dots or \; \gamma_{i,j} \neq 0 & \forall_i = N_1 + 1, \dots, N \end{cases}$$

where $N_1 \in [0, N-1]$ is not known. If $N_1 = 0$, causality exists for all individuals in the panel.

Thus, INFR homogeneously causes UNMR (or UNMR homogenously causes INFR). It should be noted that N_1 < N. Otherwise there is no causality for all individuals, and H_a reduces to H_0. Consequently, INFR does not homogeneously cause UNMR (or UNMR does not homogeneously cause INFR). Thus, we can have a case of unidirectional causality, bidirectional causality, or no causality at all within the panel. In general, the test generates W-Statistic and Zbar-Statistic, of which the significance of these statistics at the 5% level signifies the presence of causality in the panel.

Panel Unit Root Test. The panel unit root test for both the individual and common unit root is conducted to detect the time series properties of the WAMZ's inflation rate and unemployment rate. The test equation is specified as follows:

$$\begin{cases} \Delta INFR_{i,t} = \alpha_i + \beta_i INFR_{i,t-1} + \sum_{j=1}^{k} \gamma_{ij} \Delta INFR_{i,t-j} + \delta_i t + \varepsilon_{1t} \\ \Delta UNMR_{i,t} = \alpha_i + \beta_i UNMR_{i,t-1} + \sum_{j=1}^{k} \gamma_{ij} \Delta UNMR_{i,t-j} + \delta_i t + \varepsilon_{2t} \end{cases} \quad (5)$$

Equation (3) captures the model for the unit root test, with the upper segment capturing the test equation for the inflation rate and the lower segment capturing the test equation for the unemployment rate. Where Δ is the first difference operator, ε_{1t} *and* ε_{2t} are the disturbance term (which is assumed to be white-noise), *i* = 1, 2, 3, …, N indexes country, *t* = 1, 2, 3, …, T indexes time, and k is the number of lags which is often detected using the Akaike Information Criterion (AIC), Schwarz-Bayesian Criterion (SBIC) or Hannan and Quinn Information criteria (HQIC). The null hypothesis (H_0) and alternative hypothesis (H_a) for the stationarity of the panel data set from Equation (3) are given as:

$$\begin{cases} H_0: \beta_i = 1 \\ H_a: \beta_i < 1 \end{cases}$$

The decision rule is that for the null hypothesis to be rejected, the W-Statistic (for individual unit root test) and the t* Statistic (for the common unit root test) must be signed at the 5% level as reported by the p-values.

Test for Co-integration. Since our interest also centres on determining a long-run relationship between the rate of inflation and unemployment, the test for co-integration is of paramount interest. This is done using the Johansen Fisher Panel Co-integration test, which utilises the Trace and Max-Eigen Statistic. For co-integration to exist, the test result must report at least one co-integrating equation in the Trace Statistic and Max-Eigen Statistic at the 5% level.

Panel Autoregressive Distributed Lag Vector Error Correction Mechanism. Using the Panel Autoregressive Distributed Lag (PARDL) approach aids in estimating both the short-run dynamics and the long-run estimates. Also, it provides a medium through the error correction term where we can detect the speed of adjustment of the short-run distortions for equilibrium to be achieved in the long run. The model to be estimated in this regard is specified as follows:

$$\Delta INFR_{i,t} = \theta_{i,j} + \sum_{k=0}^{n} \beta_i \Delta INFR_{i,t-k} + \sum_{j=0}^{m} \sigma_j \Delta UNMR_{i,t-j} + \lambda ECM_{t-1} + \epsilon_{i,t} \quad (6)$$

Equation (6) is the specified ARDL error correction model, and the variables are as earlier defined. The component ECM captures the Error Correction Mechanism, and λ is the error correction term which captures the speed of adjustment of the model to long-run equilibrium. For such correction to occur, λ must be negative ($\lambda < 0$) and statistically significant at the 5% level.

RESULTS AND DISCUSSION

Descriptive Measures. The exploration of the descriptive properties of the is portrayed in Table 1, where reflections are made on the inflation and unemployment rates.

Table 1 – Descriptive Properties of Unemployment and Inflation Rate

	Inflation Rate (%)	Unemployment Rate (%)
Mean	11.6692	5.5628
Median	10.3303	4.7730
Maximum	41.5095	11.2120
Minimum	0.8450	2.0800
Standard Deviation	6.9178	2.4878
Skewness	2.0100	0.5967
Kurtosis	8.3760	2.1983
Jarque-Bera	212.1647	9.7328
Probability	0.0000	0.0077
Observations	113	113

It is clear from Table 1 that the rate of inflation within the WAMZ averaged 11.67% with a standard deviation of 6.92%. The distribution exhibits positive skewness given the skewness coefficient of +2.01, implying that the distribution has an elongated tail to the right. The distribution is leptokurtic, given the coefficient of kurtosis of 8.376, which is greater than 3. The maximum inflation rate within the WAMZ was 41.51%, while the minimum rate was 0.845%. The distribution is not normally distributed since the Jarque-Bera statistic of 212.1647 is statistically significant at the 1% level. In the same vein, unemployment within the region averaged 5.56% with a standard deviation of 2.49%. The minimum and maximum values of the variables were 2.08% and 11.21%, respectively. The distribution is positively skewed given that the coefficient of skewness is +0.5967 and is also platykurtic as the coefficient of kurtosis (2.1983) is less than 3. Also, the distribution is not normally distributed given the significance of the Jarque-Bera statistic at the 5% significance level.

Correlation Analysis. The correlation result presented in Table 2 captures the nature of the covariability between the rate of inflation and the rate of unemployment within the WAMZ.

Table 2 – Correlation Result

No	Country	Correlation Coefficient
1	The Gambia	-0.0068
2	Ghana	0.7968
3	Guinea	-0.3043
4	Liberia	0.4619
5	Nigeria	0.2084
6	Sierra Leone	0.3287
Overall	WAMZ	-0.0361

The correlation result obtained in Table 2 portrays that the correlation between unemployment and inflation is negative in Gambia and Guinea, implying that as unemployment increases in these countries, the inflation rate declines. Meanwhile, such correlation is weak, as captured by their respective correlation coefficient of -0.0068 and -0.3043. The correlation coefficients were negative for Ghana, Liberia, Nigeria, and Sierra Leone. However, only Ghana exhibited a strong positive correlation between inflation and unemployment, given the correlation coefficient of +0.7968. This implies that for these countries, the rate of inflation and unemployment were moving in the same direction. Overall, the correlation between inflation and unemployment within the WAMZ is weak and damaging, as the correlation coefficient is reported to be -0.0361. This means that within the WAMZ, inflation and unemployment move in the opposite direction. Figure 3 captures the scatter plots for the six countries within the WAMZ.

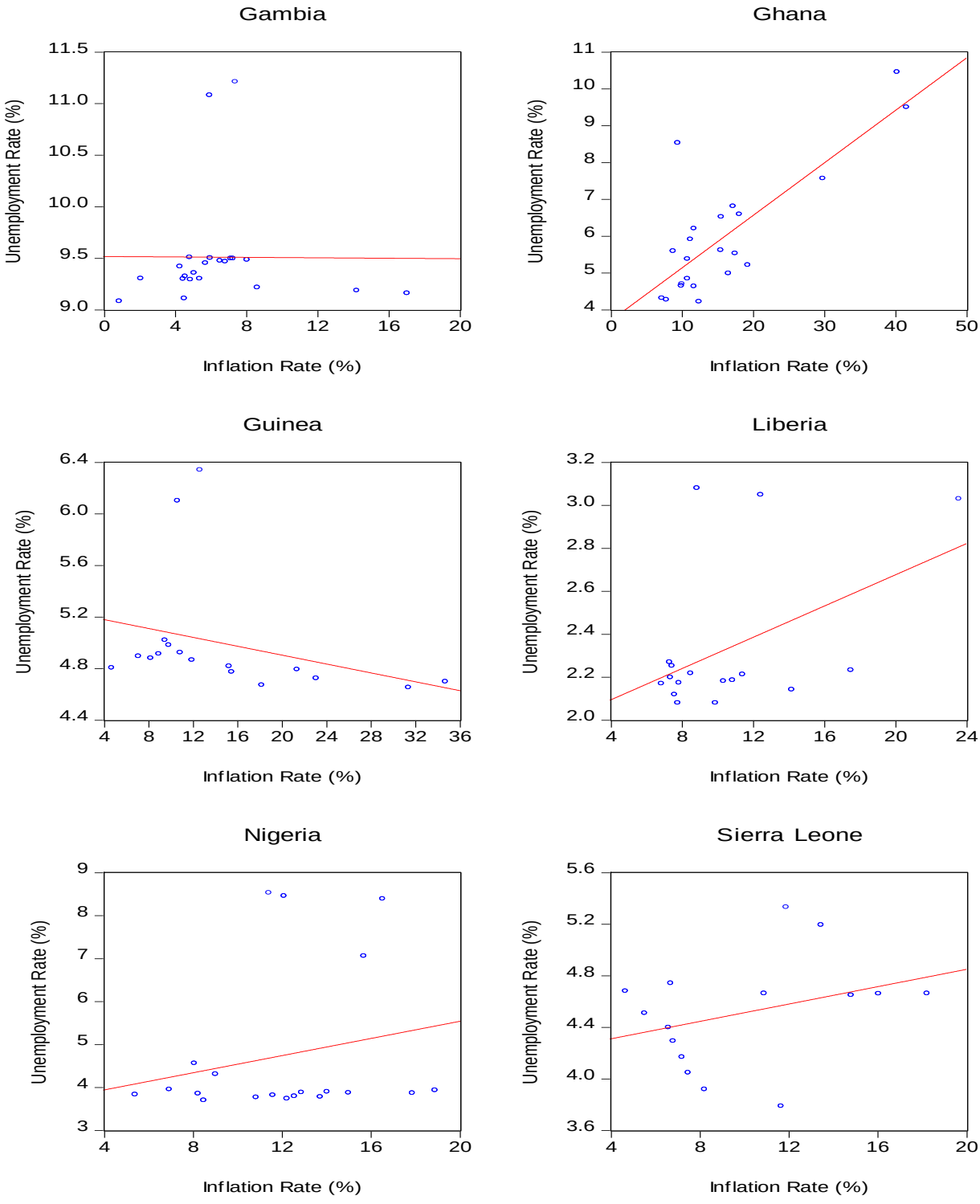

Figure 3 –Scatter Diagram for the Unemployment-Inflation Relationship within the WAMZ

Granger Causality Test. The Granger Causality test unveils the causal relationship concerning the rate of inflation and unemployment within the WAMZ. Table 3 reflects on the empirical result obtained.

Table 3 – Pairwise Dumitrescu Hurlin Panel Causality Tests Result

Null Hypothesis:	W-Stat.	Zbar-Statistic	Probability	Decision
UNMR does not Homogeneously cause INFR	5.5903	2.4887	0.0128**	Reject
INFR does not Homogeneously cause UNMR	1.0950	-1.0636	0.2875	Accept

Notes: ** denotes significance at the 5% level

With the W-statistic of 5.5903 and Zbar-Statistic of 2.4887, which are significant at the 5% level given the p-value of 0.0128, the null hypothesis that unemployment does not homogenously causes inflation is rejected. Consequently, unemployment causes inflation and inflation do not cause unemployment, as reflected in the acceptance of the second null hypothesis. The implication is that a unidirectional causality flows from unemployment to inflation within the WAMZ.

Unit Root Test. To detect the time series properties of the data, Table 4 captures the variables' individual and standard unit root test results.

Table 4 – Panel Unit Root Test Result

	Individual Unit Root Test (Im, Pesaran and Shin) W-stat		Common Unit Root Test (Levin, Lin & Chu) t* Statistic	
Variables	I(0)	I(1)	I(0)	I(1)
UNMR	-2.3528 (0.0093)**		1.4166 (0.9217)	-4.7053 (0.0000)***
INFR	-0.5312 (0.2976)	-6.8156 (0.0000)***	0.3213 (0.6260)	-6.8358 (0.0000)***

Notes: ** and *** denotes significance at the 5% and 1% respectively

Table 4 reflects that while the unemployment rate is stationary at the level of the individual unit root test reported by [24] W-Statistic, the variable only becomes fixed at the first difference under the standard unit root test reported by [33] t* statistic. On the other hand, the inflation rate at both the individual and standard unit root tests is stationary at first.

Co-integration Test. Because the variables are stationary at the level and first difference, it is pertinent to ascertain whether the variables exhibit any form of long-run relationship (co-integration). The Johansen Fisher panel co-integration test is conducted in that regard, and the result is presented in Table 5.

Table 5 – Johansen Fisher Panel Co-integration Test Result

Hypothesized No. of CE(s)	Fisher Statistic (from Trace test)	Probability	Fisher Statistic (from Max-Eigen test)	Probability
None	47.53	0.0000***	42.33	0.0000***
At most 1	22.62	0.0311**	22.62	0.0311**

Notes: ** and *** denote significance at 5% and 1%, respectively

As can be observed in Table 5, both the Fisher Statistic (from Trace tests) and the Fisher Statistic (from Max-Eigen test) are statistically significant. The result, therefore, reports the existence of two co-integrating equations (CEs); hence, co-integration exists, and a long-run relationship exists between inflation and unemployment within the WAMZ.

Panel Autoregressive Distributed Lag Model Result. For the existence of co-integration, it is, therefore, imperative to estimate both the short-run and long-run estimates of the model. Table 6 captures the result, calculated using the panel autoregressive distributed lag (PARDL) approach following one lag.

Table 6 – Short-Run and Long-Run Results

Variable	Coefficient	Std. Error	t-Statistic	Probability
Long Run Equation				
UNMR	3.6482	0.6456	5.6508	0.0000***
Short Run Equation				
ECM(-1)	-0.5997	0.1733	-3.4602	0.0008***
D(UNMR)	-3.3975	1.0964	-3.0987	0.0026**
C	-3.7569	2.0874	-1.7998	0.0751*

Notes: *, ** and *** denotes significance at 10%, 5% and 1% respectively

In the short run, it is observed that unemployment has a negative and significant effect on inflation, which validates the Phillips Curve argument of an inverse relationship between inflation and unemployment. It is clear from the short-run coefficient that a 1% change in unemployment will cause inflation to change in the opposite direction by 3.3975% on average. This validity of the Phillips Curve aligns with the findings of [38, 22, 14, 48, 36, 23, 37, 30, 15, 6, 20, 18, 42, 7]. The error correction term indicates that 59.97% of the short-run errors in inflation are corrected yearly to attain long-run equilibrium. It, therefore, requires about one year and seven months for equilibrium to be fully established in the long run.

In the long run, the Phillips Curve argument does not hold since our result reveals that unemployment positively and significantly affects the inflation rate. This aligns with the criticisms of the original Phillips Curve, where it has been asserted that the trade-off between inflation and unemployment is only valid in the short run. There is no trade-off between inflation and unemployment in the long run, and the Phillips Curve is perfectly inelastic at the natural unemployment rate. It, therefore, follows that any policy put forth to reduce unemployment will instead increase the price level. Upon our result, a 1% increase in unemployment will cause inflation to rise by 3.6482% within the WAMZ. This no trade-off between inflation and unemployment aligns with the findings [11, 39, 12, 29, 35, 32, 46, 4].

Cross-Section Short-Run Coefficients. Going by the country level, Table 7 captures the validity of the Phillips Curve in the different countries within the WAMZ in the short run.

Table 7 – Short-Run Country-Specific Estimates

No	Country	Coefficient	Probability
1	The Gambia	-2.8048	0.5009
2	Ghana	-4.2528	0.4515
3	Guinea	-2.7953	0.9457
4	Liberia	-3.9539	0.8200
5	Nigeria	0.8514	0.7946
6	Sierra Leone	-7.4294	0.7140

In the short run, it is noted that none of the countries within the WAMZ exhibited a significant effect of unemployment on inflation. Meanwhile, the coefficient sign, which captures the Phillips Curve's validity, is valid for some countries (Gambia, Ghana, Guinea, Liberia, and Sierra Leone) while not for Nigeria. This can be due to the rising trend of inflation and unemployment in Nigeria, as seen earlier in Figure 1.

Long-Run Cross-Section Coefficients. We also explore the long-run estimates to capture the Phillips Curve's validity in the WAMZ countries. Table 8 captures the result so obtained.

Table 8 – Long-Run Country-Specific Estimates

No	Country	Coefficient	R^2
1	The Gambia	-0.4673 (0.7949)	0.0053
2	Ghana	3.9059 (0.0000)***	0.4818
3	Guinea	5.2396 (0.2984)	0.0545
4	Liberia	8.0827 (0.0045)**	0.2366
5	Nigeria	0.2289 (0.6706)	0.0293
6	Sierra Leone	6.45738 (0.1473)	0.1378

Notes: ** and *** denotes significance at 5% and 1% respectively

In the long run, our result revealed that the Phillips Curve is still valid in the Gambia though such is not significant. This is portrayed by the weak explanatory power of the model given the R^2 of 0.0053, which implies that the unemployment rate account for only 0.53% of the total variation in the rate of inflation in the Gambia. For Ghana and Liberia, the Phillips Curve is no longer valid in the long run as the rate of unemployment put forth a positive and significant effect on the rate of inflation in the two countries. Consequently, a 1% increase in unemployment leads to a 3.9059% and 8.0827% increase in the rate of inflation in Ghana and Liberia, respectively. For Guinea, Nigeria and Sierra Leone, the Phillips Curve is not valid in the long run as the rate of unemployment put forth a positive but insignificant long-run effect on the inflation rate.

CONCLUSIONS

The notion of the Phillips Curve has been centred on the inverse relationship between inflation and unemployment. Criticisms of this argument introduced the concept of the natural unemploy-

ment rate to argue that there is no trade-off between inflation and unemployment in the long run and that the Phillips Curve is vertical at the natural unemployment rate. This framework explored the validity of the Phillips Curve within the West African Monetary Zone (WAMZ) comprising Gambia, Ghana, Guinea, Liberia, Nigeria, and Sierra Leone. The study utilised the panel ARDL approach, where we examined both the short-run and long-run effects of unemployment on inflation. The Johansen-Fisher panel cointegration result revealed a long-run relationship between inflation and unemployment. The ARDL result reported that the Phillips Curve is only valid in the short run within the WAMZ, which showed a negative and significant effect of unemployment on inflation in the short run. But unemployment and inflation have a positive and significant impact in the long run, pointing out that the Phillips Curve is not valid within the WAMZ.

Considering a country-specific analysis, all the countries except Nigeria reported a negative effect of unemployment in the rate of inflation in the short run, which validates the Phillips Curve postulation. Meanwhile, such a damaging effect was reported to be insignificant. In the long run, only Gambia said a negative impact of unemployment on inflation, pointing to the validity of the Phillips Curve in the country even in the long run. Other countries within the WAMZ (Ghana, Guinea, Liberia, and Sierra Leone) reported a positive effect of unemployment on inflation in the long run, therefore stating that the Phillips Curve argument is not valid in these countries' run.

This paper, therefore, concludes that the Phillips Curve argument within the WAMZ is only valid in the short run. However, country-specific results may differ due to structural issues that may cause differences among countries in the zone. Consequently, an expansionary monetary policy aimed at reducing the zone's unemployment will likely result in a higher level of inflation due to the increase in the money supply. The policy action that should be taken to reduce unemployment without increasing the rate of inflation could be related to the resting place of the money supply that may result from an easy monetary policy. Instead of boosting social assistance through unemployment insurance, that money may enhance labour market job prospects. While the former may increase unemployment and even its duration since people are unmotivated to seek work, the latter may strengthen the rate of employment.

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Post-Occupancy Evaluation of Architecture Design Studio Facilities of Abubakar Tafawa Balewa University Bauchi

Chunyi Dibi [1], Bukar Wakawa [1], Bala Ishiyaku [1], Kalu Joseph Ufere [1]

[1] *Abubakar Tafawa Balewa University*
Dass road, P. M. B. 0248, Bauchi, Nigeria

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Corresponding Author:
Chunyi Dibi
chunyidibi@gmail.com

Abstract. Architecture design studios are becoming significant resources for students to gain applied and theoretical knowledge that can be transformed with creativity into design solutions. The study is a post-occupancy evaluation of the Architectural design studio of Abubakar Tafawa Balewa University Bauchi to identify the descriptive levels of the study's variables using mean and ranking. A total number of 377 questionnaires were administered. The data collected were analyzed, and the findings revealed that facilities were provided, with visual comfort more adequate than all other components, and respondents derived most satisfied with it. A significant recommendation for further studies is to determine the inferential value to establish a statistical effect among variables.

Keywords: post occupancy evaluation; architecture design studio facilities, ATBU Bauchi; Nigeria.

INTRODUCTION

Architecture design studios are becoming significant resources for students to gain applied and theoretical knowledge that could be transformed with creativity into design solutions [17]. Likewise, they also serve as a resource for developing and upgrading the level of practical knowledge, primarily computer-based drafting among programs like architecture, architectural engineering, and planning. Institutions worldwide have become progressively more conscious of assessing their educational facilities for architectural design.

Recently, several studies have focused on exploring the role of the architectural design studio to prove its value as a significant resource to academic institutions. And as a result, several schools of architecture or the built environment are endeavouring now on means to education and different lifestyles needs of their students [5]. Previous studies on the performance appraisal of educational facilities have indicated that the comfort of architectural design space is a significant aspect to be considered and maintained for the success of the architectural education process [5]. As such, an academic institution aims to provide design studio spaces that are comfortable and conducive to collaborative learning. The core of the architecture curriculum has always been based on the design studio model, which focuses on education by doing, and all processes and procedures of problem-solving are transmitted through lecture and critique sessions [11].

Architectural graphics and design courses are introductory courses in architectural education [5]. The design studio in architectural education is one of the renowned and most commonly used spaces for developing, evaluating and exhibiting a collection of art and design works [5]. Its environment serves as a learning centre and a multifactor social setting. Students enrolled in design courses usually work in these spaces during their free time and schedule class hours [4]. Author [15] described the studio as "a physical space as a site for teaching and learning experiences, and to interactive culture between the

student and staff developed within this physical space ". It is also a combination of home and workplace [3].

The architecture studio facility can be seen as a system carrying a lot of oxygenated and deoxygenated blood for the student architect. This means that it gives life to the work of the student architect. Therefore it should be equipped with state-of-the-art facilities that make it very inviting and accommodating at all times [6]. The Architecture student then becomes easily attached both emotionally and physically to the studio and so connects with abstract ideas, transferring such ideas into designs, models, projects, auto-cad, e.t.c with the help of digital tools and physics, putting such ideas into a capital construction that would have been inconceivable twenty years ago [12].

An ideal architecture studio is a hot desk situation where anyone can sit anywhere and move desks as they please. In other words, it must be flexible and well-structured, where students are given options with some order [2]. All studios have drawing boards, storage, and high-speed wireless broadband for students to access with their laptops [6]. Little research on performance appraisal of education facilities indicates the provisions of facilities and their adequacy as an architecture education process [10]. While the studio environment has been painted as an ideal education setting [1, 12], few studies touch on the physical environment of the studio and the associated social dynamics that result from the point of view of architecture students [1].

Post occupancy evaluation. Post Occupancy Evaluation studies can be seen as a process of determining and tackling problems that were not detected at the design stage, ignored during construction but observed when the facility is in occupation [8]. Thus it is a process that is concerned with increasing environmental performance. According to [7], post-occupancy evaluation is an efficient and practical means of building evaluation where the construction is completed, and the occupancy process is in progress. The approach, therefore, hubs on the building occupants and their needs in light of the design decisions made in the past and viewing the resulting performance of such a building or facility [13]. Post occupancy evaluation approach has been considered a helpful tool with which designers scrutinize the built environment and learn from their own experience. The post-occupancy evaluation approach combines research and design, providing a knowledge base for plans [2].

The purpose of the study is to evaluate the architectural design studio facilities provided, facilities adequacy, and students' satisfaction to identify the descriptive levels of the study's variables.

METHODOLOGY

The study employed a descriptive survey using a well-structured questionnaire on a five-point rating scale, administered to 377 users of the architectural design studio of ATBU Bauchi randomly selected. The data collected were analyzed using descriptive statistics (mean and ranking).

RESULTS AND DISCUSSION

Demographic Characteristics show in Figure 1–2.

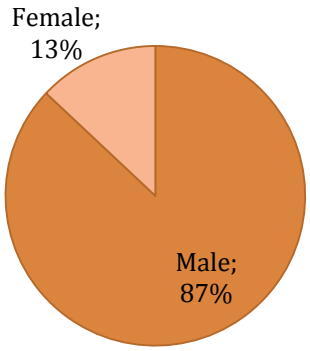

Figure 1 – Respondents' Gender Distribution

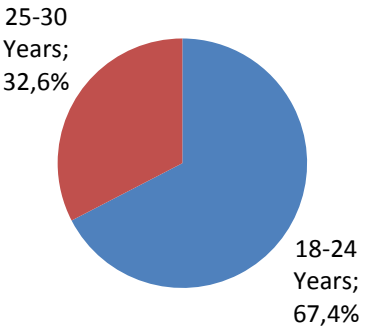

Figure 2 – Respondents' Age Distribution

The gender distribution of the respondents shows that 87 % are male while 13 % of the respondents are female. Thus, most of the students are male.

The age range of the respondents indicates that more than half (67.4 %) are within 18-24 years, and the remaining 32.6 % fall within the margin of 25-30 years.

Major Types of Facilities Provided at the Architecture Design Studio of ATBU, Bauchi. Table 1 shows the different types of facilities, numbering eight. The visible light with a mean score of 4.45 was ranked first, while fire safety ranked sixth had a mean score of 3.25.

Table 1 – Descriptive statistics for major types of facilities provided

Facilities provided	Mean	Standard Deviation	Remarks
Visual light	4.45	.705	1
Thermal comfort	3.86	1.105	2
Acoustic comfort	3.67	1.218	3
Interior finishes	3.48	1.061	4
Brainstorming space	3.27	1.248	5
Fire safety	3.25	1.184	6
Cubicle layout	3.18	.985	7
Building support services	3.15	1.319	8

The observation made under visual (lighting) comfort in this study agrees with the study of [9], which indicated that the provision of a suitable lighting level could positively impact the health and performance of occupants. Authors [14, 16] show that a well-designed ventilation system in space provides quality indoor air, which improves the performance and productivity of the occupants, which hitherto agrees with the observations made about thermal (heat) comfort. Acoustic comfort was observed to be poor as sound or noise quickly travels in and out of the studio.

Level of Adequacy of Facilities Provided in the Study Area. Table 2 shows the indicators involved in measuring the adequacy of facilities provided in the studio. The mean values are obtained along with standard deviation and remarks. The findings revealed that visual (light) comfort ranked highest, with a mean score of 4.21. Thermal (heat) comfort was adequately provided as its mean score was 3.54 and ranked second. Acoustic (sound) comfort, fire safety, interior finishes, and cubicle layout mean scores of 3.36, 3.27, 3.53, and 3.17, respectively. Also, brainstorming space (3.12) and building support services (2.96) both have mean scores above the minimum adequacy index of 1.50 as compared to the work of [10]. This infers that the facilities provided in the architecture design studio are adequate, agreeing with the study of [10], where the identified facilities recorded a mean score of 2.79, 2.64, 2.29, 2.58, 2.23, 2.05, 2.38 and 2.12, respectively.

Table 2 – Adequacy of the types of facilities provided

No	Facilities Provided	Mean	Standard Deviation	Remarks
1	Visual Comfort	4.21	.881	1
2	Thermal comfort	3.54	1.139	2
6	Interior finishes	3.53	1.061	3
3	Acoustic comfort	3.36	1.218	4
4	Fire safety	3.27	1.184	5
5	Cubicle layout	3.17	.985	6
7	Brainstorming space	3.12	1.248	7
8	Building support services	2.96	1.319	8

Level of Students' Satisfaction with Facilities Provided. Table 3 shows the satisfaction index; thus, visual comfort with a satisfaction index of 4.21 ranked highest at 3.71, while building support services ranked eighth, having a mean value of 2.96.

Table 3 – Descriptive statistics for students' satisfaction

No	Facilities Provided	Mean	Standard Deviation	Remarks
1	Visual Comfort	4.19	.830	1
2	Thermal comfort	3.71	.962	2
3	Acoustic comfort	3.67	1.018	3
6	Interior finishes	3.43	1.103	4
5	Cubicle layout	3.25	1.159	5
4	Fire safety	3.22	1.233	6
7	Brainstorming space	3.02	1.208	7
8	Building support services	2.90	1.304	8

CONCLUSIONS

Design studios consist of spaces where students frequently use and appreciate spending time. Each student should be able to exercise some level of control over their own "learning" experience at the studio beyond being merely physical spaces where education is provided. This control

entails being able to modify physical comfort components according to personal inclinations.

The study identified the types of facilities provided in the area, equating them to global standards. The facility provided with the highest adequacy index of 4.21 is visual (light) comfort. Students expressed more satisfaction with visible (light) condolence than other components, and building support services had the lowest satisfaction level. Future research should look into establishing a statistical effect among the study variables.

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Evaluation of the Performance of Supervisors in Planning the Supervision Program for the State Tsanawiyah Madrasah in Mataram city

Alipvia Kesuna Septi [1], **Sudirman** [1], **Fahruddin** [1]

[1] *University of Mataram*
Jl. Majapahit No. 62 Mataram, Nusa Tenggara Barat, Indonesia

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Corresponding Author:
Alipvia Kesuna Septi
hamidi@unram.ac.id

Abstract. This research method aims to examine: (1) the performance of supervisors in the supervisory working group (Pokjawas) of Mataram City Madrasah in 2022 in terms of planning aspects. This study uses a qualitative approach that is descriptive-analytic - collecting data using the method of observation, documentation and interviews. Data analysis uses the Analysis Interactive theory of Miles and Huberman, which divides data analysis activities into four parts: data collection, data reduction, data presentation, and conclusion. The results of the study indicate that the preparation of the supervisory program carried out by the madrasa supervisor has not accommodated the findings of the weaknesses that exist in each supervisor.

Keywords: evaluation; performance; state Madrasah supervisor.

INTRODUCTION

The problem faced by the world of education in Indonesia is the low quality of education [1]. The low quality of education can be perceived from many sides which causes the low quality: 1) the quality of supervisors; 2) the quality of the principal; 3) teacher quality; 4) the quality of the teaching and learning process; 5) Quality of facilities and infrastructure; 6) Quality of raw-input; 7) Social, cultural, and economic quality.

From the supervisor's point of view, it dramatically affects the quality of education because school/madrasah supervisors are one of the components that play a role in improving the quality of education so that the evaluation of education is not carried out properly by supervisors in carrying out their duties. The research result of [2] concluded that the performance of school supervisors in implementing educational supervision in terms of planning, implementation and results was low. This general conclusion is reduced from the following specific findings: first, Madrasah Education cluster supervisors have not made an educational supervision planning program as regulated in the supervisor's workshop manual. Second, the provisions have not fulfilled the frequency of class visits. Third, obstacles in implementing educational supervision are caused by the average age of supervisors (more than 50 years), low commitment, work motivation and low competence. It is also caused by external factors, namely recruitment that is not by the rules, the large number of tasks and the lack of guidance for supervisors. Some instruments to support supervisory performance are available, but the supervisory activities have not run optimally [3]. As a result of weak academic and managerial supervision, the quality of education can decrease, such as; low test results, and the quality of education management is less achievement-oriented [4].

The success of improving the quality of education in Islamic religious education institutions (madrasas), which are continuously implemented, has a close relationship with the performance of madrasa supervisors [5]. Supervisors have a strategic position in improving the quality of madrasas. This can be seen in the role that must be carried out through teacher competency devel-

opment towards improving the quality of education, in this case, the quality of madrasas. Recruitment of supervisors properly, correctly, and by existing standards and requirements, continuous coaching and development of supervisor competencies through supervisory training activities. Becoming a professional supervisor requires a high commitment from the supervisor himself. Equally important is awarding especially adequate welfare and streamlining the supervisory organisation for the development of its members.

School supervisors have a significant and strategic role in the quality education process and school outcomes [6]. In this context, the supervisor's role includes monitoring, supervision, evaluation, reporting, and follow-up, which must be carried out regularly and continuously [7]. The main task of school supervisors is to carry out academic and managerial supervisory duties in academic units. It includes the preparation of supervision programs, implementation of coaching, monitoring of the performance of the eight national education standards, assessment, mentoring, and professional teacher training, evaluation of the results of the implementation of supervision programs and the implementation of supervisory duties in the regions particular.

Evidence of the low quality of graduates is that students graduate only because of the mercy of their teachers, graduating with grades that do not meet the standard target. The passing grades made by the school are not the pure grades achieved by the students but "the grades fall from the sky". Supervision, as one of the management functions in addition to planning and organising, can be interpreted as monitoring activities to ensure that all organisational activities are carried out as planned. At the same time, it is also an activity to correct and correct if any deviations are found that will interfere with the achievement of goals [8].

School supervisors, as one element of the education staff, have an essential and strategic role in the overall effort to improve the quality of education, especially in improving the quality and performance of schools, including guiding the management of a school or madrasah [7]. Supervisors of State Madrasah Tsanawiyah in Mataram City must understand their duties in fostering and developing professional teachers, especially those related to creativity and motivation. Professional teacher development is a program for Supervision of State Madrasah Tsanawiyah in Mataram City that must be prioritised. Another thing that must be considered is the development of science and knowledge. The development of science and knowledge can be related to the substance of scientific disciplines. It can also be related to approaches, methods, and supervision techniques.

The steps are always based on a thought process that is carried out consciously and planned so that the activities to be carried out can contribute results to the original expectations. However, it is also realised that implementing these activities are not a few problems, obstacles and challenges faced and need attention to analytical thinking and ways to solve them. In a modern society as it is today, especially in the era of globalisation, all apparatus are required to face increasingly competitive competition, both at home and abroad. One way to anticipate the increasingly competitive match is through a comprehensive improvement in the quality of human resources. According to [9], "One aspect of life that comes to the surface today with a stronger echo than the past is the improvement of the quality of human life. Quality of life boils down to the recognition of human dignity".

The performance of school supervisors is seen from the role of school supervisors in carrying out their duties optimally. But several studies have revealed that supervision activities in several districts have not run optimally because the actions of preparing the supervision program plan, implementation of supervision and reports on the supervision results have not been well structured and implemented. The results of brief observations and the performance of academic management that has taken place so far are still inclined to regular inspections. Academic supervision has not been carried out by madrasa supervisors regularly according to a set schedule, so the quality of learning is not optimal but is more monotonous. Besides, those teachers are not ready to make supervision results.

Based on these observations, researchers are interested in researching the evaluation of the supervisor's performance in planning the supervision program for the State Madrasah Tsanawiyah in Mataram City.

METHODS

This research will be carried out in State MTs throughout Mataram from January to March 2022. Considering the time, cost, and ability of

researchers using a qualitative phenomenological research approach. This qualitative research is research that seeks to find the meaning that underlies human behaviour and has the following characteristics: 1) natural setting as a data source, 2) researcher is the key instrument, 3) qualitative research is more concerned with process than results, 4) researcher with a qualitative approach tends to analyse data deductively, 5) the meaning that actors have that underlies their actions is an essential aspect in qualitative research.

The data collected through this study is by the research focus, which is related to the evaluation of the performance of madrasa supervisors at Madrasah Tsanawiyah Negeri in Mataram City. The data needed is sourced from informants (school supervisors, teachers), Learning Processes, and Documents. In this qualitative descriptive study, three techniques were used to collect data: interviews, observations, and document studies. The data obtained were then analysed using an interactive qualitative data analysis from Miles and Huberman, which consisted of data reduction, data presentation, and conclusions. The process took place circularly during the research. In the early stages of data collection, the research focus is still comprehensive and not transparent, while the observations are still general. After the focus became more apparent, the researcher used more structured words to obtain more specific data.

In this case, the theory can assist researchers in collecting and analysing data. For this reason, the data obtained were then analysed using interactive qualitative Miles and Huberman's models: Data Reduction, Data Presentation, and Drawing Conclusions/Verification. In qualitative research, the validity of the data is also significant because a research result is meaningless if it is not recognised or trusted. To obtain recognition of the results of this study lies in the validity of the research data that has been collected. Based on [9], the data validity test in qualitative research includes credibility, transferability, dependability, and comparability tests.

RESULTS AND DISCUSSION

Implementation the performance of Madrasah supervisors in the supervisory working group (Pokjawas) can be seen from the preparation of supervisory programs. Preparation of supervision programs is the activities of school supervisors in preparing academic and managerial supervision programs, teacher and/or school principal coaching programs, monitoring programs for the implementation of National Education Standards and performance appraisal programs for teachers and/or school principals, and mentoring and professional training programs for teachers and/or school principals or school principal. Based on information obtained by researchers through interviews with the head of the Pokjawas Madrasah, the Ministry of Religion, Mataram City, all supervisors must prepare annual and semester programs and schedule supervision visits. As stated by the Head of the Mataram City Ministry of Religion that:

We strive to build a shared commitment that all supervisors must maximise their primary duties and functions as madrasa supervisors. Every academic year, especially at the beginning of the school year, to enter the odd semester, the Ministry of Religion of the City of Mataram invites madrasas to conduct a coordination meeting for program preparation. The panel discussed the rationale for implementing supervision based on the findings and problems that occurred in the previous academic year. This is a guideline for preparing annual and semester programs for the current year.

In addition to the interview with the Head of the Mataram City Ministry of Religion, the researcher also sought information by interviewing the Pokjawas secretary. The result was that the madrasa education supervisor program was prepared at the beginning of the odd semester. Meanwhile, to improve the program, an internal supervisory meeting was held on the flow of the formulation and program preparation, starting by looking at the results of supervision and problems encountered in management in the previous academic year. The practice of the supervision program, both annual and semester in nature, was carried out after observing and analysing the supervision results and the problems revealed to know the previous teachings. All madrasa supervisors at the Ministry of Religion of the City of Mataram are fully involved in preparing the supervision program. According to the MTs supervisor coordinator and as MTs supervisor in Mataram City in an interview said that:

The preparation of the supervision program is annual and semester. The yearly program is still very general when viewed from the time of its implementation because it only shows the month of per-

formance. The semester program consists of odd and even semesters derived from the annual program. Supervision activities, coaching, monitoring and assessment in the semester program are determined by the month and week of implementation. In addition, an activity plan is prepared as a working guideline by dividing the work area, compiling a list of fostered institutions and preparing blanks. Each supervisor should develop a more detailed supervision program that includes the types of activities, implementation time, targets and so on so that the implementation of supervision is carried out sustainably and consistently.

Observations made by researchers when an evaluation meeting and preparation of a monitoring program were being held in the first week of each month, the head of the MTs supervisory coordinator was seen leading the discussion. The supervisory meeting was attended by ten supervisors and was held at the home of a member of the MTs supervisory board. In the observations of the researchers, it can be seen that the improvement of the supervision program for each supervisor, whether an annual program or a semester program, is carried out by conveying opinions about the program and submitting the targets and targets of the previous year's supervision. The course is also accompanied by the delivery of the obstacles faced in the last year's charge. All meeting participants were allowed to convey the rationale for the program's achievements in the previous year. Each coordinator inputs the results of the program evaluation meeting and the preparation of the annual program and semester program to be further documented by the Pokjawas secretary.

For the duties and functions of madrasa supervisors to run well, supervisors must be able to develop a supervisory program as a working guide in carrying out their responsibilities and functions. As stated earlier that the preparation of the supervision program at the Ministry of Religion of the City of Mataram is carried out through a meeting of all supervisors who are members of the supervisory working group (Pokjawas) of the Ministry of Religion of the City of Mataram. All supervisors, not program heads of Pokjaws, and officials at the Ministry of Religion of Mataram City. This shows that the preparation of the program uses the supervisory results approach. It's just that the results of the supervisory evaluation have not been optimally oriented by looking at the need for sustainable development of managerial competence and professional competence of teachers in the future, so the construction of the supervisor's work program has not been given serious attention to the competence of madrasa principals and teachers.

Compiling the supervision program at the Ministry of Religion of the City of Mataram provides an excellent opportunity for all supervisory members to give input and consideration to the program. Moreover, before the preparation of the program is carried out, the meeting begins with an evaluation of the achievements of the previous year's supervision program. What the supervisors do shows the existence and togetherness in preparing the program because if the preparation of the program is not carried out in a participatory collective manner, it will have an impact on the implementation of the supervisory program that relies on one another. There is no synergy, and it will run independently alone. Therefore, it can be said that the mechanism for compiling the supervision program at the Ministry of Religion of the City of Mataram has been running in an open and participatory manner. It's just that the preparation of the supervision program has not been based on the supervisory evaluation results; namely, the program's practice is based on facts and data from the results of the supervisor's performance. Suppose the preparation of the supervision program is based on facts and data on the results of supervision performance. In that case, it will reflect the maximum competency development and supervisory development program in the madrasa supervisor's work program. Of course, the supervisor can make a comprehensive improvement plan or adjustment to the program. In addition, the preparation of work programs for madrasah supervisors has not been oriented to future needs for supervisory competence development.

The annual program is still widespread in terms of the implementation time, while in the semester program, supervision activities are indicated by the month and week of implementation. For more operational needs, supervisors prepare activity plans as work guidelines, such as compiling a list of fostered madrasas and madrasah principals and their teachers and preparing blanks or instruments to be used in supervisory activities, such as learning administration assessment instruments, learning tools, and learning implementation. Based on process standards, prepare blanks to check the completeness of curriculum documents, document one and two (syllabus attachments and lesson plans).

Four programs must be owned by every program supervisor who supervises activities in the annual program: general programs, teaching programs (PBM), evaluation programs, and coaching programs. It's just that the madrasa supervisor does not make a detailed schedule of activities, especially the schedule for visits to madrasas. Ideally, every academic supervisor must create a work plan that shows the date and day of the stay at the target madrasah. The work plan also describes the goals and targets of coaching and is known by madrasas and teachers who will be the coaching target.

It can be stated that the madrasah supervisors in the city of Mataram have prepared programs at the beginning of each school year, both annual and semester programs. To achieve the goals that have been set as mentioned above, an activity plan is made for each supervisor. This means that supervisors must have work guidelines and know what to do.

The researcher observes that the preparation of the madrasah supervisor's supervision program has not reflected future needs, namely the need for sustainable development of the madrasa principal's competence, teacher competence, and administrative staff. Preparing future-oriented programs provides the maximum coaching for madrasah principals, teachers and administrative staff to prevent obstacles in overcoming problems arising in learning activities and career development of madrasah principals and teachers.

The study's findings indicate that the preparation of the supervisory program carried out by the madrasah supervisor, although through a meeting with the supervisory working group, has not accommodated the findings of the weaknesses that exist in each supervisor. This can be seen clearly from the construction of the supervisor's work program, which has not provided the top portion for the managerial competence of madrasah principals and teacher competence development. The preparation of supervision programs as part of planning must be carefully and intelligently arranged about everything that will be done in the future with a view to [9], programming (planning) is carried out, among others, to determine the objectives or framework of actions needed to achieve specific goals. Program preparation is carried out by assessing the organisation's strengths and weaknesses, identifying opportunities and threats, strategies, policies, tactics and programs that are taken through a scientific decision-making process.

Referring to the concept offered by [9], the preparation of the supervision program has not been thoroughly carried out through a systematic procedure. This can be seen from the work program products that the supervisory working group has produced at the Ministry of Religion of Mataram City. Based on the results of the researcher's analysis of the problems faced by madrasah supervisors in the field of competency development for the development of managerial competence of madrasah principals and teacher competencies that are not optimal, group coaching through Madrasah Working Group (KKM) activities is very dependent on the activities of the institution, and the intensity of the training required. Conducted by madrasa supervisors is still very low, which results in results that are not optimal.

CONCLUSIONS

Based on the results of the study, it can be concluded that the preparation of the supervisory program carried out by the madrasa supervisor, although through a meeting with the supervisory working group, has not accommodated the findings of the weaknesses that exist in each supervisor.

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The Perceived Usefulness, Perceived Ease of Use, Behaviour Towards, and Intention to Use Mobile Compilers in Learning Computer Programming

Cris Norman P. Olipas [1], **Rodibelle F. Leona** [1]

[1] *Nueva Ecija University of Science and Technology*
Sumacab este, Cabanatuan City, 3100, Philippines

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Corresponding Author:
olipas.cris@gmail.com

Abstract. Using mobile learning in different learning institutions provides a lot of possibilities and opportunities for improving the quality of instruction delivered to every student. The concept of Bring-Your-Own-Device (BYOD) is one of the trends which learning institutions are adopting to provide more opportunities for students to learn and collaborate. The use of mobile compilers can be adopted as a technology integrated into the teaching and learning process. This study sought to comprehend information technology students' perceptions of the Technology Acceptance Model (TAM) constructs, which include perceived usefulness, perceived ease of use, attitude toward, and intention to use mobile compilers, at a higher learning institution in Nueva Ecija, Philippines. A descriptive-correlational design was used. The findings revealed that the respondents generally accepted portable compilers in learning computer programming. A significant difference was found between males and females regarding the technology's ease. Other variables showed no significant difference. Based on the findings, recommendations were made by the researchers.

Keywords: BYOD; Computer Programming; Mobile Compilers; Technology Acceptance Model; Technology Integration.

INTRODUCTION

The concept of BYOD, or Bring Your Own Device, in higher education has become the practice of various learning institutions today. BYOD is a technology-based model that requires students to bring their own devices to school [1]. This practice has several benefits not only for the students and teachers but also for the learning institutions. In the classroom, BYOD solidifies communication and collaboration among the students. It contributes to the increase in learning engagement and cooperation between them. Thus, providing real-time production of output and necessary feedback is essential for improving learning. Author [1] further asserted that the BYOD technology model creates a seamless learning environment attributed to the affordances of mobile technologies. However, to make it an effective practice, mediation using a good pedagogical design is necessarily administered by teachers.

By using BYOD, learning institutions can do away with the expense of obtaining the equipment necessary to deliver instruction [2]. The BYOD approach also reduces the cost of buying textbooks, papers, and other educational materials [4]. Students have complete control of BYOD. With their own devices, they can quickly exchange learning resources with their friends, do activities immediately after each learning session, and learn new information whenever and wherever they want [4].

However, potential barriers caused by BYOD were analyzed by [5]. They discovered that potential obstacles might include a digital divide among students, student misuse of technology; hostile school policy; and a negative perception of teachers regarding the use and benefits of technology. Because of this, exploring the acceptance of new technologies integrated into the teaching and learning process from the student's perspective is necessary for the effective implementation and integration of technologies. This gap aims to be addressed by the present study.

Another gap that the researchers aim to fill is the limited amount of available literature focusing on implementing the BYOD approach in the classroom [6], such as using mobile compilers. Thus, this study seeks to contribute to the growing body of literature available.

Further, while several papers investigating the use of mobile compilers in learning programming have been conducted [7–9], exploring it using the Technology Acceptance Model (TAM) constructs is limited. Hence, this study aims to examine the level of agreement among the information technology undergraduate students on their perceptions about the usefulness and ease of use of mobile compilers, as well as the attitude towards and the intention to use portable compilers in learning computer programming. This scholarly undertaking further aims to provide a basis for educators to successfully design classroom strategies to integrate technologies into the teaching and learning process.

Mobile Learning. The BYOD paradigm is a concrete application of mobile learning. Mobile learning (M-Learning) empowers learners to learn anytime, anywhere. The benefits associated with mobile learning include expanding the reach and equity of education, facilitating personalized learning, and providing immediate feedback and assessment [10]. M-Learning increases productivity and maximizes instructional time. It also aids in building new learning communities among learners. M-Learning is a concept that ensures seamless delivery of instruction and supports the learning needs of differently-abled learners in and outside the classroom. Through M-Learning, the quality of education delivered by various learning institutions increases and improves [11].

In learning institutions offering computing courses, the concept of BYOD is suitable since students are required to write computer programs and develop information systems. Laptops, tablets, and smartphones are the standard devices that students have. Author [12] explains that mobile phones and tablets are mobile learning devices that can support collaborative learning in conventional and online environments. In addition, the capacity of mobile devices to provide instant access to information offers more flexibility, allowing collaboration among students [13]. Thus, educational programs and tools using these devices are practical and suitable. Moreover, it allows for flexibility in learning and collaboration among the students.

Mobile Compilers. Authors [8] in a study explored the use of an Android-based C/C++ compiler in learning computer programming courses by university students. They found that mobile learning was the preferred mode of understanding among the students. They further stated that learning institutions might use available mobile applications to supplement students' learning to deliver instruction effectively.

Another study was conducted to examine the usefulness of mobile compilers for learning computer programming, led by [7]. The researcher emphasized that portable compilers significantly contributed to the learning of undergraduate students in computer programming. Further, mobile compilers benefitted the students in the following ways: improved programming skills, increased learning flexibility and enjoyment, participation, and self-study [7].

Mobile compilers provide flexibility in learning computer programming because they can be installed on mobile devices such as tablets and smartphones. In this manner, students can conduct programming practices and exercises at any time. The technology also empowers them to expand their knowledge and develop advanced skills in computer programming by enabling them to use other relevant and available resources while using mobile compilers.

However, only a few available papers examine mobile compilers' use. In this regard, researchers seek to add to this growing field of study to understand the implications and acceptance of portable compilers in teaching and learning.

Technology Acceptance Model. The Technology Acceptance Model (TAM) is a paradigm for analyzing information technology adoption and user adoption of emerging technologies. According to the theory, a person's intentions to use technology and their behaviour while using technology are determined by how beneficial they perceive the particular technology to be, as well as how simple it is to use. TAM has the following constructs: perceived usefulness, perceived ease of use, attitude towards, and intention to use [14, 15, 16].

Perceived usefulness refers to the extent to which a technology is expected to improve a potential user's performance. On the other hand, the perceived ease of use refers to the effort re-

quired to use a technology [17] effectively. Meanwhile, the attitude towards using technology is the degree to which an individual looks at how technology affects their performance in the job [18]. Lastly, the intention to use is the individual's subjective probability that they will perform a specified behaviour using the technology [17].

Using a TAM is critical to user acceptance and establishing a solid foundation and confidence for the further progress and development of new technology [19]. Thus, users must understand and accept a technology to be more effective and beneficial. Using TAM is a good foundation for creating web portals, especially in the Business-to-Business (B2B) area, because it ensures a more functional and easier-to-use system.

In the education sector, many research projects have been conducted focusing on applying TAM in integrating new technologies into the classroom to understand its implications for teaching and learning better.

This study adds to the growing number of literature available to provide more insights, better understanding, and a deeper perspective on the acceptance of new technologies for the effective delivery of instruction.

Statement of the Problem

In general, this study aims to determine IT students' perceptions of mobile compilers' usefulness and ease of use and their attitude towards and intention to use the technology in learning computer programming.

Specifically, it sought to answer the following:

1. What is the level of agreement among the respondents based on the following constructs of the Technology Acceptance Model: perceived usefulness; perceived ease of use; attitude towards; intention to Use?

2. Is there a significant difference between the perceived usefulness, perceived ease of use, and attitude towards and intention to use mobile compilers based on sex?

Hypothesis

H_o: There is no significant difference between the perceived usefulness, perceived ease of use, attitude towards, and intention to use mobile compilers based on sex.

H_A: There is no significant difference between the perceived usefulness, perceived ease of use, attitude towards, and intention to use mobile compilers based on sex.

METHODOLOGY

Research Design. A descriptive-correlational research design is a quantitative research method used in this study. The researchers aimed to systematically describe the population to clearly understand and answer the research problem while identifying significant differences among the variables. By employing a descriptive-correlational research design, the researchers could identify and differentiate the perceived usefulness, perceived ease of use, attitude towards, and the intention of the students to use mobile compilers in learning C++ programming to their sex.

Research Respondents and Locale of the Study. The respondents for this study were first-year students enrolled in the Computer Programming 1 course during the first semester of the Academic Year 2022–2023 in a higher learning institution in Nueva Ecija, Philippines. The total number of first-year students enrolled in the college was 454. The researchers calculated the total number of samples based on the population. With a 98% confidence level and a 3% margin of error, the computed sample size was 350. The researchers were able to collect responses from 364 respondents. It was composed of 62.64% males and 37.36% females. The number of male students is more significant than that of female students, as supported by a study conducted by [20] in a similar locale. Therefore, the number of collected responses exceeded the number of needed samples. This suggests that the model for this study was statistically significant in describing the overall view of the population.

Research Instrument. The research instrument used in this study was based on the work of [17]. The researchers modified the device to suit the context of this study. It covers the assessment of the likelihood of using mobile compilers for C++ programming based on the constructs of the Technology Acceptance Model.

Table 1 presents the response mode and the questionnaire scoring guide. In analyzing the col-

lected data, the researchers computed the weighted mean using Software Packages for the Social Sciences (SPSS) version 26.

Table 1 – Response Mode and Scoring Guide

Numerical rating	Range	Verbal description
4	3.25–4.00	Strongly Agree
3	2.50–3.24	Agree
2	1.75–2.49	Disagree
1	1.00–1.74	Strongly Disagree

To ensure that the instrument was valid, the researchers sought the help of other researchers to review its content and face validity. The reviewers provided vital feedback to improve the items written in the instrument and to suit the questions in the context of this study. The researchers also conducted a reliability analysis using SPSS. Table 2 presents the results of the reliability analysis.

Table 2 – Reliability Analysis

Scale	Cronbach's alpha	Items
Perceived Usefulness	0.858	4
Perceived Ease of Use	0.812	4
Attitude Towards	0.851	5
Intention to Use	0.870	5

The computed Cronbach's Alpha for the perceived usefulness scale with four items is 0.858, perceived ease of use with four things is 0.812, attitude towards five items is 0.851, and intention to use with five items is 0870. These computed Cronbach's Alphas indicate that the instrument was excellent and reliable. Further, results suggest that the device consistently reflects the construct it is measuring.

Data Gathering Procedures. In the conduct of data gathering, the researchers identified the background of the problem by reviewing related literature and studies. Afterwards, the researchers devised the instrument based on the reviewed materials to answer the issues identified for this study. The researchers sought approval from the college to conduct the research and perform the data-gathering activities. In performing the data gathering activities, the researchers explained the purpose of this study, its objectives, and its implications to the respondents. The researchers also ensured the respondents that the survey would not cause any harm to them.

Furthermore, researchers ensured compliance to research ethics norms, data confidentiality, and the respondents' anonymity. The instrument was administered using Google Forms. This tool was used to conform to the guidelines of ensuring the safety of the respondents in following health protocols during the pandemic.

RESULTS AND DISCUSSION

Technology Acceptance Model Constructs. In Table 3, the results of the assessment of the perceived usefulness of mobile compilers are presented. The development of the evaluation made on the respondents' perception is that using portable compilers can improve their academic performance.

Table 3 – Perceived Usefulness

Item statements	Weighted mean	Verbal description
Using the mobile compiler will help me to understand how to write C++ programs better.	3.223	Agree
Using the mobile compiler will contribute to the improvement of my academic performance.	3.206	Agee
I find using mobile compilers very useful in my computer programming class.	3.208	Agree
With the use of mobile compilers when discussing computer programming, it is easier to catch the attention of every student.	3.314	Strongly Agree
Overall Grand Mean	3.238	
Verbal Description	Agree	

According to the respondents, using mobile compilers is useful when discussing computer programming lessons. They strongly agree that using portable compilers helps catch their attention (WM=3.314), thus increasing learning engage-

ment and active participation in the classroom. With mobile compilers, the students agree that the technology is helpful in their programming classes (WM=3.208). Further, they also agree that it can help them to quickly write C++ programs using mobile compilers (WM=3.223) and that the technology contributes to the improvement in the academic performance of the students (WM=3.206).

Meanwhile, table 4 shows the assessment of mobile compilers' perceived ease of use.

Table 4 – Perceived Ease of Use

Item statements	Weighted mean	Verbal description
It will be easy to become skilful in computer programming when using mobile compilers.	3.044	Agree
I find it very easy to apply the learning I gained in the computer programming lessons when using the mobile compilers to practice the skill	3.082	Agree
The use of mobile compilers is easy to use and easy to understand.	3.038	Agree
Using mobile compilers provides flexibility because learning and practising the skills may happen anytime, anywhere.	3.189	Agree
Overall Grand Mean	3.088	
Verbal Description	Agree	

Findings indicate that students agree that using mobile compilers offers flexibility in learning, as depicted in the computed weighted mean rating of 3.189. Students also agree that they find it easier to apply the things they have learned in different lessons related to computer programming when using mobile compilers based on the computed mean rating of 3.082. Because of the technology, they agree that it is easy to use and easy to understand the lessons, as shown in the computed mean rating of 3.008. Lastly, with the use of mobile compilers, the students agree that they are confident that they can quickly develop vital computer programming and problem-solving skills essential for the future profession, as presented in the computed weighted mean rating of 3.044.

In table 5, the results of the assessment on the attitude toward using mobile compilers are presented.

Table 5 – Attitude Towards

Item statements	Weighted mean	Verbal description
Using the mobile compiler is good in class.	3.151	Agree
My experience using the mobile compiler in class is favourable.	2.972	Agree
It positively influences me to use a mobile compiler in class.	3.060	Agree
I think it is valuable to use a mobile compiler when learning computer programming in class.	3.107	Agree
I think it is a trend to use mobile compilers in class.	2.923	Agree
Overall Grand Mean	3.043	
Verbal Description	Agree	

Results show that the respondents agree that using mobile compilers is good in class (WM=3.151). They also agree that it is valuable for them to learn their computer programming lessons (WM=3.107). Further, respondents expressed that they agree that technology positively influences their learning (WM=3.060) and that it is essential to use technology to learn in class (WM=3.107) effectively. Lastly, respondents believe using mobile compilers is one of the trends today (WM=2.923).

Table 6 shows the respondent's assessment of the intention to use mobile compilers in learning computer programming.

Findings suggest that the respondents are interested in using mobile compilers to learn computer programming (WM=3.137) and that the technology increases their interest in the subject (WM=3.126).

Table 6 – Intention to Use

Item statements	Weighted mean	Verbal description
I intend to use a mobile compiler in my computer programming class.	2.991	Agree
I increase the occurrence of using the mobile compiler in class.	2.992	Agree
Using a mobile compiler helps to increase the learning interests of the students.	3.126	Agree
I am very interested in using mobile compilers to learn computer programming.	3.137	Agree
I use the mobile compiler to have multiple platforms for learning computer programming.	3.054	Agree
Overall Grand Mean	3.060	
Verbal Description	Agree	

Also, the use of mobile compilers allows the respondents to learn computer programming using different platforms available to them (WM=3.054), and they intend to use it frequently in class (WM=2.992) in learning computer programming (WM=2.991).

Difference between Male and Female on the TAM Constructs. Table 7 presents the difference test between males and females on the different constructs of the Technology Acceptance Model.

Table 7 – Test of Difference between Male and Female on the TAM Constructs

Variables	Male Mean	Female Mean	Mean difference	T-test
Perceived Usefulness	3.165	3.239	-0.074	0.105
Perceived Ease of Use	3.050	3.152	-0.102	0.030*
Attitude Towards	3.023	3.076	-0.053	0.244
Intention to Use	3.028	3.113	-0.085	0.079

Notes: statistically significant at less than 5% level based on two-tailed tests.

The hypothesis investigates whether male and female perceptions of the usefulness, ease of use, attitude toward, and intention to use mobile compilers differ. Levene's perceived usefulness statistic is insignificant, as shown in the computed p-value of 0.226. Thus, equal variance is assumed. Meanwhile, Levene's statistic p-value for perceived ease of use is 0.490. Also, equal variance is considered. Regarding the attitude towards using mobile compilers, the computed p-value for Levene's statistic is 0.246, indicating equal variances assumed. Lastly, the intention to use has a calculated p-value of 0.358 for Levene's statistic, meaning equal variances are also considered.

As presented in table 7, the mean difference for the perceived usefulness is –0.074 with a p-value of 0.105 and the attitude towards it with a mean difference of -0.053 and a p-value of 0.244. The intention is to use it with a mean difference of –0.085 and a p-value of 0.079. These results indicate no significant difference between males and females. Thus, the researchers accept the null hypothesis.

However, in terms of the perceived ease of use, results show a significant difference between males and females, as presented in the mean difference of –0.102 and p-value of 0.030. Therefore, rejecting the null hypothesis.

The overall mean ratings for mobile compilers' usefulness and ease of use in learning computer programming are 3.238 and 3.088, respectively. This corresponds to an "agree" verbal description among the respondents. Based on the assessment, the students have confidence that using mobile compilers will enable them to understand every lesson quickly. This is important in mobile learning because the technology allows learners to acquire new knowledge and develop necessary skills in the discipline. Similarly, using portable compilers empowers students to have better academic performance because of their capability to be utilized anytime and anywhere. Learning acquisition can happen anytime when tools are available for the students in an "on-demand" scheme.

Author [7] explains that mobile compilers significantly benefit students learning computer programming. Benefits include improved programming knowledge, flexibility in learning, enjoyment, and increased active participation and motivation. These benefits of mobile learning contribute to the overall learning experience of un-

dergraduate students. Today, Generation Z learners are more actively engaged in using different technologies integrated into their education to acquire and develop new knowledge. When new knowledge is properly utilized, it contributes to more effective delivery of instruction. For instance, when used to deliver education, platforms like social media become effective because they allow students more flexibility in learning and collaborating with their peers. The same goes for the use of mobile compilers. It offers a new way for students to interact with their classmates while having a better learning experience for their holistic development [21–22].

Further, mobile compilers were found to be a necessary tool in effectively learning how to write computer programs because they promote active engagement and increase student interest because of their several features. Ensuring active engagement promotes collaboration among learners. Active engagement in the classroom can also lead to improved communication skills among the students, nurture their creativity, and enhance their academic performance [23]. When learners are highly interested, motivated, and engaged, learning new things is seamless and productive. Thus, contributing to the holistic development of the students.

Regarding the attitude towards and the intention to use mobile compilers, the computed overall mean ratings were 3.043 and 3.060 with verbal descriptions of "agree," respectively. It is noteworthy to mention that students have a positive attitude towards technology. Thus, increasing the probability of accepting it for the improvement of the teaching and learning process. Also, the intention to use the technology is very much possible, as depicted in the assessment made by the respondents. This implies that the respondents are willing and intend to use mobile compilers to improve knowledge acquisition and develop new skills in the computer programming course.

The ability of the students to recognize the importance of mobile compilers in learning computer programming is one indicator that they are aware of the use and relevance of different ICT tools in the delivery of instruction. According to [24], the ICT awareness of students was very high, and students possessed the necessary skills to use these tools for learning purposes. Thus, mobile compilers are essential for effectively integrating technology into teaching programming courses.

In understanding the assessment between the males and females, the evidence presented that these variables varied only in the TAM's perceived ease of use construct. A significant difference was found, as reflected in the computed p-value of 0.030. In the remaining variables of the model, no significant difference was found. Based on the findings, it can be noted that since males differ from females in their views about the perceived ease of use of mobile compilers, gender-based preference may be a significant factor. Typically, in computing programs, the number of males is greater than the number of females [25] because of the nature of the discipline. However, it is noteworthy that a study by [26] found that females have better academic performance than males in a computer programming course, though they have experienced higher levels of programming anxiety. Thus, how females perceive how easy it is to use a tool can contribute to a better learning process for them.

CONCLUSIONS

This study assesses the respondents' perceptions of mobile compilers' usefulness and ease of use in learning computer programming courses. Also, the attitude towards and the intention to use the technology were examined. These variables were based on the Technology Acceptance Model. A descriptive-correlational research design was employed in this study. Results suggest that the respondents generally agreed with the items included under perceived usefulness, perceived ease of use, attitude towards, and the intention to use mobile compilers. Also, a significant difference was not found in the correlation analysis between sex.

Based on the findings of this study, the following recommendations are given:

1. Computer programming course teachers may use mobile compilers to deliver instruction to students to improve their academic performance, increase their active engagement and participation, and provide alternatives using the BYOD technology model.

2. Teachers may clearly explain the relevance and use of mobile compilers to students for them to profoundly understand the use of the technology and view it as a tool and a valuable resource for learning.

3. Learning institutions may use the results of this study as a basis for crafting instructional policies related to BYOD and technology integration.

4. Future researchers may look at the qualitative assessment of different respondents as to how relevant, effective, and productive the use of mobile compilers in learning computer programming is to the student's academic performance.

The implications of the results on the assessment of the perceived usefulness, perceived ease of use, attitude towards, and intention to use mobile compilers in learning computer programming provide an understanding and basis for educators to craft and design instructional strategies involving technology integration in the classroom. When technologies are properly integrated into the teaching and learning process, improvement in the academic performance of students can be achieved. Additionally, improved learning experiences may be observed, and enhancement of pedagogical strategies for teaching programming courses can be attained.

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The Effect of Teacher Work Group on the Performance of Elementary School Teachers in Pujut District, Central Lombok Regency

Mardan [1], **ZM Hamidsyukrie** [1], **Asrin** [1]

[1] *University of Mataram*
Jl. Majapahit No. 62 Mataram, Nusa Tenggara Barat, Indonesia

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Corresponding Author:
ZM Hamidsyukrie
hamidsyukriezm@unram.ac.id

Abstract. The purpose of this study was to determine the effect of the activities of the Teacher Working Group on the performance of elementary school teachers in Pujut District, Central Lombok Regency. The population of this study were elementary school teachers in Pujut District, Central Lombok Regency, totalling 101 teachers and the research sample. The technique used for data collection is a questionnaire. The data analysis used was descriptive analysis, prerequisite test and hypothesis testing, which included linear regression analysis in determining the effect of teacher working group activities on teacher performance. The results showed that the KKG activity significantly affected the performance of elementary school teachers in Pujut District, Central Lombok Regency, by 51.1%, with p=0.001. This means that the more the Teacher Working Group activities increase, the teacher's performance will improve.

Keywords: Teacher Working Group; Teacher Performance; Primary school.

INTRODUCTION

Teacher performance is related to the quality of tasks and work-oriented behaviour [3]. This can be seen from the accepted sense of moral responsibility. That will be seen in obedience and loyalty in carrying out teacher duties inside and outside the classroom. In general, teacher performance can be interpreted as performance/work results that can be seen in quality and quantity, achieved by a teacher in carrying out the tasks and responsibilities assigned to him [6].

The situation in the field shows that teachers' teaching performance is in the poor category. This is based on the low reading ability of fourth-grade elementary school students. According to [7], based on the results of the Progress in International Reading Literacy Study (PIRLS) survey that the reading literacy achievement of Indonesia's fourth-grade students (405) is below the international average (500) and is ranked 41 out of 45 participating countries. The results of this study are also supported by [5], which shows that on reading ability of elementary school students in Indonesia is ranked 26th out of 27 study participating countries.

The condition of not optimal performance of elementary school teachers also occurs in Central Lombok Regency. Based on the Teacher Competency Examination (UKG) results of Central Lombok Regency, SD obtained UKG results of 50.54, SMP 54.14, SMA 57.92, and SMK 54.12. From these results, the SD level ranks the lowest compared to other districts (NTB Regional Education Balance, 2020/2021).

Obtaining the UKG results determines the teacher's performance assessment. Teachers with scores below the standard will participate in training, while teachers above the average will become learning teachers and receive an educator certificate. According to [9] factors that cause low UKG scores to consist of internal and external factors. Internal factors are teacher competence, teacher literacy ability, and teacher professionalism. At the same time, the external factor is the composition of the questions.

It is necessary to evaluate teachers' teaching performance in the teaching and learning process, and it is essential to improve teachers' teaching

performance. Given that the role of the teacher is so important in the teaching and learning process, teacher performance needs to be enhanced and nurtured regularly and continuously so that teachers have professional teaching performance. Efforts are made to improve teacher performance, so teachers must have a forum to improve their work professionalism through the Teacher Working Group (KKG) at the sub-district level.

Central Lombok Regency, which has 14 subdistricts in Central Lombok Regency as a whole, has implemented the implementation of the KKG. This program is directly supervised and monitored by the Education Office of Central Lombok Regency, which has 51 school supervisors spread over 14 sub-districts in Central Lombok Regency. The implementation of the KKG in Central Lombok Regency is carried out by the Technical Implementation Unit (UPT) for Kindergarten and Elementary Schools, which are divided into four areas covering the Central Lombok Regency. Pujut District has 77 elementary schools consisting of 72 public schools and five private schools. Implementing the KKG at the Pujut District level, elementary schools were grouped based on cluster clusters of 6-7 elementary schools. Each collection has a core school and an impact school. The core school is a school that is the place for planning KKG activities as well as a place for discussion, and the impact school is a school that is a member of a cluster. The KKG in Pujut District consists of 3 groups, while the core schools are SD Negeri 1 Kawo, SD Negeri 2 Sengkol, and SD Negeri Ketangan.

The KKG is seen as ineffective in improving teachers' performance and professionalism in the cluster. Activities that have been planned do not always get a positive response from the teacher. KKG is seen as a formality activity that must be followed without clear outputs. Besides that, teachers in KKG activities lack initiative or always need guidance from resource persons to advance KKG activities. Research results [5] revealed that KKG activities affect teacher performance. This shows that the teacher working group (KKG) exercises are likely to be an effective vehicle for improving teachers' performance in the field. KKG activities can be said to develop teacher performance in the form of teacher study groups. KKG activities can assist teachers in developing pedagogic competence, professional competence, social competence and personality competence.

METHODS

This research is quantitative, where the researcher describes the phenomenon in more detail with quantitative data. This study will use a correlational approach and an ex post facto approach. The place of this research was carried out in Cluster 09 Rambitan, Pujut District, Central Lombok Regency.

The population in this study were all elementary school class teachers who participated in the KKG in Pujut District, Central Lombok Regency, totalling 136 teachers. The sample of this study is part of the research population obtained using the Slovin formula, so the number of pieces is 101 teachers. This research sample was obtained using a proportionate random sampling technique.

Before the research instrument is used, validity and reliability tests are first carried out. The data analysis technique used in this research is regression analysis. Before the hypothesis test, data analysis requirements were tested, including normality, homogeneity, multicollinearity, and autocorrelation tests.

RESULTS AND DISCUSSION

The KKG activity variable was measured using a questionnaire that had been divided and filled out by the teacher as a respondent. Table 1 shows 101 respondents' highest score was 149, and the lowest was 75. The research instrument consisted of 30 items with five answer choices: never, rarely, sometimes, often, and always.

Table 1 – Respondents' Perception of KKG Activities

Score Range	Category	Amount	Percentage
135–149	Very high	47	49
120–134	Tall	36	34
105–119	Currently	12	12
90–104	Low	5	4
75–89	Very low	1	1
Total		101	100

Table 1 shows that most of the respondent's responses to the KKG activities were included in the very high category, namely 47 respondents (49%). The reaction of respondents who stated that the KKG activity was deficient was one person (1%).

Single linear regression analysis was used to test the effect of one independent variable on one dependent variable. In this study, a single linear regression analysis was used to test whether KKG activities affect teacher performance and the impact of academic supervision on teacher performance. The results of single linear regression analysis are as follows.

Table 2 – Results of Single I Regression Analysis

Independent Variable	Dependent variable	Constant	Coefficient
KKG activities	Teacher Performance	61,667	0.715

The single linear regression analysis results become the following equation: Teacher performance = 61.667 + 0.715 KKG activities. The regression equation can be interpreted that:

1) The constant shows the value of the dependent variable if the independent variable is 0. The constant in the regression equation is 61,667, which means that if the KKG activity variable is 0, then the teacher's performance is 61,667.

2) The positive coefficient on the independent variable shows a unidirectional relationship, meaning that an increase will follow an increase in the independent variable in the dependent variable. This indicates that if there is an increase in KKG activities. An increase will follow in teacher performance.

The magnitude of the influence of the KKG on teacher performance can be determined through the coefficient of determination, as shown in Table 3.

Table 3 – Coefficient of Determination of KKG Activities on Teacher Performance

Independent Variable	Dependent variable	R^2
KKG activities	Teacher Performance	0.511

The coefficient of determination generated by the regression model is 0.511, so the contribution of the influence of the KKG activity variable on teacher performance is 0.511 × 100 = 51.1%.

The results of this study indicate that the KKG activity has a positive and significant effect on teacher performance. The statistical tests' results on the impact of KKG activities on teacher performance show that the significance value of the KKG activity variable is 0.001 (smaller than 0.05) and the regression coefficient is 0.400 (positive). Hypothesis 1 (H1) is accepted, which means that the activity KKG has a positive and significant effect on teacher performance. This study's results align with the research conducted by [2, 4], which stated that KKG activities contributed positively and significantly to teacher performance. The more the KKG activities increase, the teacher's routine will increase.

Regarding this KKG, the author [1] explained that the Teacher Working Group (KKG) is a forum for the professional development of elementary school teachers who are members of school clusters. The KKG is a non-structural forum or organization that is independent, based on kinship and has no hierarchical relationship with other institutions. The existence of the KKG is part of the embodiment of the professional coaching system because it includes a series of activities to improve the quality of education, teacher professional abilities, the quality of the teaching and learning process, and learning outcomes by utilizing all the resources and potentials possessed by schools, education personnel and the surrounding community.

Teacher working group (KKG) activities can be an effective vehicle to improve teachers' performance in the field. Teacher performance is the result achieved by the teacher in carrying out the tasks assigned to him based on skills, experience, sincerity, and time, with the resulting output reflected in quantity and quality. The working principle of the KKG is activities from teachers, by teachers and for teachers from all schools. The Teacher Working Group consists of all teachers in the group concerned, which operationally, the Teacher Working Group can be further divided into smaller groups based on grade level or per subject [8].

The purpose of the KKG, according to [7], is to solve the various main tasks and functions of teachers in schools and create a forum for teachers to be together in determining the planning, implementation, and assessment of learning. KKG activities must be carried out continuously, programmed, and scheduled based on the needs of teachers in schools. This is done so that the

KKG activities positively impact teachers in the teaching and learning process because the activities discussed in the KKG are related to teaching and learning activities. Therefore, in KKG activities, teachers are required to play an active role in the implementation of all activities held in the KKG, namely, cooperation between one teacher and another teacher.

CONCLUSIONS

Based on the results of the descriptive analysis, it can be concluded that the KKG activity significantly affects the performance of elementary school teachers in Pujut District, Central Lombok Regency, by 51.1% with p = 0.001. This means that the more the KKG activities increase, the teacher's performance will improve.

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The Effect of Problem-Based Learning Strategies and Direct Learning Strategies on Students' Fiqh Learning Outcomes

Lalu Moh. Fahri [1]

[1] *Mataram State Islamic University*
100 Gadjah Mada Jempong, Mataram, Nusa Tenggara Barat, Indonesia

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Corresponding Author:
lalufahri@gmail.com

Abstract. This study aims to determine whether there is a positive influence on the use of problem-based learning strategies and the use of direct learning strategies on Fiqh learning outcomes for MA Palapa Nusantara students. The type of research used in this research is quantitative research with an experimental research approach with Quasi-Experimental Design research methods. Data collection techniques in the study used tests, observations, and documentation. In the Experiment class, teachers' teaching activities are in the Good and Very Good categories, and the value of student learning activities is 90.2%. While in the Control class, the value of teacher teaching activities is in the Good and Very Good category, and the importance of student learning activities is 80.8%. The prerequisite test shows that the data is typically distributed and homogeneous. It is concluded that using Problem Based Learning strategies can significantly improve achievement or learning outcomes. In contrast, direct learning strategies cannot substantially improve learning achievement or outcomes.

Keywords: Learning Strategies; Problem Based Learning; Direct Learning; Learning Outcomes.

INTRODUCTION

Teachers should provide opportunities for students to think, analyze, solve problems, and act without fear so that the learning process can run more effectively and efficiently [14]. The success of the teaching and learning process is the main thing that must be achieved in implementing education in schools [11]. Student participation in learning activities is essential in determining the success of learning activities [18]. Teaching and learning activities in schools aim to achieve increased learning outcomes [16]. Learning outcomes are the value of student achievement after following the learning process as a form of knowledge and understanding and their application [8].

The learning process implemented for students can effectively improve knowledge, skills and changes in characteristics as a provision to be applied in everyday life. Therefore, learning effectiveness depends on the learning objectives that will improve specific learning outcomes [9]. Thus, learning outcomes are changes in student behaviour after learning material in a subject at school.

One of the subjects taught at the Madrasah Aliyah level is Fiqh. Fiqh is knowledge of Islamic Shari'a laws obtained through the ijtihad method [3]. Fiqh subjects in the Madrasah Aliyah curriculum are defined as one of the clusters of Islamic religious education subjects that aim to prepare students to recognize, understand, appreciate, and practice Islamic law, which becomes the basis for their way of life [15].

In Fiqh, subjects students are taught about the concepts of Fiqh and worship in Islam, including property ownership contracts, buying and selling, khiyar, muamalah, alms, grants, gifts, endowments, usury and insurance [6]. Likewise, at MA Palapa Nusantara, Fiqh learning is expected to provide understanding for students in responding and practising it in their social life. By understanding Fiqh, students can carry out worship properly and correctly because Fiqh is the

understanding of the scholars of Islamic law contained in legal sources (Al-Qur'an and As-Sunnah) [2]. MA Palapa Nusantara has an educational identity that leads to religious education and provides a forum for teaching and learning. So the Fiqh learning process supports the realization of increasing students' human resources from the intellectual side, emotional and spiritual, that the vision and mission of the MA Palapa Nusantara can be realized and implemented correctly through effective and efficient planning, implementation and evaluation.

The process of learning Fiqh at MA Palapa Nusantara has been carried out quite well. The student's activities in the classroom and the level of students' understanding of the material being taught are still very lacking. This is thought to be influenced by the learning strategy applied by the teacher is still not appropriate. The passive learning process the teacher uses causes students to sit, listen, and record learning and impacts students' difficulties in understanding and exploring what is being learned. Students do not play an active role in the learning process, and it is challenging to develop their thinking skills. What the teacher said they ignored and did not become something important to them. Then some students also look sleepy because the class atmosphere is less lively. Students rarely ask questions, although teachers often ask students to ask students if there are things that are not clear or not understood. This problem arises because students ignore what the teacher says. The material presented by the teacher does not become the focus of their thinking.

Some teachers at MA Palapa Nusantara have not fully presented the appropriate learning stages. For example, teachers rarely do apperception activities to attract students' attention to new material to be taught when starting learning, even though those activities are essential because the understanding depends on students' readiness to accept the latest material. In addition, not many teachers explain the learning objectives or objectives of the material to be taught. The teacher directs students to listen to the explanation of the material and even reads the material directly without requiring the purpose of the learning being carried out. It is not uncommon for teachers to leave the topic being taught, so misconceptions among students often happen.

The preliminary observations on students' Fiqh abilities at MA Palapa Nusantara showed that many students did not understand the proposed Fiqh principles, which became the initial foundation in learning Fiqh. Students are also unable to relate the problems given by the teacher with the appropriate arguments of the Qur'an or Hadith. Even students consider what is found in the book far from social practice. In this condition, students should be able to practice the laws contained in the Qur'an and Al-Hadith as a basis for carrying out daily activities.

The teacher does not present problems related to the material being taught, even though Fiqh in social practice is constantly developing. Still, in reality, the issues presented by the teacher are only fixated on what is contained in the book. These problems are still general and not infrequently; what exists is very far from what students face in their environment. So indirectly, the strategies prepared by the teacher have not been fully able to develop student's analytical skills or investigations related to the topic of problems they receive. Learning activities are still centred on the teacher, and the teacher is the main object, while students only act as passive listeners who are still confused by what the teacher says.

The teacher-centred learning process results in a lack of student-cooperative attitudes [4]. Students tend not to be able to discuss with their classmates because learning comes entirely from the teacher. Teachers rarely direct students to consult with their classmates about the problems and do not give students the time to present or reflect on what they have learned. It is essential to strengthen the material and conclude learning outcomes through reflection activities during the learning process. These activities will provide material conclusions to students so they can be implemented in their daily lives.

Then the results of observations on student activities during the learning process are students rarely pay attention to the teacher while studying. Students tend to do other activities in the classroom, such as playing and talking with their classmates and sometimes, students are found sleeping in class. Student responses when learning activities are very lacking, and student's ability to solve problems and deliver problem-solving results are not so good. When directed to analyze, most students cannot find a clear picture of the issues they receive. Then when making presentations or reading the results of discussions in front of the class, students tend to be

nervous, embarrassed, and unable to convey the results of their meetings.

Observing these problems and the current issues that are developing in education today, we need a learning strategy that has appropriate characteristics and can solve educational problems at MA Palapa Nusantara. It's a learning strategy that gives students an active role in current conditions, can develop thinking and demands students to explore the problem so that students can provide their conclusions on the current situation and find solutions to problems in the learning process. One of the active learning strategies is the Problem Based Learning strategy.

The problem-Based Learning Strategy was initially developed by Howard Barrow in the 70s in medical science at Southern Illinois University School. At first, Problem Based Learning was used to study various cases in patients with diseases to be cured [10]. Then after Problem Based Learning was successfully applied to overcome problems in the medical world, scientists tried to use Problem Based Learning strategies in the field of education to overcome issues in the field of education [19]. So there is a Problem Based Learning strategy at MA Palapa Nusantara in Fiqh subjects to solve problems teachers, and students face in the teaching and learning process. A problem-Based Learning strategy is learning that begins by directing students to present problems related to learning materials that are closely related to everyday life. From the issues raised, the teacher requires students to solve these problems according to the steps of Problem Based Learning [17].

According to [5], the Problem Based Learning strategy can be applied through 5 phases, namely 1) problem orientation, 2) student organization for learning, 3) group investigation, 4) presentation of results, and 5) analysis and evaluation. Meanwhile, according to [12], the Problem Based Learning strategy is applied through four phases:

1) Reviewing and presenting problems. In this phase, the teacher reviews students' prior knowledge and directs students to give issues closely related to real-world life related to the material to be studied. This condition allows students to be motivated to explore information from several references as material to solve the problems that have been presented.

2) Develop strategies. In this phase, departing from the information collected in the first phase, students are directed to develop appropriate strategies to solve the problems that have been presented.

3) Apply strategies. In this phase, students use the methods that have been prepared in the second phase to solve the problems that have been presented.

4) Discuss and evaluate the results. In this phase, the teacher asks students to assess the validity of their solutions by asking representatives from each group to report the results in front of the class.

The four phases allow the Problem Based Learning strategy to influence students' Fiqh learning outcomes because, in the Problem Based Learning strategy, students gain knowledge from the problem-solving process that has been carried out [20]. This condition is in line with what was stated by [20] that the Problem Based Learning strategy can affect students' knowledge in solving social problems that exist in society [12]. Because applying those strategies can help students understand the Fiqh concepts, they are learning and help them find links between ideas.

This is in line with the results of research by [13], that the Problem Based learning strategy affects students' cognitive abilities because it is one of the student-centred learning strategies that begin with presenting real-world problems and then solved by students [7]. This condition allows Fiqh subjects to become a preferred field of study so that, in the end, it can affect students' Fiqh learning outcomes. Problem Based Learning strategy can solve Fiqh learning problems at MA Palapa Nusantara by looking for issues experienced by students in studying Fiqh subjects, then influencing overcoming problems encountered in learning. However, from the beginning of 2020 to 2022, all countries worldwide, especially Indonesia, are still hit by the disaster, namely the COVID-19 outbreak. The COVID-19 pandemic is a health crisis that has hit almost all corners of the world [1]. This pandemic impacts various fields, one of which is the field of education. To overcome the COVID-19 pandemic, all countries in the world, especially Indonesia, have implemented social distancing, namely social distancing designed to reduce the interaction of people in the broader community [1]. With social distancing, learning in schools is hindered, so the government urges the government to carry out online learning for areas exposed to COVID-19 and face-to-face for areas not exposed to COVID-19.

Based on the description above, it is necessary to research the effect of problem-based and direct learning strategies on the fiqh learning outcomes of MA Palapa Nusantara East Lombok students in the 2021/2022 academic year.

METHODS

The type of research used in this research is quantitative with an experimental research approach with Quasi-Experimental Design research methods. The population in this study were MA Palapa Nusantara students as a whole, with the number of classes consisting of 8 and the total number of students being 210. The sampling technique used in this research is group sampling (Cluster Random Sampling). So that the section or class used to represent the population consists of two classes, namely the experimental class, which is taught by problem-based learning strategies and the control class, which is taught by direct learning strategies.

This research was conducted in MA Palapa Nusantara Selebung, Keruak District, East Lombok Regency. The analysis is carried out in the even semester of the 2021/2022 academic year. The research variables used in this study are:

1) The dependent variable measured in this study is the student's Fiqh learning outcomes in Fiqh subjects;

2) The independent variables used in this study are problem-based learning strategies and direct learning strategies – the research design used in this study is a nonequivalent control group design (Table 1).

Table 1 – Research design nonequivalent control group design

Group	Pre-Test	Treatment	Post Test
Experiment	O1	X	O2
Control	O3		O4

Notes: O1 – Initial ability test results in the experimental class (pre-test); O2 – Final ability test results in the experimental class (post-test); O3 – Initial ability test results in the control class (pre-test); O4 – Final ability test results in control class (post-test); X – Treatment with problem-based learning strategies

The data collection techniques used in this study were the test, observation, and documentation to obtain relevant results. The data analysis techniques for this research are prerequisite, normality, homogeneity, and hypothesis testing. After the prerequisite test is met, the research hypothesis test is carried out by the Independent Samples T Test. This test is conducted to test the subject before and after a process. The criteria used to test the hypothesis are: If the probability value (sig) > 0.05, Ho is accepted.

RESULTS AND DISCUSSION

The Effect of Problem-Based Learning Strategies on Students' Fiqh Learning Outcomes. The data collected in this study came from the results of students' Fiqh tests which consisted of students' pre-test and post-test scores, teacher teaching activities, student learning activities, discriminating power of questions, and level of difficulty. The data that has been collected is then analyzed carefully. So the analysis results will be a strong basis for making decisions or conclusions in this study.

After taking action using the Problem Based Learning strategy, it can be seen that the changes in the scores or scores obtained by the students, namely the average value of 67 in the pre-test, increased to 85.7 in the post-test. And the highest score on the pre-test, 80, rose to 95 on the post-test. And the lowest score of 50 on the pre-test increased to 77.5 on the post-test.

Data on teaching activities during the teaching and learning process takes place using a problem-based learning approach. It can be seen that teacher teaching activities using a Problem Based Learning approach are in the Good and Very Good categories. For teacher teaching activities for eighteen, the number of very good predicates is 13 times, and for suitable predicates, five times.

Data on student learning activities during the study showed that student learning activities using a learning approach using Problem Based Learning had a value of 90.2% with the percentage of student learning activities in each face-to-face meeting, which varied considerably.

For the difficulty level, the questions are at the Easy and Medium levels, consisting of 9 items having a moderate level of difficulty and 31 questions having an Easy level of difficulty. After conducting the test of the discriminatory power of

the items, it is known that for each item, there is "an excellent distinguishing power of the items".

Before testing the hypothesis of each problem formulation, what must be done first is to determine the Normality and Homogeneity test. The results of the calculation show t count > t table, it can be concluded that the application of Problem Based Learning strategies can improve learning outcomes or student achievement. Decision: Because t arithmetic (5.84)>t table (1.69 ,with degrees of freedom (dk) = n–1=32–1=31, α= 0.05, then there is a significant difference. Thus, it can be concluded that applying Problem Based Learning (PBL) Learning Strategies can significantly improve achievement or learning outcomes.

In research activities on Problem Based Learning strategies, it is clearly seen that learning achievement has increased significantly. The significance of this learning achievement is influenced by the learning strategies used so that the value of students has a significant difference after experiencing the action in the classroom.

The Influence of Direct Learning Strategies on Students' Fiqh Learning Outcomes. After taking action using the Direct Learning strategy, it can be seen that the changes in the scores or scores obtained by the students, namely the average value of 67 in the pre-test, increased to 79 in the post-test. And the highest score on the pre-test, 77.5, increased to 85 on the post-test. And the lowest score of 57.6 on the pre-test increased to 72.5 on the post-test. The teacher's activities for eighteen meetings revolved around the predicates of Good and Very Good, where the number of very good predicates is five times and of suitable predicates 13 times.

Data on student learning activities during the study showed that learning activities using a learning approach using Direct Learning had a value of 80.8%. The percentage of student learning activities in each face-to-face meeting varied considerably.

The questions are at the Easy and Medium levels for the difficulty level. Which consists of 10 items having a moderate level of difficulty level and 30 questions having an Easy level of difficulty level. As for the differentiating power of the items in this research, the different ability of the questions is good, and the extra power of the questions is excellent, which consists of 2 questions that have good discriminatory power and 38 questions with superior discriminating power.

After analyzing the data, it is known that t count (-12,63) < t table(1,69) , with degrees of freedom (dk) = n – 1 = 32 – 1 = 31,α= 0.05, then there is no significant difference. So the conclusion is that implementing Direct Learning (DL) learning strategies cannot significantly improve achievement or learning outcomes.

Differences in Fiqh Learning Outcomes by MA Palapa Nusantara Students who were taught with Problem Based Learning Strategies with Direct Learning Strategies on Fiqh Learning Outcomes of MA Palapa Nusantara Students. In the Experimental class that uses Problem Based Learning strategies after the post-test activity, the student's average score is 85.7. The highest value is 95, and the lowest value is 77.5. The teacher's teaching activities revolve around Good and Very Good predicates, where the number of very good predicates is 13 times and of suitable predicates five times. At the same time, the average percentage of student learning activities contributed to 90.2%. The item discrepancy is very good for the discriminatory power of the items; as for the difficulty level, the questions are at the Easy and Medium levels. Which consists of 9 items having a moderate level of difficulty level and 31 questions having a manageable level of difficulty level α= 0.05, then H_0 is accepted. So based on the results of the analysis above, it can be concluded that "The application of Problem Based Learning (PBL) Learning Strategies can significantly improve achievement or learning outcomes".

Based on the calculations carried out, it was obtained that there was a sufficient or moderate correlation coefficient between the pre-test and post-test scores. It got t-count (-12.63 < t table (1.69) with the conclusion that the application of Direct Learning (DL) learning strategies did not can significantly improve achievement or learning outcomes. After conducting post-test activities in the control class using Direct Learning strategies, the student's average score was 79. The highest score was 85, and the lowest was 75 in teacher-teaching activities ranges in the predicate Good and Very Good. The average percentage for student learning activities is 80.8%. The differentiating power of the items is in the Distinctive Power of Good Questions and the Distinctive Power of Very Good Questions.

Based on the results of the analysis, it is clear that there are differences in the achievement of stu-

dent learning outcomes that are taught using Problem Based Learning and Direct Learning strategies. The two differences have a significant difference. Some tests are carried out, such as the pre-test and post-test correlation tests in the experimental class or classes taught using the Problem Based Learning strategy. The correlation value shows good quality as evidenced by the correlation value that has been fulfilled; namely t count is more significant than the t table. While in the control class or the class taught using the Direct Learning strategy. There was no significant change, as evidenced by the pre-test and post-test correlation tests results that still did not meet the calculation criteria, namely, the t-count is smaller than the t-table. In addition, the average student learning outcomes using Problem Based Learning is higher than Direct Learning with normally distributed data. Several other factors are discriminatory power and difficulty level, leading to problem-based learning strategies. It is concluded that applying Problem Based Learning strategies is more effective than Direct Learning.

CONCLUSIONS

Based on the results of the study, it can be concluded that:

1) There is a positive (significantly) effect on the use of Problem Based Learning (PBL) learning strategies on Fiqh learning outcomes for MA Palapa Nusantara students;

2) There is no positive effect (significantly) of the use of Direct Learning strategies on Fiqh learning outcomes for MA Palapa Nusantara students;

3) There are differences in Fiqh learning outcomes for Palapa Nusantara MA students who are taught using Problem Based Learning (PBL) strategies with students who are taught using Direct Learning strategies.

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Finite Element Analysis of Continuous Plates Using a High-Performance Programming Language (MATLAB)

Amaefule Excel Obumneme [1], **Abuka Owen Chukwuebuka** [1], **Nwachukwu Nnaemeka Chukwudi** [1], **Nnadi Chukwuebuka Oscar** [1], **Ogbonna Chibueze Nelson** [1], **Adeyemo Habeeb Keji** [1], **Ogundu Meshack Ibeamaka** [1], **Okechukwu Sunday** [1], **Chinomso Don-Ugbaga** [1], **Gregory Ezeokpube** [1]

[1] *Michael Okpara University of Agriculture, Umudike*
PMB 7267, Umuahia Umudike, Abia State, Nigeria

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Corresponding Author:
olipas.cris@gmail.com

Abstract. This paper uses MATLAB, a finite element software program to compare the results of several finite analysis methods for continuous plates and check the degree of correlation with the exact values obtained by Timoshenko (1959) and Cheung (1996). The results showed little or no significant difference between plates in finite elements. Two different finite Numerical techniques are used. The Finite Strip and Exact methods and their results are compared to the results from the MATLAB program. Finite element analysis (FEA) workflow using MATLAB includes generation of meshes, geometry creation, defining physics of load, initial conditions and boundary problems, calculation, and results from visualization. FEA is a very general approach for solving Equations in science and engineering. This work offers solutions to the increasing errors associated with several other numerical methods when solving any equations of plates (continuous). It makes it easier to calculate and design larger structures through geometry discretization of plates and plains into more minor elements.

Keywords: Finite Element Analysis; Finite Element Method; MATLAB; Continuous Plates; Finite Strip Method; Exact Method.

INTRODUCTION

The finite element method (FEM) is a technique that is used to analyze finite elements of any given phenomenon. For any physical phenomena to be quantified and comprehended, it is necessary to use mathematics; such physical phenomena can include thermal transport, structural or fluid behaviour, biological cell growth, and wave propagation. Partial differential equations (PDEs) describe most of these processes. However, the finite element method and other numerical techniques developed over the past decades are used to solve partial differential equations using a computer.

Finite element analysis is a numerical technique based on the finite element method (FEM). This technique uses computer programs to predict behaviours of several physical systems, such as the deformation of solids, fluid flow, and heat conduction. Engineers and physicists use FEA as it allows the application of physical laws to practical scenarios. This allows for precision, versatility, and practicality.

FEM is widely used to get solutions for complex problems in the engineering field that are formulated using PDEs.

The development of reliable computer programs is required for numerical simulations based FEM to get correct solutions. This undergraduate thesis aims to help students understand how finite element processes solve problems through computer programs. The foundations of FEM and other computational problems have been taught and discussed in class lectures. Although, a class alone is not sufficient to grasp deep knowledge of how the operations like matrix assembly, boundary conditions, etc. all work effectively.

The role of plate structures in every structural system that man has ever built cannot be overemphasized. Closed-form solutions to specific plate problems are seen in the literature and are an asset to this century's designers.

These solutions, however, are generally for plates with relatively simple support and loading conditions and restricted to elastic, homogenous, isotropic plates of constant thickness. During the early periods of engineering, plates were designed with much more strength than was required. With the introduction of digital computers, investigators have all focused on numerical techniques and their study, like the FEA, used to solve the problem of plate structures.

This work simply tries to offer solutions linked to the other numerical methods in solving continuous plate's equations through FEA. It aims at:

1. Reducing errors in calculation.

2. Aiding calculations of larger structures.

3. Aiding in the design of larger structures.

4. Develop programs that tackle issues on any form of continuous plates.

METHODOLOGY

Matrix Laboratory is a programming software used for quick and easy scientific calculations and Input/Output (I/O).

It has hundreds of built-in functions for a wide range of computations and many toolboxes set for different research disciplines, for example, data analysis, optimization, and statistics. Among much strength:

1) MATLAB may behave as a calculator or as a programming language.

2) MATLAB combines calculations and efficiently plots graphs.

3) MATLAB is not challenging to learn.

4) MATLAB is interpreted (not compiled), and errors are not hard to fix.

5) MATLAB is optimized to perform matrix operations quickly and efficiently.

6) MATLAB has some object-oriented elements.

Finite element analysis of continuous plates. Outline of steps. In any region of space where a particular phenomenon is occurring (continuum), a problem of any dimension, the field variables (stress, displacement, etc.) can assume an infinite set of values because it is a function of each generic point on the continuum. The finite element discretization procedure decreases the issues to one with a limited number of unknowns by dividing the solution region into smaller bits and expressing the unknown field variable in terms of an appropriate approximating function within each element. The values of the field variables gotten for specific pints which let on the element boundaries every other point in which the details are completely defined using the interpolation (approximating) function.

Step 1. Discretization of plate. The discretization is done accordingly, and if the number of divisions increases, it is done similarly. Sixty-four elements were discretized. The node and element numbers are also shown below [35].

Figure 1 shows the figures denoting the number of nodes in which the graphs are plotted in y and x directions using MATLAB for a 64-element division.

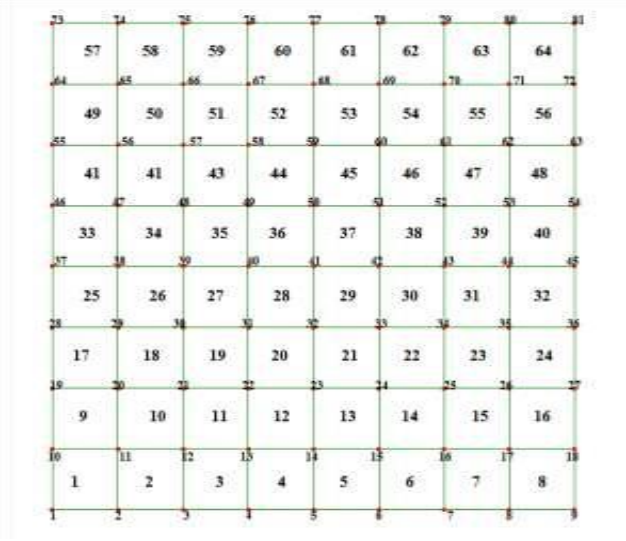

Figure 1

Figure 2 shows the node numbering done in the MATLAB program for the x-axis for 64 elements. The same procedure is used to number nodes. When the node number increases, the total will start from the centre of the plate along the x axis from left to right.

Figure 3 shows the numbering of nodes done in the MATLAB program for the y-axis for 64 elements. The same procedure will follow in the number of factors; increased node numbering will be done along the centre line of the plate from top to bottom.

The first thing to do in FEA is to divide the rectangular plate into more minor elements. The discretization can be achieved using a variety of factors, which depends on the degree of accuracy needed and the nature of the solution region.

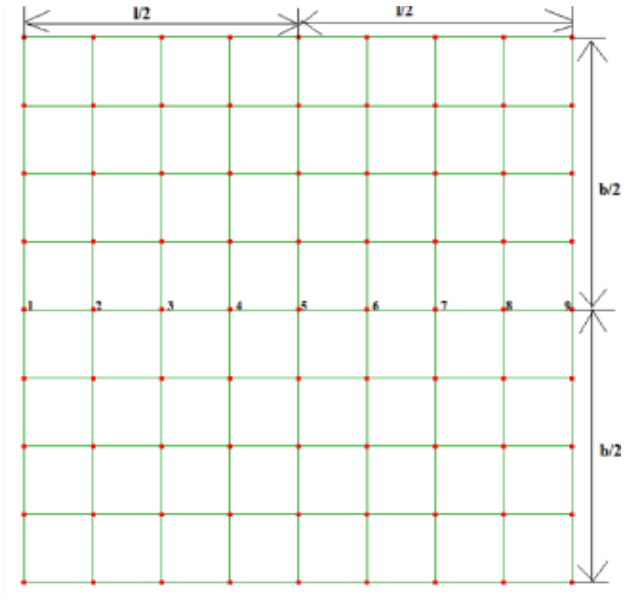

Figure 2

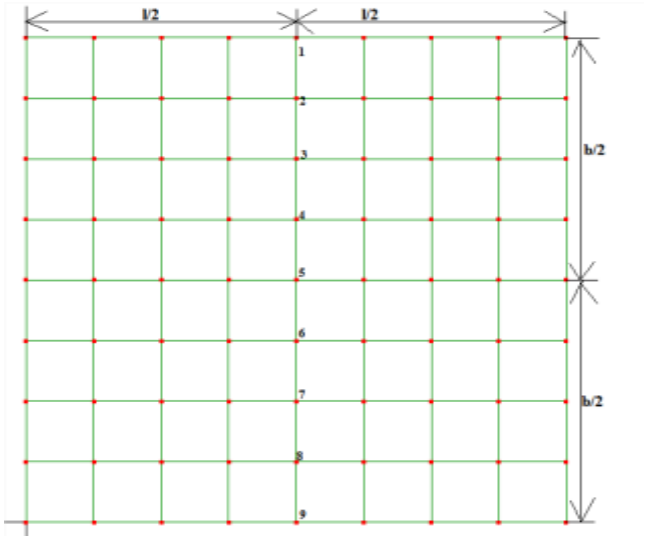

Figure 3

During the analysis of plates by FEM, the choice of the number and the kind of element used is only a matter of good judgment and experience. The number of finite elements in a portion of the solution region where the variable is being modelled (displacement) differs. An essential part of the discretization process is node identification and numbering. And the total of nodes should be orderly.

This is important because the finite element equation generated for each element takes cognizance of the node numbers around that element.

Step 2. Develop or write the MATLAB program for the plate.

```
% FiniteElementParkings1.m Program for Finite Element Analysis of
% Rectangular Plates subjected to Bending using Automatic Mesh Generation
% Data Programs
% FiniteElemMeshGen5a
% FiniteElemMeshGen5b
% FiniteElemMeshGen7a
% FiniteElemMeshGen7b
% FiniteElemMeshGen7c
% FiniteElemMeshGen7d
tic
FiniteElemMeshGen3aRebecca
% Ex = E;
% Ey = E;
% Vx = v;
% Vy = v;
% Gxy = E/(2*(1+v));
% Dx = Ex*t^3/(12*(1-Vx*Vy));
% Dy = Ey*t^3/(12*(1-Vx*Vy));
% D1 = Vx*Ey*t^3/(12*(1-Vx*Vy));
% Dxy = Gxy*t^3/12;
Ks=zeros(3*f,3*f);
K=zeros(12,12,s);
% k=zeros(12,12,s);
% ELEMENT STIFFNESS MATRIX CALCULATION
disp ('ELEMENT STIFFNESS MATRIX CALCULATION:');
for a1=1:s
%    FiniteElemStiffnessMatrix1
   p = a/b;
   s1 = 20*a^2*Dy + 8*b^2*Dxy;
   s2 = 15*a*b*D1;
   s3 = 20*b^2*Dx + 8*a^2*Dxy;
   s4 = 30*a*p*Dy + 15*b*D1 + 6*b*Dxy;
   s5 = 30*b*p^(-1)*Dy + 15*a*D1 + 6*a*Dxy;
   s6 = 60*p^(-2)*Dx + 60*p^2*Dy + 30*D1 + 84*Dxy;
   s7 = 10*a^2*Dy - 2*b^2*Dxy;
   s8 = -30*a*p*Dy - 6*b*Dxy;
   s9 = 10*b^2*Dx - 8*a^2*Dxy;
   s10 = 15*b*p^(-1)*Dx - 15*a*D1 - 6*a*Dxy;
   s11 = 30*p^(-2)*Dx - 60*p^2*Dy - 30*D1 - 84*Dxy;
   s12 = 10*a^2*Dy - 8*b^2*Dxy;
   s13 = -15*a*p*Dy + 15*b*D1 + 6*b*Dxy;
   s14 = 5*a^2*Dy + 2*b^2*Dxy;
   s15 = 15*a*p*Dy - 6*b*Dxy;
   s16 = 10*b^2*Dx - 2*a^2*Dxy;
   s17 = 30*b*p^(-1)*Dx + 6*a*Dxy;
   s18 = 5*b^2*Dx + 2*a^2*Dxy;
   s19 = 15*b*p^(-1)*Dx - 6*a*Dxy;
   s20 = -60*p^(-2)*Dx + 30*p^2*Dy - 30*D1 - 84*Dxy;
   s21 = -30*p^(-2)*Dx - 30*p^2*Dy + 30*D1 + 84*Dxy;
   k1 = [s1 -s2 -s4 s7 0 -s8
      -s2 s3 s5 0 s9 s10
      -s4 s5 s6 s8 s10 s11
      s7 0 s8 s1 s2 s4
```

```
        0 s9 s10 s2 s3 s5
       -s8 s10 s11 s4 s5 s6];
    k2 = [s12 0 s13 s14 0 s15
          0 s16 -s17 0 s18 -s19
          s13 s17 s20 -s15 s19 s21
          s14 0 -s15 s12 0 -s13
          0 s18 -s19 0 s16 -s17
          s15 s19 s21 -s13 s17 s20];
    k3 = [s1 s2 -s4 s7 0 -s8
          s2 s3 -s5 0 s9 -s10
          -s4 -s5 s6 s8 -s10 s11
          s7 0 s8 s1 -s2 s4
          0 s9 -s10 -s2 s3 -s5
          -s8 -s10 s11 s4 -s5 s6];
%    k(:,:,a1) = [k1 k2; k2' k3]*(15*a*b)^(-1);
   K(:,:,a1) = [k1 k2; k2' k3]/(15*a*b);
%    K = k(:,:,a1);
   N1 = Connectivity(a1,1);
   N2 = Connectivity(a1,2);
   N3 = Connectivity(a1,3);
   N4 = Connectivity(a1,4);
   X = [3*N1-2 3*N1-1 3*N1 3*N2-2 3*N2-1 3*N2 3*N3-2
3*N3-1 3*N3 3*N4-2 3*N4-1 3*N4];
   Ks(X,X) = Ks(X,X)+ K(:,:,a1);
%    Ks(X,X) = Ks(X,X)+ K;
   disp(Ks);
end
disp('FINAL GLOBAL STIFFNESS MATRIX IS:');
disp(Ks);
Fqs = zeros(12,1,s);
Fq = zeros(3*f,1);
for c3 = 1:length(sq) % Number of Finite Elements
considered for UDL (sq = s or 0)
%    q = SpecificGravity*t; % for self weight or specify the
value of q
%    q = 6; % for example
   N1 = Connectivity(sq(c3),1);
   N2 = Connectivity(sq(c3),2);
   N3 = Connectivity(sq(c3),3);
   N4 = Connectivity(sq(c3),4);
   Mx1 = -a*b^2*q/24;
   My1 = a^2*b*q/24;
   Fw1 = a*b*q/4;
   Mx2 = a*b^2*q/24;
   My2 = a^2*b*q/24;
   Fw2 = a*b*q/4;
   Mx3 = -a*b^2*q/24;
   My3 = -a^2*b*q/24;
   Fw3 = a*b*q/4;
   Mx4 = a*b^2*q/24;
   My4 = -a^2*b*q/24;
   Fw4 = a*b*q/4;
   Nq = [Mx1 My1 Fw1 Mx2 My2 Fw2 Mx3 My3 Fw3 Mx4
My4 Fw4];
%    disp('Element Load Vector due to Distributed Load q:
');
%    disp(Nq');
   Fqs(:,:,c3) = Nq';
   X1 = [3*N1-2 3*N1-1 3*N1 3*N2-2 3*N2-1 3*N2 3*N3-2
3*N3-1 3*N3 3*N4-2 3*N4-1 3*N4];
   Fq(X1) = Fq(X1) + Fqs(:,:,c3);
end
% disp('Net Global Load Vector due to Distributed Load : ');
% disp(Fq);
% disp('Global Load Vector due to Nodal Loads : ');
FnL = zeros(3*f,1); % Nodal Loads
% nL = Number of Nodes containing Nodal Loads
for a4 = 1:nL
   Nn = NodalNumber(a4); % Nodal Number of Node
containing Nodal Loads
   Mx = NodalLoad(a4,1);
   My = NodalLoad(a4,2);
   Fw = NodalLoad(a4,3);
   FnL(3*Nn-2,1) = FnL(3*Nn-2,1) + Mx;
   FnL(3*Nn-1,1) = FnL(3*Nn-1,1) + My;
   FnL(3*Nn,1) = FnL(3*Nn,1) + Fw;
end
% disp('Net Global Load Vector due to Nodal Loads : ');
% disp(FnL);
Fs = Fq + FnL;
% disp('Net Global Load Vector = ');
% disp(Fs);
% disp('CALCULATION OF DISPLACEMENTS:');
% disp('Put zero boundary conditions for displacements :');
Ds = zeros(3*f,1);
BCs = zeros(3*f,1);
for c5=1:f;
   Ns = Nodes(c5); %input('Give nodal number : ');
   U = BoundaryCondition(c5,1); %input('Type [0] for no
Translation in the Global X Direction else Type [1] : ');
   V = BoundaryCondition(c5,2); %input('Type [0] for no
Translation in the Global Y Direction else Type [1] : ');
   W = BoundaryCondition(c5,3); %input('Type [0] for no
Translation in the Global Z Direction else Type [1] : ');
   BCs(3*Ns-2,1) = U;
   BCs(3*Ns-1,1) = V;
   BCs(3*Ns,1) = W;
end
Dr = find(BCs);
Kr = Ks(Dr,Dr);
disp('Reduced Structure Stiffness Matrix is:');
disp(Kr);
Fr = Fs(Dr,1);
% disp('Reduced Force Vector is:');
% disp(Fr);
% Ds(Dr,1) = Kr^(-1)*Fr;
Ds(Dr,1) = Kr\Fr;
% disp('DISPLACEMENT MATRIX IS OBTAINED AS :');
% disp(Ds);
% disp('CALCULATION OF MEMBER FORCES');
% % POST-PROCESSING
% % Calculation of STRAIN B and ELASTICITY MATRIX D
% % A = Inverse Matrix of C
A = [0 0 1 0 0 0 0 0 0 0 0 0
```

```
   0 1 0 0 0 0 0 0 0 0 0 0
   -1 0 0 0 0 0 0 0 0 0 0 0
   0 -2/a -3/a^2 0 0 0 0 -1/a 3/a^2 0 0 0
   1/a -1/b -1/(a*b) 0 1/b 1/(a*b) -1/a 0 1/(a*b) 0 0 -
1/(a*b)
   2/b 0 -3/b^2 1/b 0 3/b^2 0 0 0 0 0 0
   0 1/a^2 2/a^3 0 0 0 0 1/a^2 -2/a^3 0 0 0
   0 2/(a*b) 3/(a^2*b) 0 -2/(a*b) -3/(a^2*b) 0 1/(a*b) -
3/(a^2*b) 0 -1/(a*b) 3/(a^2*b)
   -2/(a*b) 0 3/(a*b^2) -1/(a*b) 0 -3/(a*b^2) 2/(a*b) 0 -
3/(a*b^2) 1/(a*b) 0 3/(a*b^2)
   -1/b^2 0 2/b^3 -1/b^2 0 -2/b^3 0 0 0 0 0 0
   0 -1/(a^2*b) -2/(a^3*b) 0 1/(a^2*b) 2/(a^3*b) 0 -
1/(a^2*b) 2/(a^3*b) 0 1/(a^2*b) -2/(a^3*b)
   1/(a*b^2) 0 -2/(a*b^3) 1/(a*b^2) 0 2/(a*b^3) -1/(a*b^2)
0 2/(a*b^3) -1/(a*b^2) 0 -2/(a*b^3)];
% disp('Inverse Matrix of C : ');
% disp(A);
syms x y
Wxy = [1 x y x^2 x*y y^2 x^3 x^2*y x*y^2 y^3 x^3*y x*y^3];
B1 = -[diff(Wxy,x,2); diff(Wxy,y,2); -2*diff(diff(Wxy,x),y)]*A;
D = [Dx D1 0; D1 Dy 0; 0 0 Dxy]; % D is Elasticity Matrix
% % CALCULATION OF ELEMENT FORCES IN LOCAL
COORDINATES
for Pannel = 1:Pannels
   for c6 = 1:Elements % Number of Finite Elements in a
Pannel for Post-Processing
      N11 = RespElemNumber(Pannel,c6);
      N1 = Connectivity(N11,1);
      N2 = Connectivity(N11,2);
      N3 = Connectivity(N11,3);
      N4 = Connectivity(N11,4);
      X2 = [3*N1-2 3*N1-1 3*N1 3*N2-2 3*N2-1 3*N2 3*N3-
2 3*N3-1 3*N3 3*N4-2 3*N4-1 3*N4];
      ElemDispl = Ds(X2,1);
      fprintf('Panel %d \n' , Pannel);
      fprintf('ELEMENT NUMBER %d \n' ,N11);
%       for c7 = 1:Ntp % Number of Interpoltion Points in the
Element
      x1 = ElemInterpolCoord(c6,1);
      y1 = ElemInterpolCoord(c6,2);
      B = subs(subs(B1,x,x1),y,y1); % B is the Strain Matrix
      Stresses = (D*B*Ds(X2,1))';
      NodalDisplacements = [ElemDispl(3*c6-2)
ElemDispl(3*c6-1) ElemDispl(3*c6)];
      fprintf('Stresses at Node %d \n' , c6);
      disp('Mx, My, Mxy : ');
      disp(Stresses);
      fprintf('Displacements at Node %d \n' , c6);
      disp('Rotation about X, Rotation about Y, Deflection :
');
      disp(NodalDisplacements);
   end
end
% Special Response
% Twisting and Bending Moments at Node 1 of First
Corners of Pannels
for c8 = 1:Pannels
   N22 = FirstCornerElemNumber(c8);
   N1 = Connectivity(N22,1);
   N2 = Connectivity(N22,2);
   N3 = Connectivity(N22,3);
   N4 = Connectivity(N22,4);
   X3 = [3*N1-2 3*N1-1 3*N1 3*N2-2 3*N2-1 3*N2 3*N3-2
3*N3-1 3*N3 3*N4-2 3*N4-1 3*N4];
   ElemDispl = Ds(X3,1);
   x1 = 0;
   y1 = 0;
   B = subs(subs(B1,x,x1),y,y1); % B is the Strain Matrix
   Stresses = (D*B*Ds(X3,1))';
   fprintf('ELEMENT NUMBER %d \n' ,N22);
   NodalDisplacements = [ElemDispl(1) ElemDispl(2)
ElemDispl(3)];
   fprintf('Stresses at Node 1 of Panel %d \n' , c8);
   disp('Mx, My, Mxy : ');
   disp(Stresses);
   fprintf('Displacements at Node 1 of Pannel %d \n' , c8);
   disp('Rotation about X, Rotation about Y, Deflection : ');
   disp(NodalDisplacements);
end
toc
```

Step 3. Run program for result. After all the essential information, click on the run menu to run the program for the result.

Step 4. Compare the result with the finite strip method and the exact method. After getting the results, compare the result with Timoshenko's exact method [40] and Cheung's finite strip method [4].

Step 5. Solve for a plate with different widths and lengths. Assume the width of a plate is four and the length is also four for each of the spans. Assume also the value of q in the *UDL* to be 10000 N/m^2, with thickness as 0.2; Young's modulus E=30×10^6 N/m^2, Poison's ratio v=0.2 and D=Et^3/(12(1–v^2).

RESULTS AND DISCUSSION

Finite element analysis for thin plates continuous over three spans. This section of the research work has solved a thin rectangular plate continuous over three spans using the limited element software program developed by the authors. The scale is simply supported on all edges, including the intermediate lines.

Plate properties: S – Number of finite element; W – Width of plate; a=1; L – Length of plate = 3a = 1; E – Young's modulus = 30×10^6 N/m^2; V – Poison's ratio = 0.2; t – thickness = 0.2; q – Uniformly distributed load (UDL) = 10000 N/m^2.

$$D = \frac{Et^3}{12(1-v^2)} = \frac{30\times10^6\times0.2^3}{12(1-0.2^2)} = 20833.33\ N/m^2$$

The analysis has been done for: a plate with width and length equals one; a plate with width and length equals four with the same thickness.

Results for a plate with width and length equal to one (Table 1). The results from this research were compared to [40, p. 231; 4, pp. 87–88].

Result for plate with width and length equals to four (Table 2). Consider a continuous plate with three equal spans of width = 4 and length = 4 using the same thickness of 0.2; q=10000 N/m^2; D=20833.33 N/m^2 ; a = 4.

Table 1 – Refined Methods – Finite element answer, and the answers also corresponds with that of finite strip method and exact method

m/n	Number of finite elements	Deflection of the middle of the panel 1, WA $(\frac{qa4}{D})$	Deflection of middle of panel 2, W	Longitudinal moment of first interior support, M_yB (qa^2)	Transverse moment of panel 2, M_xC	Longitudinal moment of panel 2, M_yC
5	48	-0.0719	0.0036	-6112	5152	6064
7	108	-0.0719	0.0036	-6112	5152	6064
9	192	-0.0719	0.0036	-6112	5152	6064
11	300	-0.0720	0.0036	-6112	5168	6096
13	432	-0.0719	0.0036	-6112	5152	6064
15	588	-0.0718	0.0036	-6112	5136	6048

Table 2 – Finite element method for the continuous plate

m/n	Number of finite elements	Deflection of the middle of the panel 1, WA $(\frac{qa4}{D})$	Deflection of middle of panel 2, W	Longitudinal moment of first interior support, M_yB (qa^2)	Transverse moment of panel 2, M_xC	Longitudinal moment of panel 2, M_yC
5	48	-0.0585	0.0029	-0.0382	0.0322	0.0379
7	108	-0.0585	0.0029	-0.0382	0.0322	0.0379
9	192	-0.0585	0.0029	-0.0382	0.0322	0.0379
11	300	-0.0586	0.0029	-0.0382	0.0323	0.0381
13	432	-0.0585	0.0029	-0.0382	0.0322	0.0379
15	588	-0.0584	0.0029	-0.0372	0.0317	0.0378
Finite strip method [4]		-0.0583	0.0029	-0.0372	0.0319	0.0373
Exact method [40]		-00583	0.0029	-0.0381	0.0317	0.0375

CONCLUSIONS

The results from MATLAB for continuous plates exhibit a high degree of correlation with the values of [40] and [4]. The analysis shows that the accuracy of results obtained for the plate in various finite elements had negligible differences.

Computerization of plate analysis by numerical methods (finite element method) presents the difficulty of computer memory management and ample execution time. It was observed that the execution time for various element software would increase as the number of finite elements. A new area of research has arisen recently, which would help tackle the problem of high execution time and efficient memory usage during program execution. Given the trouble of execution time, it is advised that a computer of higher memory capacity be used at least a quad-processor (4 GB RAM and above) for calculations to generate the desired solution.

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Study of Road Surface Damage due to Rainwater Puddles using the Pavement Condition Index

Taufikurrahman [1], **I Dewa Made Alit Karyawan** [1], **I Wayan Yasa** [1]

[1] *University of Mataram*
Jl. Majapahit No. 62 Mataram, Nusa Tenggara Barat, Indonesia

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Corresponding Author:
I Dewa Made Alit Karyawan
dewaalit@unram.ac.id

Abstract. Damage to the road surface will cause many losses that users can feel directly. One of the factors that influence the damage is waterlogging. In Mataram City, several roads experience inundation and water runoff when it rains, such as Jalan Swasembada Kekalik and Jalan Kesra Raya Perumnas. The impact on road construction is a change in the shape of the road surface layer, which causes road service performance to decline. So, it needs to be analyzed to determine the damage to the pavement structure in several segments, both flooded and not. The method used to carry out road damage analysis is the method (Pavement Condition Index) PCI. Surveying road conditions in the field collected data. The PCI value is obtained after calculating the parameters, namely: density, deduct value (DV), total deduct value (TDV), and corrected deduct value (CDV). The results showed that the types and average values of damage to Jalan Swasembada Kekalik were: subsidence (6.22%), edge cracks (3.22%), vertical downhill road edges (8.22%), patches (4.25 %), holes (1%), grain release (27.33%). The average value of the Pavement Condition Index (PCI) for each segment is 36.33%, which is at a lousy level (Poor). In comparison, on Jalan Kesra Raya Perumnas, the PCI value is 82.5%, which is at a reasonable level (Good) evidence that the inundated section has a worse condition than the unflooded section is seen in the Jalan Swasembada Kekalik section, where the inundated area has a poor to poor condition. In contrast, the unflooded team has a very good to perfect condition. For the Jalan Kesra Raya Perumnas section, although in flooded areas, the road conditions are less than those that are not flooded, overall, the roads are in good to perfect condition. By looking at the conditions on each lane, it is necessary to deal damage to several road segments immediately to have a decent performance in serving traffic.

Keywords: Road Damage; Pavement Condition Index; Puddles.

INTRODUCTION

The components that cause road damage are increased traffic loads, inadequate drainage systems and asphalt pavement materials. Other causes are climate, unstable soil conditions, and planning and execution of work that is not by specifications [1]. Road damage is not caused by one factor alone but can be a combination of several interrelated causes [11].

Factors causing road damage, in general, are increased traffic volume loads, poor drainage systems, poor pavement construction material properties, weather, unstable soil conditions, very thin pavement layer planning, and inappropriate work implementation processes with specifications [5, 10, 12].

Drainage channels not functioning properly lead to puddles on the road surface. Other things that cause inundation are changes in land function and reduced catchment areas [7]. Empirical observations show that the dominant pool of water above the road surface occurs because of the road drainage system. This is due to the lack of integration with the spatial water system of the area around the road and uncontrolled spatial planning. Water in this puddle enters through the pores of the pavement surface so that it can damage the asphalt bond [9].

Several road segments in Mataram City experience inundation and water runoff when it rains. These areas include Kekalik (Jalan Swasembada) and Perumnas (Jalan Kesra Raya). The condition

of the road shows that there are puddles in several segments during the rain and persist after the rain has stopped. The impact on road pavement is a change in the shape of the road surface layer in the form of potholes, rutting, cracks, ravelling, and edge scouring. This causes road service performance to decline. According to [6], waterlogging causes the pavement base to be entirely or partially saturated in the road drainage system.

The damage that occurred in the segment that experienced inundation appeared to be more severe than that which was only inundated when it rained. The effect of inundation on road damage can be determined by comparing the analysis results of road damage analysis on the flooded (submerged) and the un-submerged segments. Several methods can be used to analyze road damage, including the Pavement Condition Index (PCI). PCI is a road pavement condition assessment system based on the type and level of damage that occurs and can be used as a reference in maintenance efforts. Identify the type of damage, the severity of the injury, and its size based on the observations during the visual condition survey [8].

It is necessary to study the effect of inundation on road surface damage by looking at the conditions on two roads (Jalan Swasembada Kekalik and Jalan Kesra Raya Perumnas). The purpose of the study was to determine the damage to several road segments in the inundated and unflooded sections when it rains using the PCI method. Based on the results of the analysis, it can be seen the condition of the road surface, whether it is in a state of failure, good to perfect. This is needed to provide recommendations for handling, so that road conditions are feasible to serve traffic.

Types of Pavement Damage [2], divided into 19 damages, namely:
1) Crocodile Cracking (Alligator Cracking)
2) Overweight (Bleeding)
3) Block Cracking
4) Basin (Bumb and Sags)
5) Curly (Corrugation)
6) Depression
7) Edge Cracking
8) Joint Reflec Cracking
9) Vertical Downhill Edge (Lane/Shoulder Drop Off)
10) Longitudinal Crack /Transverse Cracking)
11) Patching (Patching end Utility Cut Patching)
12) Wearing Aggregate (Polished Aggregate)
13) Pothole
14) Damaged Railroad Crossing (Railroad Crossing)
15) Groove (Rutting)
16) Sungkur (Shoving)
17) Broken Slip (Slippage Cracking)
18) Swelling (Swell)
19) Grain Release (Weathering/Raveling).

Pavement Condition Index (PCI) is the level of the condition of the pavement surface and the size in terms of road capability, which refers to the state and damage to the pavement surface. PCI is a numerical index whose value ranges from 0 to 100. A value of 0 indicates the pavement is in a failed condition, and a weight of 100 means that the pavement is still perfect. This PCI is based on the results of a visual condition survey. The type of damage, the extent of the damage, and its size are identified when surveying the condition. PCI was developed to provide an index of pavement structural integrity and surface operational conditions. Damage information obtained as part of the PCI condition survey includes information on the causes of the damage and whether the damage is load-related or climate-related.

In the PCI method, the severity of pavement damage is a function of 3 main factors: a) Type of damage, b) The severity of the damage, and c) The amount or density of the damage. The PCI method only provides information on pavement conditions when the survey is conducted but cannot provide a predictive picture in the future. However, by conducting periodic condition surveys, information on pavement conditions can help predict future performance. In addition, it can also be used as input for more detailed measurements.

Theoretical basis

Determination of Pavement Condition Index Value. PCI values are obtained in the following order: a) determine the density, b) determine the deduct value, c) determine the total deduct value, d) find the value of q, e) find the correct deduct value (CDV), f) calculate Pavement Condition Index (PCI) value.

Density. Density is the percentage of the total area or length of one type of damage to the size or total length of the measured road section. Thus, the damage density can be expressed in equations 1 or 2.

$$Density = \frac{Ad}{As} \times 100, \quad (1)$$

$$Density = \frac{Ld}{As} \times 100, \quad (2)$$

Where *Ad* – total area of damage type for each level of damage (m^2), *Ld* – full length of damage type for each level of damage (m), *As* – total area of segment unit (m^2).

Deduct Value. Deduct value is a deduction value for each type of damage obtained from the curve (Figure 1) of the relationship between density and severity level of damage.

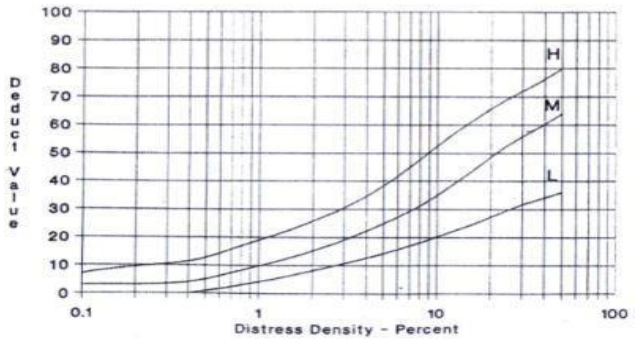

Figure 1 – Graph of deducting value (deduct value)

Total Deduct Value. Total Deduct Value (TDV) is the full value of the individual deduct value for each type of damage and the damage level in a research unit (Table 1).

Table 1 – TDV Nilai value

STA	Deduct Value (DV)					TDV
0+*** to 0+***	13	23	18	27	42	123

Finding the value of q. The requirement to determine the value of q is determined by the sum of the individual deduct values greater than 5 in each road segment under study (Table 2). For example, if there are five values of DV>5, then *q*=5.

Table 2 – *q* value

STA	Deduct Value (DV)						q
0+*** to 0+***	13>5	23>5	18>5	27>5	42>5	4<5	5

Finding the Correct Deduct Value. The Correct Deduct Value (CDV) value can be found after the *q*, and TDV values are obtained (see points *c* and *d* using the curve in Figure 2.

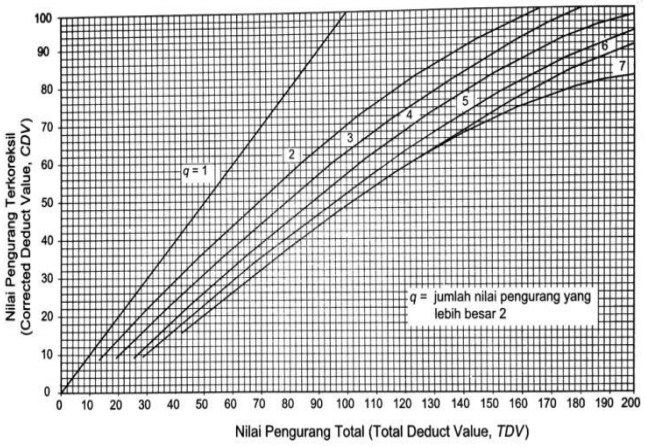

Figure 2 – CDV Graphics

Calculating PCI Nilai Value. The PCI value is obtained using equation 3, using the CDV value.

$$PCI = 100 - CDV, \quad (3)$$

The overall pavement PCI value is N. The overall PCI value on a particular road pavement segment is researched using equation 4 [4].

$$PCI_f = \sum_{i=1}^{N} PCI, \quad (4)$$

where PCI_f – Average PCI value of all research segments; *PCI* – PCI for each sample unit or research unit; *N* – number of sample units.

The condition of road damage based on PCI values can be seen in Table 3.

Table 3 – PCI Value Magnitude

PCI value	Condition
0–10	Failed
11–25	Very bad (very poor)
26–40	Bad (poor)
41–55	Medium (fair)
56–70	Good (good)
71–85	Very good (very good)
86–100	Perfect (excellent)

Repair Method. According to the practical instructions for routine maintenance of roads UPR.02.1 of 1992, the Director General of Highways has several methods of handling that can be done, among others: Met Handling ode 2 (P2) and Handling Method 5 (P5). Handling Method 2 (P2) is Local Sealing, while Handling Method 5 (P5) is Hole Patching [3].

Method (P2) (Local Sealing), performed on damage: Cracking lines (cracking) and Crocodile skin cracking (alligator cracking). The handling steps are cleaning the area to be handled, marking the square in the place to be dealt, spraying 1.5 kg/m^2 emulsion asphalt on the marked area until evenly distributed, spreading coarse sand or fine aggregate and levelling when using fine aggregate compacted with a light compactor [3].

Method (P5) Hole Patching can be done on damage: rutting Edge cracking, Holes (potholes), Deformation (deformation). Handling steps: making square marks on the area to be treated with paint or chalk, digging the road layer in the area that has been marked square until it reaches a solid layer, compacting the bottom of the excavation, filling the dug hole with substitute material (aggregate foundation layer or cold asphalt mix), consolidating layer by layer, and applying local asphalt over the last layer [3].

METHODS

Figure 3 – Research areas

Research Stages. The research stages include 1) the Research preparation stage, 2) the Data collection survey stage, and 3) the analysis of road damage data and discussion of the results.

The preparation stage is a series of activities before starting data collection and processing. This stage is carried out by preparing a plan to obtain efficiency and effectiveness of time and work. At this stage, preliminary observations are also carried out to get a general picture of identifying and formulating problems in the field. This preparatory stage includes 1) Study of literature/literature from the latest publications related to research; 2) Listing agencies and institutions that can be used as data sources; 3) Determining data needs, data collection methods and personnel needs in the field as well as data analysis methods and discussion of results.

Survey phase of direct visual data collection at the study site on the condition of road damage. The survey location is Section Mataram Self-Sufficiency Street and Perumnas Kesra Raya Street. The survey focuses on the current problems and the state of the damaged pavement under study. The data used to determine the level of road damage is in the form of data on the length, width, area, and depth of each type of damage. The tools used include stationery, roll meter, camera, and motor spray paint. At the same time, the materials used at the data collection stage are the first step after the preparation stage in the critical evaluation and planning process. Because from here, the problem can be determined, and a series of determining alternative problem solving is taken. The data needed include primary data and secondary data. The data analysis is carried out by finding the value of road conditions and knowing how to handle them, including maintenance or rehabilitation.

The analysis and discussion stage is carried out after the data is collected using the PCI method. The analysis results in PCI values are used to determine the level of damage and appropriate repair plans/recommendations. Besides that, there is also a discussion about the effect of the inundated and not flooded parts.

RESULTS AND DISCUSSION

Data on road conditions and damage. Based on the survey results, the condition and road damage on the Kekalik Self-Sufficiency Road and Perumnas Kesra Raya Road can be seen in Table 4.

Determine the Deduct Value (DV). The analysis is carried out for each segment on each segment. For example, the analysis used segments STA 0+100 to 0+150 Self-Sufficiency of Kekalik. In Table 4, it can be seen that the total value of each level of damage is: Side of the vertical descending road = 29 m; Patch= 22.5 m; Grain release= 39 m; Edge crack= 8 m; Amblas= 20 m.

Table 4 – Values of damage area of two road sections

Airfield asphalt pavement sketch: condition survey data sheet for the sample unit		Length: 50 m
1. Crocodile crack (m²) 2. Overweight (m²) 3. Checkered Crack (m²) 4. Basin (m²) 5. Curly (m²) 6. Amblas (m²) 7. Edge Cracks (m²) 8. Joint Crack (m²)	9. Sidewalk Downhill Vertical (m²) 10. Longitudinal / Transverse Crack (m²) 11. Patches (m²) 12. Aggregate Wear (m²) 13. Hole (count) 14. Rail Intersection (m²) 15. Groove (m²) 16. Sungkur (m²)	17. Broken Slip (m²) 18. Inflated Head (m²) 19. Grain Release (m²)

STA	Kekalik Self-Sufficiency Road Section					Perumnas Raya Welfare Road Section			
	Quantity, m					Quantity, m			
	19					12			
0+000 to 0+050	12					12			
Total	12					12			
	Quantity, m					Quantity, m			
	9	11	19						
0+050 to 0+100	15	2	20						
			4						
			5						
Total	15	2	29						
	Quantity, m					Quantity, m			
	6	7	9	11	19	1	6	7	19
	20	8	2	15	20	2	7	10	8
0+100 to 0+150			5	4.5	4				
			7	1.5	15				
			12	1.5					
			3						
Total	20	8	29	22.5	39	2	7	10	8
	Quantity, m					Quantity, m			
0+150 to 0+200	11	13 (counts)	19			1	6	12	
	3	1	10			4	4	15	
Total	3	1	10			4	4	15	
	Quantity, m					Quantity, m			
0+200 to 0+250	6	7	19			11	12	19	
	10	7	8			2	40	7	
Total	10	7	8			2	40	7	
	Quantity, m					Quantity, m			
0+250 to 0+300	13 (counts)	19				12	19		
	2	10				12	8		
Total	2	10				12	8		

Calculating density. Density is calculated by equation 3, as follows:

Side of the road down vertically = 29/(6×50)×100 = 9.67 %

Patches = 22.5/(6×50)×100 = 7.75 %

Grain release = 39/(6×50)×100 = 13 %

Edge Crack=8/(6×50)×100 = 2.67 %

Sink = 20/(6×50)×100 = 6.67 %

Deduct value is the reduction value for each type of damage obtained from the graph. Deduct Value (DV) STA 0+100 to 0+150 on Jalan Swasembada Kekalik can be seen in Figure 4.

Finding the maximum corrected subtraction (CDV). The CDV value in the STA segment 0+100 to 0+150 on the Jalan Swasembada Kekalik section is q = 5 (there are 5 DV values > 5), see Table 5 the CDV value = 65.

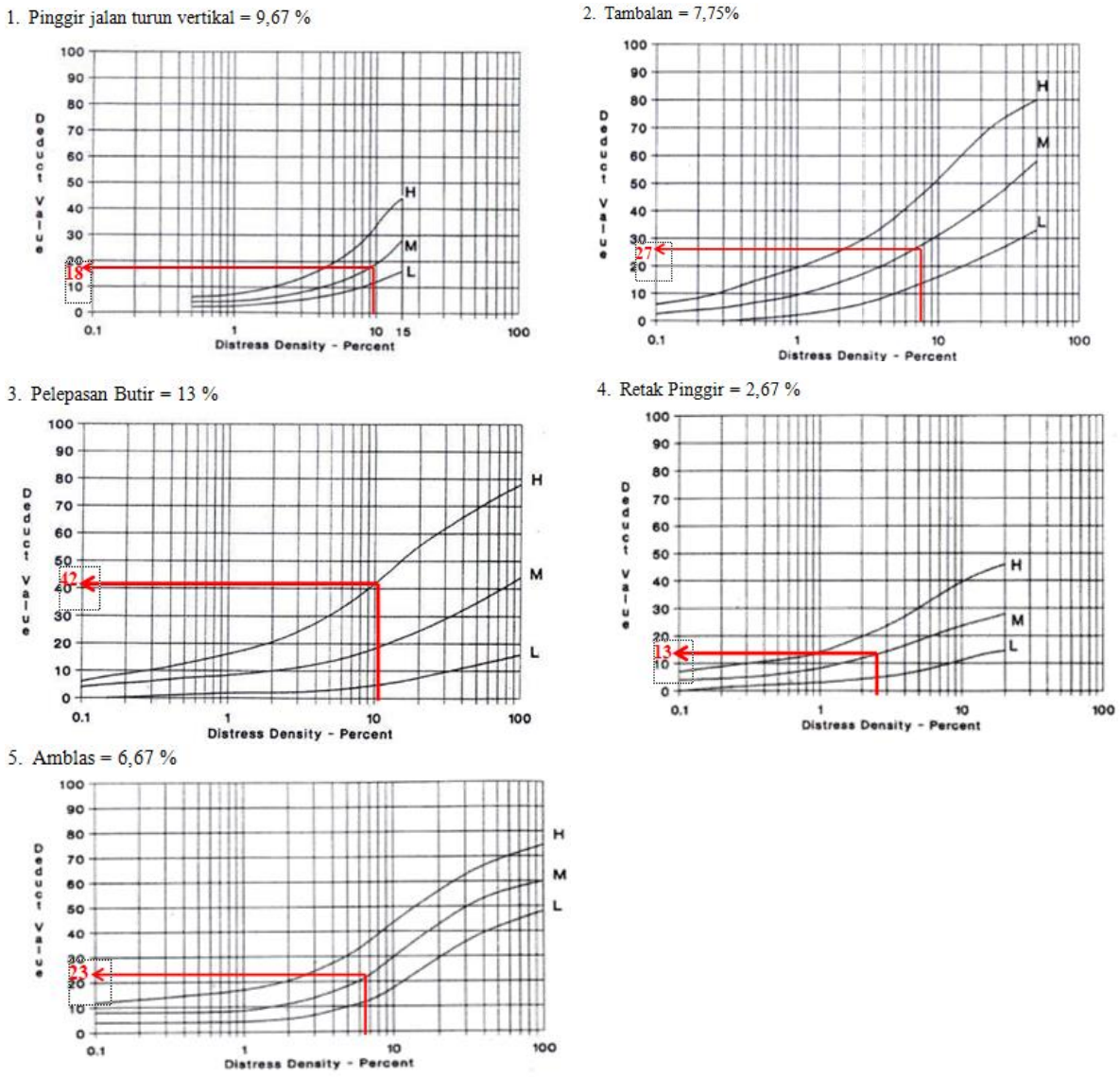

Figure 4

Table 5 – STA CDV value 0+100 to 0+150 Jalan Swasembada Kekalik

STA	Deduct Value (DV)						Total	q	CDV
0+100 to 0+150	13	23	18	27	42		123	5	65

Calculating PCI. After the CDV value on the Jalan Swasembada section with STA 0+100 to 0+150 is obtained, the PCI value is obtained by equation 3.

PCI value = 100–65 = 35.

Furthermore, the PCI values for all segments on Jalan Swasembada Kekalik and Jalan Kesra Raya Perumnas can be seen in Tables 5, 6.

Road Conditions and Recommendations for Handling. Based on the analysis that has been carried out above, the value of the pavement condition for six segments of two roads is obtained, which is calculated using the following formula: *PCIs = 100 – CDV.* The results are shown in Table 7.

The average PCI value of the number of 6 segments that have been calculated on the Swasembada Kekalik road section is the following value 36.33 %

From the average PCI value of each segment shown in Table 7, the classification of damage to the pavement structure in each part can be seen, so it can be seen that the average PCI value on the Kekalik Swasembada road section is 36.33% which is a lousy level (Poor). The average PCI value on the Perumnas Kesra Raya road section is 82.5%, which is reasonable (Good).

Table 5 – PCI value of each segment on Jalan Swasembada Kekalik

STA	Damage Type	Damage Class, m	Size(m/m²)	Density (%)	DVD	CDV	PCI
0+000s / d0+050	Grain release	19	12	4.00	12		
					12	12	88
0+050s / d0+100	Sidewalk down vertical	9	15	5.00	7		
	Patches	11	2	0.67	8		
	Grain release	19	29	9.67	18		
					33	19	81
0+100s / d0+150	Sink	6	6.67	2.22	13		
	Edge crack	7	2.67	0.89	23		
	Sidewalk down vertical	9	9.67	3.22	18		
	Patches	11	7.75	2.58	27		
	Grain release	19	13	4.33	42		
					123	65	35
0+150s / d0+200	Patches	11	3	1.00	10		
	Hole, count	13	1	0.33	35		
	Grain Release	19	10	3.33	15		
					60	48	52
0+200s / d0+250	Sink	6	12	4.00	18		
	Edge crack	7	7	2.33	12		
	Grain release	19	8	2.67	10		
					40	26	74
0+250s / d0+300	Hole, count	13	2	0.67	52		
	Grain release	19	10	3.33	15		
					67	48	52

Table 6 – The PCI value of each segment on the Jalan Kesra Raya Perumnas section

STA	Damage Type	Damage Class, m	Size(m/m²)	Density (%)	DVD	CDV	PCI
0+000s / d0+050	Aggregate Wear	12	12	4.00	2		
					2	0	100
0+050s / d0+100	Crocodile crack	1	2	0.67	19		
	Edge crack	7	10	3.33	17		
	Grain release	19	8	2.67	12		
					48	30	70
0+100s / d0+150	Sink	6	7	2.33	8		
	Aggregate Wear	12	20	6.67	4		
	Grain release	19	10	3.33	17		
					29	22	78
0+150s / d0+200	Crocodile crack	1	4	1.33	24		
	Sink	6	4	1.33	8		
	Aggregate Wear	12	15	5.00	4		
					36	27	73
0+200s / d0+250	Patches	11	2	0.67	8		
	Aggregate Wear	12	40	13.33	9		
	Grain release	19	7	2.33	10		
					27	14	86
0+250s / d0+300	Aggregate wear	12	12	4.00	2		
	Grain release	19	8	2.67	12		
					14	12	88

Table 7 – Comparison of the PCI values of flooded and unflooded roads

STA	Kekalik Self-Sufficiency Road Section			Perumnas Raya Welfare Road Section		
	PCI value	Road Status	Damage rate	PCI value	Road Status	Damage Rate
0+000 to 0+050	88	Not flooded	Perfect	100	Not flooded	Perfect
0+050 to 0+100	81	Not flooded	Very good	70	Flooded	Well
0+100 to 0+150	35	Flooded	Bad	78	Not flooded	Very good
0+150 to 0+200	52	Flooded	Currently	73	Flooded	Very good
0+200 to 0+250	74	Not flooded	Very good	86	Not flooded	Perfect
0+250 to 0+300	52	Flooded	Currently	88	Not flooded	Perfect

Based on the above conditions, then by the instructions/regulations of Binamrga [3], it is recommended that the appropriate type of treatment is treatment method 2 (P2)local asphalt sealing (Local Sealing), handling method 5 (P5) Hole Patching on the Jalan Swasembada Kekalik section. In contrast, for the Jalan Kesra Raya Perumnas section, it is recommended to only use handling method 2 (P2).

CONCLUSIONS

The average Pavement Condition Index (PCI) on Jalan Swasembada Kekalik is 36.33%, which is at a poor level with the lowest PCI segment value of 35%. While on the Jalan Kesra Raya Perumnas section, 82.5% is reasonable, with the lowest PCI segment value of 70%. The method of maintenance and repair of damage to the road pavement structure on the Jalan Swasembada Kekalik section is the P2 and P5 Repair method. In contrast, the P2 method is used in the Jalan Kesra Raya Perumnas section.

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Риторические вопросы в политической речи

Rhetorical Questions in Political Speech

Заманов Нагдали [1]
Zamanov Nagdali

[1] *Azerbaijan National Academy of Science, Institute of Linguistics named after Nasimi*
115 H. Cavid Avenu, Baku, Azerbaijan

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Corresponding Author:
ilinguistics@lan.ab.az

Аннотация. В статье анализируются основные функции риторических вопросов в политической речи. В качестве языкового материала автор использует выступления политика Гейдара Алиева. Поскольку выступления Г. Алиева в основном были на азербайджанском языке, вопрос рассматривается на базе азербайджанского языка, что является весьма актуальным для азербайджанского языкознания. Речь Гейдара Алиева богата риторическими вопросами; данным приемом оратор придавал выразительность своим выступлениям. В статье отмечается, что одним из синтаксических средств, используемых в полемике, являются риторические вопросы, которые одновременно создают эмоциональность речи и придают ей острый критический тон, подготавливая почву для подъема интонации. Автор, подводя итоги, пишет, что риторические вопросы усиливают воздействие речи на слушателей, вызывают эмоции, несут большой смысл и эмоциональную нагрузку.

Ключевые слова: Гейдар Алиев; политическая речь; речь; культура речи; риторические вопросы.

Abstract. The article analyses the main functions of rhetorical questions in political speech. The author uses politician Heydar Aliyev's speeches as linguistic material. As Heydar Aliyev's speeches were mostly in the Azerbaijani language, the issue is considered based on the Azerbaijani language, which is very relevant for Azerbaijani linguistics. Heydar Aliyev's speech was rich in rhetorical questions. The article mentions that one of the syntactic means used in polemics is the rhetorical question used to make the address emotional and critical, thus paving the way for the rise of intonation. The author, summing up, writes that rhetorical questions increase the impact of speech on the audience, evoke emotion, and carry significant meaning and emotional load.

Keywords: Heydar Aliyev; political speech; speech; culture of speech; rhetorical questions.

ВВЕДЕНИЕ

В нашу эпоху глобализации речь и речевые процессы обрели высокую значимость в общественно-политической сфере взаимоотношений. Естественно, что развитие речевого процесса связано с языком народа, которому лингвисты должны придавать особое значение (Бабаев А. [4], Головин В. [5], Махмудов М. [10] и т.д.). Особенно у народов постсоветского пространства, вступивших в независимость, неоценима роль речи во включении в процесс дипломатической деятельности.

В последние годы лингвисты и исследователи межотраслевых научных сфер, пересекающиеся с лингвистикой, выделяют 8 типов вопросительных предложений, среди которых важное значение в речи Гейдара Алиева можно отнести риторические вопросы, разъяснительные вопросы (*expositery question*), вопросы-уточнения (*speculative question*), вопросы экзаменационного характера (*exam question*) и вопросы, адресованные к самому себе (*self- adressed question*). По словам азербайджанского лингвиста Маммадли Н., «Гейдар Алиев, агитировавший в своих политиче-

ских выступлениях плюрализм, демократическое и свободное мышление, острое чувство социальной справедливости и национального самосознания, был одним из блестящих знатоков азербайджанского языка, а его выступления и речи сформировали новый политический стиль» [11, с. 67].

Риторические вопросы усиливают воздействие речи на слушателей, вызывают эмоции, несут большой смысл и эмоциональную нагрузку. Вопросительные предложения имеют большое значение с точки зрения стилистического качества в силу цели выражения. Такие предложения используются как в художественном, научном, так и в общественно-политическом стиле. Вопросительные предложения являются «описательными» [7] и «уточняющими элементами» [12] по стилю речи.

Некоторые авторы высоко оценивают роль риторических вопросов в создании эффективного речевого стиля. По мнению исследователей [6; 13], риторический вопрос усиливает воздействие речи на слушателей, вызывает у них соответствующие чувства, несет большую смысловую и эмоциональную нагрузку, способствует диалогизации монологической речи. Основная цель статьи заключается в изучении выразительности риторических вопросов на основе выступлений Гейдара Алиева в сфере политической речи.

В исследовании были использованы описательный и сравнительный методы лингвистики. Практическим материалом исследования являются политические выступления и опубликованные речи Гейдара Алиева.

РЕЗУЛЬТАТЫ ИССЛЕДОВАНИЯ

Статус риторических вопросов в речи Гейдара Алиева. Выступления Гейдара Алиева внесли свой вклад в сокровищницу мирового политического ораторского искусства XX века. Политическое ораторское искусство как важный раздел речевой культуры заслуживает специального изучения [3; 8]. Риторические вопросительные предложения являлись для Гейдара Алиева важным инструментом передачи тонких и глубоких мыслей. На X съезде писателей, выражая отношение о защите прав поэтов и писателей государством, Г. Алиев выражался так: “*Məsələn, indi biz böyük şairimiz Şəhriyarın 90 illiyini qeyd edəcəyik. Biz Şəhriyarın 90 illiyini qeyd edəcəyik. Biz bu yubileyi Azərbaycanda geniş qeyd etməliyik... Bilmirəm dövlət ona orada bir ev vermişdi, yoxsa yox? Siz bunları yaxşı bilərsiniz. Yaxud onun yazdığı əsərləri özü çap elətdirirdi, yoxsa kim?”* – Например, сейчас мы будем отмечать 90-летие нашего великого поэта Шахрияра. Мы будем отмечать 90-летие Шахрияра. Мы должны широко отпраздновать этот юбилей в Азербайджане... Я не знаю, дало ли ему государство там квартиру или нет? Вы лучше меня знаете это. Или может он на свои средства печатал свои произведения, или кто? [1, с. 93] (перевод автора).

Риторические вопросы в выступлении Гейдара Алиева – это вопросы, побуждающие аудиторию задуматься, подумать, сделать выводы. Оратор, в своей речи привычно демонстрировал присоединение к мнению аудитории с помощью частицы *Bəli* (Да), пояснял ситуацию риторическими вопросами: *“Mənim fikrim belədir. Qiymətim də budur. Burada dedilər, mən yenə də qeyd edirəm: Bəli, həmin zonada, həmin bölgədə sosial-iqtisadi problemlər var. Ancaq gəlin fikirləşək: Azərbaycanın hansı zonasında sosial-iqtisadi problemlər yoxdur? Dedilər Lənkəranda işsizlər var. Azərbaycanın hansı zonasında işsizlər yoxdur?”* – Это мое мнение. Я оцениваю ситуацию так. Здесь сказали, еще раз напомню: Да, в той зоне, в этом регионе есть социально-экономические проблемы. Но давайте подумаем: в какой зоне Азербайджана нет социально-экономических проблем? Сказали, что в Лянкяране есть безработные. В какой зоне Азербайджана нет безработных? [1, с. 78] (перевод автора).

Риторический вопрос иногда задается в прошедшем времени с помощью фразы *xatırlamaq* (помнить). Таким риторическим вопросом оратор оживляет перед аудиторией события прошлого: *“Xatırlayın, o vaxt vəziyyət nə cür idi? O vaxt sərhəd yox dərəcəsində idi, kim haradan istəyirdi, oradan da keçirdi. İndi bu sahədə vəziyyət xeyli yaxşılaşıbdır, nizam-intizam yaranıbdır”*. – Вы помните, какая ситуация была в то время? В то время границы почти не существовало, любой мог пересечь ее, где хотел. Сейчас ситуация в этой сфере намного улучшилась, наведен порядок [1, с. 195] (перевод автора).

Риторические вопросительные предложения используются оратором, как педагогом для закрепления мысли в памяти. С помощью ри-

торических вопросов перед миллионами раскрывается характер Гейдара Алиева: *"Bakıda hər şey dağıdıldığı, viran qoyulduğu halda buraya gəlmək üçün sakit, dinc həyatımı narahat, təlatümlü həyata dəyişmək mənim nəyimə gərək idi? Axı vətəndaş müharibəsi gedirdi... Məni Bakıya çağırdılar, parlamentin sədri vəzifəsini təklif etdilər. Mən razılaşmadım. Bir həftə mənimlə danışıqlar apardılar. Sonra gördüm ki, ürəkdən sevdiyim xalqın vəziyyəti ağırdır..."*. – Зачем мне было менять свою тихую, мирную жизнь на беспокойную, бурную жизнь, чтобы приехать сюда, когда в Баку все было разрушено? Ведь шла гражданская война... Меня вызвали в Баку и предложили должность председателя парламента. Я не согласился. Они вели переговоры со мной в течение недели. Потом я увидел, что положение людей, которых я люблю от всего сердца, ужасно... [1, с. 80] (перевод автора).

В выступлениях сначала политическая ситуация доносится до аудитории с неопровержимыми доказательствами, а в конце высказанные мнения завершаются риторическими вопросами.

В некоторых случаях в речи Гейдара Алиева риторические вопросы предшествуют ситуациям. В некоторых случаях сначала разъясняется ситуация для аудитории, затем задается ряд риторических вопросов для закрепления этой ситуации в памяти: *"Burada çıxış edənlər qeyd etdilər ki, 600 minə qədər qaçqın var. Evi yox, eşiyi yox, çöllərdə yaşayır. Biz getdik Qarabağa. Ağcabədidə olduq. Bərdədə olduq. İnsanlar çöllərə tökülüb. İndi hələ ki, hava istidir, yaşamaq olur. Ağac altında, çadır altında yaşayırlar. İlan vurur onları. Bəs onlar insan deyildirlərmi? Onlara sosial-iqtisadi təminat lazım deyilmi? Belə çıxır ki, onlar da respublika yaratmalıdırlarmı? Onlar da silahlı dəstələr qurub cürbəcür cinayət etməlidirlərmi?"*– Выступавшие здесь отметили, что беженцев насчитывается до 600 тысяч человек. Без дома, без крова. Мы поехали в Карабах. Мы посетили Агджабеди. Мы были в Барде. Люди рассыпались по полям. Теперь, когда погода еще теплая, можно жить. Живут под деревом, под палаткой. Их жалят змеи. Разве они не люди? Разве им не нужна социальная и экономическая безопасность? Получается, им тоже республику создать? Должны ли они также формировать вооруженные банды и совершать различные преступления? [1, с. 78] (перевод автора).

Иногда риторические вопросы в речи Гейдара Алиева имеют форму вопросов, ответы которых уже известны: *"Bilirsiniz, Ermənistan tərəfindən torpaqlarımızın 20 faizinin işğal edilməsinə dözə bilmirəm. Dözə bilmirəm ki, Azərbaycan əsgəri erməni əsgərindən gücsüz olubdur, geri çəkilibdir. Bu, daim mənə əzab verir. Nə üçün, nəyə görə? Bizim xalqımız ermənilərdən zəifmi xalqdır? Və yaxud respublikamız Ermənistan Respublikasından kiçikdirmi? Doğrudur, bunun başqa səbəbləri var. Mən bunu dəfələrlə demişəm"*. – Вы знаете, я терпеть не могу оккупацию Арменией 20 процентов наших земель. Я не могу допустить, чтобы азербайджанский солдат был слабее армянского солдата и отступил. Меня это всегда беспокоит. Почему, зачем? Наша нация слабее армян? Или наша республика меньше Республики Армении? Правда, на это есть и другие причины. Я говорил это много раз [1, с. 129] (перевод автора).

Здесь с помощью модального слова *bilirsiniz* (знаете) оратор выражает свое эмоциональное отношение к оккупации наших земель и обращается к аудитории с последовательными риторическими вопросами. На риторические вопросы отвечает модальное слово *doğrudur* (правда).

В некоторых случаях на короткие риторические вопросы даются лаконичные ответы. Публика получает ответ непосредственно от самого оратора и слышит очередной риторический вопрос, дается очередной ответ: *"O vaxt ki, – 1992-ci ildə – dövlətçiliyi pozurdular onda siz bu fürsətdən istifadə edib bunu pozmusunuz. Elə bildiniz ki, bu, sizə xeyir gətirəcəkdir? Xeyr, gətirməyəcəkdir. Görürsünüz gəlib nə günə düşdünüz? Ona görə öz səhvlərinizin bəlasını çəkirsiniz və mən bu səhvlərə yol verə bilmərəm"*. – Когда в 1992 году они нарушили государственность, вы воспользовались этой возможностью и разрушили ее. Вы думали, что это принесет вам выгоду? Нет, этого не случилось. Видите, в какой ситуации вы оказались? Вот почему вы страдаете по причине своих ошибок, а я не могу совершать те же ошибки [1, с. 371] (перевод автора).

Стороны, сбитые с толку риторическими вопросами, словно просыпаются, эти вопросы озаряют неверующие сердца, как молнии, сияющие в темной ночи. Используя вопросительный оборот на азербайджанском языке *bəs* (а) и условный союз *əgər* (если), он объяс-

няет экономическую ситуацию в Азербайджане для представителей диаспоры, проживающих в Польше: *"İndi Azərbaycan dünyanın bütün ölkələrinin iqtisadi maraq mərkəzinə çevrilibdir. Bəs Amerika Birləşmiş Ştatlarının o qədər neft şirkətləri Azərbaycana nədən ötrü gəliblər? Əgər Azərbaycanda siyasi sabitlik, iqtisadi qanunlar, xarici sərmayənin gəlməsi üçün imkanlar olmasaydı, onlar Azərbaycana gələ bilərdilərmi? Onlar bizdən xahiş edirlər, bizə müraciət edirlər"*. – Сейчас Азербайджан стал центром экономических интересов всех стран мира. А почему так много нефтяных компаний Соединенных Штатов Америки пришли в Азербайджан? Если бы в Азербайджане не было политической стабильности, экономических законов и возможностей для иностранных инвестиций, смогли бы они прийти в Азербайджан? Нас спрашивают, к нам обращаются [1, с. 95] (перевод автора).

Характеристика риторических вопросов в выступлениях Гейдара Алиева. Постановка риторических вопросов в единстве с другими элементами речи, повышение выразительности речи, способы красивого выступления всегда заставляли исследователей задуматься над экспрессивностью и «манипуляционным воздействием риторических вопросов» [2]. Обычно такие ответы на риторические вопросы в речи Гейдара Алиева украшены модальными словами и укрепляющими частицами, что усиливает выразительность и смысл речи: *"Məsələn, indi biz Orta Asiya ölkələrində olarkən, yaxud oradakı soydaşlarımız buraya gələrkən maraqlanırıq,- necə oldu ki, azərbaycanlılar Qazaxıstanda da, Özbəkistanda da, Qırğızıstanda da, Türkmənistanda da yaşayırlar? Onların böyük əksəriyyəti hələ o dövrdə repressiyalar nəticəsində və xüsusən kənd təsərrüfatının kollektivləşdirilməsi ilə əlaqədar yerlərindən kütləvi surətdə sürgün edilmiş, malmülkü əlindən alınmış adamlardır"*. – Например, когда мы находимся в странах Средней Азии, или когда сюда приезжают наши соотечественники оттуда, мы интересуемся – как же азербайджанцы живут в Казахстане, Узбекистане, Киргизии, Туркмении? Подавляющее большинство из них – это люди, которые были массово депортированы со своих мест, а их имущество было конфисковано в результате репрессий того времени, особенно в связи с коллективизацией сельского хозяйства [1, с. 87] (перевод автора).

В выступлениях Гейдара Алиева риторические вопросы, в основном, занимают позицию в начале выступлений, ответы на которые аудитория хочет услышать с нетерпением и большим интересом. В некоторых случаях в речи Гейдара Алиева риторические вопросы предшествуют ситуациям, а в некоторых случаях сначала разъясняется ситуация для аудитории, затем задаются риторические вопросы с целью закрепления этой ситуации в памяти. Хотя риторические вопросы в речи Гейдара Алиева в основном сформированы с участием вопросительных частиц, в некоторых случаях наблюдается простая вопросительная интонация без грамматических указателей. В его речи с помощью вопросительных предложений создается открытая и естественная полемика: *"Yenə də deyirəm, hər bir partiya, hər bir təşkilat fəaliyyət göstərir və fəaliyyət göstərə bilər. Ancaq gəlin açıq danışaq. Bu partiyaların-filanların məqsədi nədir? Azərbaycanın müstəqil dövlət olması? Azərbaycan müstəqil dövlətdir. Dəfələrlə demişəm, Azərbaycanın müstəqilliyini qorumaq Prezident kimi mənim və mənim rəhbərliyim altında olan strukturların hamısının birinci vəzifəmizdir və onu qoruyuruq, qoruyacağıq. Müharibənin qurtarması məsələsi? Bu barədə nə işlər gördüyümü bilirsiniz. Ərazimizin bütövlüyünün təmin olunması, işğal edilmiş torpaqlarımızın azad olunması, qaçqınların öz yerlərinə qayıtması? Bu məsələrlə də məşğul oluruq. Yəni, o dövlətin götürdüyü prinsipial xətlə bu partiyaların, təşkilatların prinsipial xətləri arasında fərq nədən ibarətdir?"* – Еще раз говорю, каждая партия, каждая организация работает и может работать. Но давайте проясним. Какова цель этих партий? Является ли Азербайджан независимым государством? Азербайджан является независимым государством. Я много раз говорил, что защита независимости Азербайджана является моей первой обязанностью как Президента и всех структур, находящихся под моим руководством, и мы ее защищаем и будем защищать. Вопрос об окончании войны? Вы знаете, что я сделал по этому поводу. Обеспечение целостности нашей территории, освобождение наших оккупированных земель, возвращение беженцев на свои места? Мы занимаемся и этими вопросами. То есть чем отличается принципиальная линия этого государства от принципиальной линии этих партий и организаций? [1, с. 565] (перевод автора).

ВЫВОДЫ

1. Риторические вопросительные предложения являлись для Гейдара Алиева важным инструментом для передачи тонких и глубоких смысловых моментов.

2. Риторические вопросы в выступлениях Гейдара Алиева – это вопросы, побуждающие аудиторию задуматься, подумать, сделать выводы. Гейдар Алиев в своих выступлениях риторические вопросы употреблял, в основном, в конце после полного выяснения общественно-политической (какой-либо) ситуации.

3. Риторическими вопросами Гейдар Алиев переносил аудиторию в прошлое, освежая в памяти былую ситуацию, и после сравнивал ее с настоящим.

Исследование риторических вопросов, используемых в речах и выступлениях Гейдара Алиева, показывает, что лидер страны не стремился получить на них ответы, когда использовал подобные вопросы. Утверждение или отрицание заданных риторических вопросов служит средством дальнейшего повышения и усиления эмоциональности речи.

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