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## Sensitivity Analysis of Housing Affordability under Public Private Partnership (PPP) Scheme in Niger State

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The provision of affordable housing has been a concern in developed and developing world because of its role in man's welfare and productivity. This study aimed to carry out a sensitivity analysis of the affordability of a Public Private Partnership (PPP) housing scheme in Niger State. The study set out to establish what can be done to make repayment for such housing affordable for all categories of allottees. Sensitivity analysis was applied to building cost, repayment period and interest rate. Data used for the analysis were sourced through the collection of archival data and carrying out of a questionnaire survey. The random sampling technique was employed in administering the questionnaire to a sample of 187 beneficiaries. Against standard affordability criteria that housing should consume not more than 30 percent of gross household income, the results revealed that only civil servant allottees on Salary Grade Levels 10 - 16 can afford monthly repayments of ₦10, 000.00 for 2-bedroom housing costing ₦1,900,000.00. The application of sensitivity analysis enabled the study to recommend modifications to the PPP housing scheme that will allow all workers on Salary Grade Levels 01 - 16 to afford a 2-bedroom house at a selling price of ₦1,200,000M, mortgage interest of 3 percent and a repayment period of 25 years.

**Key Words:** Affordability, housing, Public-Private-Partnership, sensitivity analysis

### INTRODUCTION

Housing is an integral element of a nation's economy. The backward and forward linkages of housing with other parts of the economy are closely bound up with people's needs, demands and social processes. A functioning housing sector offers appropriate, affordable housing and sustainable patterns of urbanization which are critical for the future of this over-urbanizing planet (Shuid, 2016). Decent housing is one of the indices for measuring the standard of living of the people across societies (Abdullahi *et al.*, 2017). The consumption of housing is a life-long endeavour with quantitative, qualitative, value and environmental challenges. One of the critical barriers against the satisfactory consumption of housing services is their affordability.

According to Cox and Pavletich (2016), housing affordability has been widely recognized as an essential issue in creating sustainable built environment especially in the context of developing world cities. Baxter and Murphy (2017) described affordable housing for a particular income group as the range of houses for which the total monthly repayment costs fall within the monthly repayment capability of the average household in that income group. Padley and Marshall (2019) stressed that for housing to be affordable for certain level of households, there should be provision for subsidy (i.e. assistance). Low affordability has been attributed to several factors central among which is the inability of

households to afford the available housing products and services on offer (Musa-Haddary, 2011).

The housing policy focus of succeeding governments in Nigeria since 1928 has been the public service employees (Bala & Bustani, 2009). Housing programme was initiated under various National Development Plans from 1962 to 1991 to address the worsening housing situation of majority of her citizen. Little success was recorded from these efforts (Aribigbola, 2000). The most ambitious of these plans was that initiated in 1979 by the Shehu Shagari administration; yet it was the most underperformed recording a success rate of 14% only (Jolaoso, 2001; Akeju, 2007; Ademiluyi & Raji, 2008). This focus has now shifted with the advent of the Public-Private-Partnership (PPP) concept that has become popular since the turn of the new millennium (Eziyi, 2010; Obozuwa, 2011), in order to accelerate urban housing provision, address housing affordability and reduce accessibility challenges.

Public housing delivery for civil servants started after the creation of Niger State in 1976 with the construction of staff quarters under the supervision of the State Ministry of Works, Transport and Housing. In 1979 the Niger State Housing Corporation (NSHC) was created for housing delivery, and by 2007 had built less than 3,000 houses against a demand for 30,000 units (a mere 10% performance), (Niger State Government, 2007a). A consequence of this low performance was the adoption of Public-Private Partnership as an alternative housing delivery strategy, which

according to Niger State Gateway to Land and Housing (Niger State Government, 2007b), involves a contract between a public sector authority and a private party which assumes substantial financial, technical and operational risk for delivering the project. One example of this PPP arrangement is the Mohammed Inuwa Wushishi (M.I.W) Housing Scheme.

This paper presents the results of a study aimed at carrying out a sensitivity analysis of the affordability of a Public Private Partnership (PPP) housing scheme in Niger State. Sensitivity analysis was used to analyse the response of affordability to changes in (i) cost of building, (ii) duration of repayment, and (iii) interest rate of the 2-bedroom housing type under the M.I.W. Housing Scheme in Minna, Niger State.

## LITERATURE REVIEW

### Housing Affordability

Housing, whether publicly or privately provided, should be adequate. Adequacy of housing refers not just to the dwelling unit (shelter) but also to the external surroundings and neighbourhood facilities and amenities. Housing is termed adequate when it meets the minimum standard of being decent, accessible, available, safe, sanitary and affordable (Musa-Haddary, 2011). A key determinant of adequate housing is its affordability, which refers to the ability of the consumer to acquire an adequate amount of available housing. A shortfall in the supply of adequate amount of housing has existed ever since people began to congregate in towns and cities and is one of the major challenges facing Nigeria (Olanrele *et al.*, 2018). The economy of housing is hugely influenced by the activities and ingenuity of the various participants involved in its production: planners, designers, regulators, financiers, developers, consumers, cost managers and such others. The cost of housing which significantly controls its affordability is determined by the quantum of functions served, and the level of quality provided. Creative engineering of these functions under varying constraints of production and consumption can open new window of opportunities towards improving their affordability (Musa-Haddary 2011).

The need for affordable housing is fast taking centre stage globally as well as in the national agenda in Nigeria (Nnametu & Emoh, 2020). Governments are in continual search for ways and means of providing effective access to affordable housing for their citizenry (Ibem, 2010). Nigeria has an estimated housing deficit of 17 million; notwithstanding an abundance of potential, she is yet to adopt the right mix of policies for providing affordable housing adequately (Onyemaechi & Samy, 2016). Several studies conducted across Nigeria (Ibem, 2010; Onyemaechi & Samy, 2016)

have observed that PPP for housing delivery is yet to make any significant impact in affordable housing provision in Nigeria. There are PPP housing schemes that have been completed but are still unoccupied, or have very low occupancy rate (Jimoh *et al.*, 2015), which is because these schemes failed to effectively address the cardinal problem of affordability of housing for the urban poor.

### Housing Affordability Crisis

Housing is a fundamental need of humanity; however, housing is an expensive phenomenon for individuals as well as nations. Only in a minority situation is the need for housing services adequately matched with the ability to satisfy such needs. Conceptually, the affordability problem is an economic crisis of insufficient resources. Individuals as well as Governments lack sufficient resources (be it land, money, manpower or technology) to meet their housing needs. The consequence is that people make do with what they can afford (mansions for the rich, shanties for the poor) (Padley & Marshall, 2019) while those who cannot afford any type of housing at all remain homeless.

There are numerous reasons why the affordability crisis exists; these include low income or purchasing power, inadequate provision for meeting the specific need, high product cost and standard, high consumer taste, poor facilitation instruments, and income stagnation in the face of spiralling inflation (Davis *et al.*, 2018). For example, between 1990 and 2000, the average wage of a Nigerian federal civil servant increased by 6,000 percent while the cost of housing increased by 20,000 percent (Federal Office of Statistics (FOS), 1992; FOS, 2004). The resultant effect on the nation's housing market became severe. Households could not afford the very exorbitant rents charged while, at the same time, the property owners were complaining of low margins of return with very high vacancies.

### Resolving the Housing Affordability Problem

Nelson *et al.* (2002) expressed affordability as a ratio of housing cost to household income. This can be expressed functionally as

$$\text{Affordability} = \frac{\text{Housing income}}{\text{Housing cost}} \dots \text{equation (1)}$$

Expert have long established that as households' incomes rise, their affordability also increases and so also their consumption of housing services too (Bangura & Lee, 2023). Thus, a sure means of ensuring adequate consumption of housing services is to enhance the household income and purchasing power. Affordability on the other hand decreases with increasing cost of housing. Households are unable to acquire adequate housing because the products are too expensive (Clarke *et al.*, 2016).

The affordability crisis means either “incomes are too low” or “houses are too expensive”. To resolve such a problem then would require elevating incomes and/or lowering housing costs. The only way one can acquire what he cannot afford is for someone else to pay for it. Subsidies for the housing sector either to suppliers, financiers or consumers is just paying for someone else’s consumption. This would help the poor, but it could also fuel wasteful consumption. Improving household purchasing power by increasing household income could result in increased affordability, so too will raising the proportion of incomes budgeted for housing (Aribigbola, 2006).

#### Improvement of Housing Affordability

Nelson (2002) theorised that to increase the level of affordability, what is required is to reduce housing cost. Kofi (2008) went further to suggest that if mortgage interest rates decrease, there will be more stable macroeconomic environment and mortgage, resulting in the reduction of housing prices. Chatterjee (1981) had proposed that there were two major policy components that can address the housing affordability problem in Nigeria. One group of policies is the reduction of housing prices and the second increase in housing finance. Kolawole *et al.* (1998) argued that to efficiently increase participation of targeted groups (especially the lower level) in affordable housing these three things need to be done:- (i) Extension of repayment period; (ii) Reduction of housing cost; (iii) Reduction of interest rates on housing loan.

The World Bank and the proponents of PPP have advocated provision of housing to targeted groups within defined income bracket. For such groups some writers have recommended the need to do away with over-designing and concentrating more on functional design in order to produce cost-effective designs (Alabi, 2012).

#### Sensitivity Analysis

Sensitivity analysis is a tool that helps in examining how different values of an independent variable can affect a particular dependent variable. It is used to determine how ‘sensitive’ a model is to changes in the value of the parameters of the model (Da Veiga *et al.*, 2021). By showing the response to changes in parameter value, sensitivity analysis presents a potent tool in model evaluation. Approaches to performing sensitivity analysis are numerous many of which have been developed to address specific tasks. Some of the core methods include the one-factor-at-a-time (OFAT), which changes one factor (parameter) at a time to see what effect this produces on the output (Ferretti *et al.*, 2016). OFAT method was adopted for this analysis due to its suitability and simplicity of application.

Sensitivity analysis has been used in this paper to provide confirmation of the key variables which influence the affordability of PPP-provided housing

as well as to determine the severity of the effects of changes in such key variables. The OFAT methodology was also used to assess whether decisions on the consumption of certain types of housing are likely to be affected by changes in such key variables and identify actions that could mitigate possible adverse effects on end users who consume the housing products being studied.

## RESEARCH METHODOLOGY

### Research design and data

The research was carried out using both quantitative and qualitative approaches. The types and sources of the data used for the research included:

- The memorandum of understanding (MOU) entered into by the Niger State government – this provided data on the terms of the PPP housing scheme;
- Questionnaire survey – was used to source data from the allottees of the PPP housing estates;
- A checklist – was used to obtain information on types of houses and the number built through PPP housing development, the number allocated to Niger state civil servants, their cost and repayment period from Niger State Housing Corporation, Minna.

### Study Area and Population

The study area for this research is Niger State, which is one of the 36 States of Nigeria. Niger State was created on 3<sup>rd</sup> February, 1976 from the defunct North-Western State and is situated in North-Central geo-political zone of Nigeria. It is made up of 25 Local Government Areas (LGAs) and had a total population of 3,954,772 as at 2006 census. The target population for this research was the number of Niger State civil servants allottees in M.I. Wushishi Housing Estate, which is located within the study area, in Minna, the administrative capital of Niger State. According to the Niger State database, the civil servants population is 33,431. However, only 350 civil servants were allocated with houses in the M.I. Wushishi Housing Estate. Thus the population of the study was the 350 allottees.

### Sampling Size

According to Niger State Housing Corporation (2013), there are 500 housing units in the M.I. Wushishi Housing Estate that was constructed under PPP housing scheme. Of this number, 350 housing units were allocated to Niger State civil servants and the remaining to non-civil servants. This study is however concerned with only civil servants allottees. Using the sample derivation formula employed by Lohr (2021), a sample size of 187 was obtained.

$$n = \frac{N}{1 + N(e^2)} \quad \text{--- Equation 2 (Lohr, 2021)}$$

Therefore:  $n = 350 / 1 + 350(0.05)^2 = 187$ .

Where:

$n$  = Sample Size;  $N$  = Study population (350);  $e$  = Level of Precision (5%, based on a Confidence level of 95%)

#### Method of Data Analysis

Affordability and sensitivity analyses were employed to measure the affordability of the housing scheme to the respondents. Thereafter, the effects of changing the key parameters of cost of housing repayment period, and interest rates were examined.

## RESULTS AND DISCUSSION

### Respondents' Salary and Type of Houses Allocated

Finding from the results revealed that 69.6% of the respondents were allocated 2-bedroom apartments, while 30.4% were allocated 3-bedroom apartments in the estate. Some 2.2% of the allottees were classified under Salary Grade Level (GL) 1-6, a further 92.6% under GL 7-14, and the balance of 5.2% belonged to the third category (GL 15 and above). This indicated that low and high income classes were very few among the allottees of houses in each of the two categories of apartments as indicated in Table 1.

**Table 1: Respondents' salary and type of houses allocated**

Salary grade level	House Type				Existing Repayment Schedule*			
	2-Bedroom		3-Bedroom		Total		2-Bedroom	3-Bedroom
	No	(%)	No	(%)	No	(%)	(Naira/month)	(Naira/month)
GL 1-6	2	1.54%	1	0.7%	3	2.2%	10,000	19,000
GL 7-10	46	34.1%	8	5.9%	54	40.0%	10,000	19,000
GL 12-14	43	31.9%	28	20.7%	71	52.6%	10,000	19,000
GL 15 and Above	3	2.2%	4	3.0%	7	5.2%	10,000	19,000
<b>Total</b>	<b>94</b>	<b>69.6%</b>	<b>41</b>	<b>30.4%</b>	<b>135</b>	<b>100%</b>		

\* Tenor of the mortgage repayment is a period of 20 years for both house types

An affordability analysis was conducted to determine the level of affordability of the 2-bedroom (2-Br) houses for the category of civil servants earning the lowest monthly income (Salary GL1- 16).

#### Affordability of 2-bedroom houses under existing repayment regime

Table 2 revealed the affordability level of the respondents occupying 2-bedroom houses through monthly repayment schedule of 20 years after 10% down payment of housing cost at 6% interest rate. The United Nations standard criteria was adopted from Cox and Pavletich (2016), which says that households should not spend more than 30% of gross income on housing expenditure alone.

**Table 2: Affordability of Existing Repayment of 2-bedroom House Type**

Salary grade level	Step	Gross Salary/Month (₦)	Repayment Amount/Month (₦)	Balance after deduction (₦)	% of Salary devoted to Mortgage	Remark
1	1	17,999.94	10,000.00	7,999.94	55.55	NOT AFFORDABLE
2	1	18,924.35	10,000.00	8,924.35	52.84	
3	1	19,166.11	10,000.00	9,166.11	52.18	
4	1	20,064.64	10,000.00	10,064.64	49.84	
5	1	21,698.45	10,000.00	11,698.45	46.09	
6	1	23,723.64	10,000.00	13,723.64	42.15	
7	1	26,008.80	10,000.00	16,008.80	38.45	
8	1	29,687.37	10,000.00	19,687.37	33.68	
9	1	32,633.53	10,000.00	22,633.53	30.64	
10	1	36,043.68	10,000.00	26,043.68	27.74	AFFORDABLE
12	1	40,253.43	10,000.00	30,253.43	24.84	
13	1	43,190.58	10,000.00	33,190.58	23.15	
14	1	46,394.65	10,000.00	36,394.65	21.55	
15	1	50,412.54	10,000.00	40,412.54	19.84	
16	1	54,400.38	10,000.00	44,400.38	18.38	



Table 2 showed that for civil servants on Grade level 10 to 16, repayment for the allocated houses are within the affordability zone. However, allottees on GL 1-9 cannot afford the repayment of ₦10,000.00 per month for the 2-Bedroom house type. This indicated that many of the allottees of 2 bedroom houses would be unable to repay based on the prevailing arrangement. A key discovery was that the 30% to be devoted to housing consumption by civil servants on Grade level 1 to 6 must not exceed ₦5,399.98 - ₦7,117.09 for the house type to be considered as affordable.

#### **Mortgage based affordability analysis – evaluation of housing subsidies**

A further test to determine if the repayment amount being charged for the 2-Bedroom houses in the M.I. Wushishi Housing Estate was subsidized was conducted using Mortgage Based affordability analysis (Musa-Haddary, 2011). The formula employed is:

$$R = C \frac{i(1+i)^n}{(1+i)^n - 1} \text{ ----- Equation 3}$$

Where:

n = Loan repayment period (240 months)

i = Interest rate (6%)

Down payment for the scheme was 10%

C = Amount of loan

**Table 3: Repayments under a 30-year mortgage period (Option A)**

Salary grade level	Step	Gross Salary/month (₦)	Repayment Amount/Month(₦)	% of Salary devoted to Mortgage	Repayment period	Remarks
1	1	17,999.94	7,500.00	41.66	30years repayment	NOT AFFORDABLE
2	1	18,924.35	7,500.00	39.63		
3	1	19,166.11	7,500.00	39.13		
4	1	20,064.64	7,500.00	37.38		
5	1	21,698.45	7,500.00	34.56		
6	1	23,723.64	7,500.00	31.61		
7	1	40,253.43	10,000.00	24.84	20-years repayment	AFFORDABLE
8	1	43,190.58	10,000.00	23.15		
9	1	46,394.65	10,000.00	21.55		
10	1	50,412.54	10,000.00	19.84		
11	1	54,400.38	10,000.00	18.38		

If option A is adopted then, Table 3 revealed that monthly repayments for Grade Level 1-6 will still exceed 30% of gross salary for the 2-bedroom bungalow. This is because the repayments are still outside the bounds of the ₦5,399.98 - ₦7,117.09, which is the affordability range. With the extended repayment period GL 7-9 can then afford the monthly repayment amount which now reduces to ₦ 7,500.00 from the previous ₦ 10,000.00.

#### **OPTION B: Reducing the cost of the houses**

Discussions were held with value specialists within the Niger State Housing Corporation with a view to

R = Repayment amount (₦ per month)

$$\text{Repayment/month}_{(R_m)} = \text{₦12,243.60 (2 - Bedroom)}$$

Using Equation 3 it was determined that the mortgage monthly repayment amount of 2-Bedroom house type after a 10% down payment was 12,243.60 naira. Compared to the 10,000 naira being actually paid by allottees, this meant that a subsidy of 2,243.60 naira had been provided by the Niger State government.

#### **Sensitivity Analysis of 2-Br house affordability to changes in critical parameters**

To improve the affordability of housing services for households under a constant salary income regime, three changes to critical parameters have been suggested (Kolawole *et al.* 1998; Nelson 2002; Kofi 2008; Musa-Haddary, 2011). The first is to extend the repayment period; the second is to reduce the cost of housing product; the third is to lower the interest rate. All of these options were analysed.

#### **Option A: extending the repayment period beyond 20 years**

The first change involves extending the repayment period. If allottees on GL 1-9 were to repay their mortgage in 30 years while those on GL 10-16 to repay in 20 years as shown in Table 3.

eliminating avoidable costs incurred during the production of the houses. The outcome of the value study indicated that under a lean production regime, the 2-bedroom houses could be produced at ₦1,200,000.00. If such a reduction in the cost is achieved, Table 4 shows the repayment amount for all categories of civil servants (GL 1-16) under the three repayment periods of 20 years, 22 years and 25 years after the down payment of 10% by each beneficiary at 6% interest rate.

**Table 4: Repayments if cost of 2-Br houses is N1,200,000.00 (Option B)**

Grade Level	Monthly Repayment Amounts for 2-bedroom house type @ ₦ 1,200,000.00			
	Tenor:	20yrs	22years	25years
All (1-16)		₦7,732.80	₦7,376.4	₦6,955.20

This option improved the affordability and thus increased the numbers of civil servants who can afford the 2-bedroom house; this is because the 30% of the earnings of workers on Grade level 6 to 9 now fall within the affordability range (₦5,399.98 - ₦7,117.09). However, for workers on Grade level 1-5 the monthly repayment amounts (that now range from ₦6,955.20 to ₦7,732.80, as shown in Table 4) are still unaffordable, being more than the 30% of their earnings that can be devoted to housing consumption.

**OPTION C: Lowering the interest rate**

This option presupposes that the state government re-negotiates with the Mortgage firms serving as private partner in the PPP housing project. The cost of the 2-bedroom house type is N1.710 million after the down payment of 10% at 6% interest rate. For that purpose, if repayment arrangements were revised by considering 2%, 3% and 4% interest

rates rather the 6% actually being applied, this would improve affordability of the 2-Br houses for all categories of civil servants over various repayment periods. The amounts obtained from a revision of the mortgage interest rates are displayed in Table 5. The results revealed that by reducing mortgage interest rate to 2% in 30 years for respondents in 2-bedroom, this will improve repayment for those on Grade level 5-9, as they will now fall within the affordability range (₦5,399.98 - ₦7,117.09). However, those on Grade level 1-4 are still at disadvantage despite reducing interest rates and extending repayment period because the monthly repayment amounts (that now range from ₦6,320.49 to ₦10,326.69, as shown in Table 5) are still unaffordable, being more than the 30% of their earnings that can be devoted to housing consumption.

**Table 5: Repayments under revised interest rate regime (Option C)**

Repayment	Percentage (%) Interest / Amount (N/M)		
Period	4(%)	3(%)	2(%)
20years	10,326.69	9,483.62	8,650.61
22 years	9,750.10	8,856.01	8,019.90
25 years	9,026.01	8,109.01	7,247.91
30 years	8,163.80	7,209.43	6,320.49

**OPTION D: Combining all three options (A, B and C)**

One further sensitivity analysis was carried out on the affordability of the 2-Br houses using a combination of the three options A, B & C explored in this paper (extending repayment period, reducing housing cost and lowering interest rate).

The results of this sensitivity analysis was presented in Table 6; it was based on (i) extending repayment periods to between 20 to 30 years, (ii) reducing the housing cost to N1.080M after down payment of 10% and (iii) reducing mortgage interest rate to between 2 to 4%.

**Table 6: Repayments using a combination of all options (Options A, B & C)**

Repayment Period	Repayment amounts per month at varying Interest rates		
	4(%)	3(%)	2(%)
20years	6,544.59 (D1)	5,989.65 (D5)	4,944.03 (D9)
22 years	6,157.96 (D2)	5,593.27 (D6)	5,081.08 (D10)
25 years	5,700.64 (D3)	<b>5,121.48 (D7)</b>	4,557.63 (D11)
30 years	5,156.09 (D4)	4,553.32 (D8)	3,991.89 (D12)

The results in Table 6 were made up of 12 variants obtained from the combination of the three options as earlier stated. These variants of Option D were labelled from Option D1 through to Option D12. The option that generated the most middle-of-the-

way repayment amount for all civil servants was found to be Option D7 (which required a monthly repayment of N5,121.48). The most middle-of-the-way option was considered in this paper to be the option that allows all civil servants to benefit

affordably from the PPP housing scheme under review, while not requiring that parties to the PPP make any concessions than are absolutely necessary to achieve affordable housing for all civil servants.

This was why although some other variants of Option D (such as Options D8, D9, D10, D11 and D12) returned lower repayment amounts, they were not accepted as the optimal solution because they would require the parties to the PPP accepting lower mortgage interest rates and longer repayment periods than are absolutely necessary. The acceptance of Option D7 as the optimal solution resulted in all civil servants from Grade level 1-16 now falling within the affordability range (N5,399.98 - N7,117.09) by not having more than the 30% of their earnings devoted to housing consumption.

## CONCLUSION AND RECOMMENDATIONS

Public-private-partnership (PPP) was engaged by Niger State Government to improve housing for its civil servants. However, the study revealed that most of the civil servants cannot afford to repay based on the existing repayment arrangements and the UN criteria for assessing housing affordability. A sensitivity analysis that was carried out enabled the identification of an optimal solution that allowed all civil servants to benefit affordably from the PPP housing scheme under review, without requiring the parties to the PPP housing estate making any concessions than are absolutely necessary to achieve affordable housing for all civil servants.

This optimal solution was labelled Option D7; it required the reduction of the overall cost of 2-Br houses to N1.2M, the adoption of a mortgage interest rate of 3% and a mortgage tenor of 25 years. Under these three conditions, it was feasible for civil servants from GL 1 to 16 to afford the 2-bedroom houses of the M. I. Wushishi housing estate. In view of the findings and conclusion of this study, it was recommended that for effective development of sustainable affordable housing, affordability analysis as well as sensitivity analysis should always be conducted and employed as part of the basis for making decisions on the pricing of housing products. For an effective adoption of this recommendation, it would be necessary for it to be made a specific part of clauses in policy and contractual instruments (such as the National Housing Policy and standard contracts for mortgage policies).

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