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An Analysis of the Determinants of Household Cooking Fuel Source in Bauchi State, Nigeria: A Preliminary Study

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Abstract

High rate of biomass fuel use such as plant residue and firewood as the main source of cooking fuel for households in Bauchi state is one of the major factors that cause problems like; indoor air pollution, desertification, soil erosion, lung cancer and other visual problems. This is a pilot study conducted to assess the factors that influence the choice of household main source of cooking fuel in Bauchi state, Nigeria. Being a pilot study, the main aim is to carry out a feasibility analysis in order to ascertain the possibility of conducting a study on the factors influencing household cooking fuel choice in Bauchi state. A total of 30 households were chosen systematically from one rural and one urban areas of the state. Logit regression model was used to analyse the data. Cronbach's alpha value of 0.71 shows a good reliability and accepted as a valid study and analysis. Therefore, a study to analyse the determinants of household cooking fuel choice in Bauchi state is feasible and may likely discover a valid conclusion that may benefit particularly, the people of Bauchi state. The Logit results show that marital status of the household head, income, number of rooms, nature of the home building and size of the house; are the variables that significantly and positively related to the odd of adopting modern cooking fuel sources. Therefore, policies to increase these factors will encourage households in Bauchi state to adopt modern sources of cooking fuels. On the other hand, age of the household head, gender of the household head and home appliances are negatively and significantly related to the odd of adopting modern cooking fuel sources. Therefore policies to discourage these factors; will encourage the households in Bauchi state to reduce the use of traditional biomass fuels for cooking purpose.

Keywords: cooking, fuel, households, bauchi.

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1. Introduction

Bauchi state is the most populous state with less efficient energy use in Nigeria (NBS, 2010). Over the years, there has been wider use of firewood as the main source of fuel for many households in Bauchi State, especially for cooking purposes. Available data have shown that the average rate of cleaned fuel use in Bauchi state is far lower than the national average. The rate of household fuel wood use (for cooking purpose) in Bauchi state, Nigeria is about more than 90% which is far higher than the urban national average of about 40% and the whole national average of about 70% (NBS, 2010). Figure 1 shows the categories of some selected households and their main source of cooking fuel in Bauchi state, Nigeria.

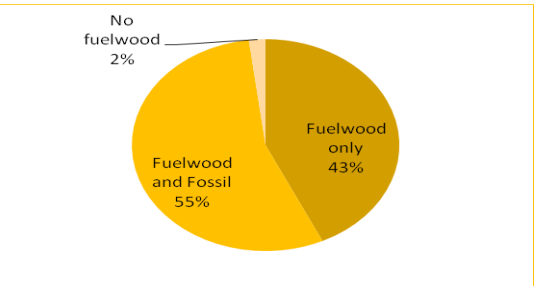

Figure 1 Categories of Households by Fuel Sources in Bauchi State, Nigeria (Source: Modified from Akpan et al., 2010)

Figure 1 shows the categories of households based on their cooking fuel sources in Bauchi State, Nigeria. About 43% of households use fuelwood solely as their source of cooking fuel while the majority of the households combine both the fuelwood and fossil fuels to source energy for cooking purposes. Furthermore, the average consumption of firewood per household in Bauchi state is about more than 600kg/month which are mainly source from forest reserve, friends' farmlands and or buy from the market (Akpan et al., 2010). As for those supplied in the market, it is argued that the monthly quantity supply of firewood per person in Bauchi State is about 750kg (Ay et al., 2011). Most of these fuel woods are sourced from the chosen preferred trees (among the available trees in the state) such as; Madobiya, Kirya, Baushe and Marke mainly due to availability, efficiency affordability and cultural reasons (Wakili et al., 2012 and Akpan et al., 2010).

The rampant use of firewood as a fuel source for the majority of the households has posed negative impacts to the inhabitants of the state. The first negative impact of wider use of firewood as the main source of cooking fuel in Bauchi State is the systematic destruction of the state's forest reserves and wood lands (Ay et al., 2011). The rapid environmental problems in the state such as; soil erosion and the persistent desertification are some of the consequences of such rapid felling of trees. In fact Bauchi state government argued that the state loses on average not less than one kilometre of land area yearly, because of desertification mainly caused by high rate of felling trees for cooking fuel and some other relevant uses (Tide, 2010). Furthermore, the total estimated number of yearly deaths due to indoor air pollution related diseases which arises as a result of high use of biomass fuel sources stands at about three thousands five hundred (3500) lost of lives yearly due to inefficient fuel source (IEA, and NBS, 2010).

Therefore, analysing the pattern of household energy use in Bauchi state can enable the relevant authority to have a clear picture and understand the factors that can shape the pattern of household energy choice in the state in order to encourage the households to adopt cleaner energy sources. This contributes to the process of government efforts in the attempt to curtail the excessive and mass use of firewood as the major source of household fuel energy in the state.

Moreover, this study is further motivated due to the fact that there are inconsistencies as per the findings and conclusions of previous studies on household energy use. For instance some studies (Oyekale et al., 2012; Lee, 2013; Nlom & Karimove, 2014) found that income has a positive significant relationship with household use of firewood. On the other hand, some studies (Mekonon & Kohlin, 2008; Onoja, 2012; Song et al., 2012) found the relationship to be negative. While, Couture et al. (2011) and Jingchao and Kotani (2011) conclude that there is no any significant relationship between income and household firewood consumption.

Additionally, variables like; age of the household head, level of education of the household head, household size, occupation, size of the dwellings among others; were concluded to be positively related to household fire wood consumption by studies like Nnaji et al. (2012), Ganchimeg and Havrland (2011) and Onoja (2012). While, Song et al. (2012), Heltberg (2005) and Jingchao and Kotani (2011) found these relationships to be negative. Additionally, some studies such as Jumbe and Angelsen (2010) and Laureti and Secondi (2012) conclude that there is no significant relationship that exists between these variables and household fuel-wood consumption. The same case applies to other sources of household energy such as kerosene, electricity and LPG, whereby some studies (Fan & Hyndman, 2010; Souza et al., 2009) conclude positive relationship, some (Petersen, 2002; Westly, 1989; Helden et al., 2001) found negative relationship and others (Ward, 2001; Terza, 2001;) found no relationship. This notifies that, results and findings of studies on households' cooking fuel use, that was carried out in one area cannot be concluded and generalised to other different areas, due to heterogeneity in the pattern and styles of household fuel consumption from one area to another. Hence, a study on household cooking fuel choice adoption in a new area under a consideration is a contribution to the existing body of knowledge.

2. Review of the Related Literature on the Determinants of Household Cooking Fuel Choice and Consumption

This section examines the factors that influence the level of household fuel choice and consumption. Each of these factors is expected to relate with the quantity of fuel consumption of households either positively or negatively. Some of these factors include; disposable household income, age, gender composition in the household, gender of the household head, education, occupation, marital status, home ownership, household size and number of children. Others are; location, cooking habit, availability of fuel alternatives and accessibility, cooking utensils, wage labour market, house type, number of rooms and size of residence (Ritche et al., 1981; Aina, 2001; Michael et al., 2001; Niemeyer, 2010; Ganchimeg & Havrland, 2011; Bradford & Joachim, 2012). Normally, the extent and the dimension of how these factors influence household energy adoption and consumption varies from area to area and also from one type of fuel source to another.

Below is the explanation of different categories of factors influencing household energy choice and consumption.

2.1 Economic Factors

This constitutes factors that serve as the measure of economic status of households which can influence the households' cooking fuel consumption decision. The variables include; households' income, occupation of the household head, home ownership, fuel cost and the prices of the end use technology. For instance, studies have established that there is a positive relationship between income and adoption of modern cleaned energy (Mensah & Adu, 2013; Ozcan et al., 2013; Couture et al., 2012; Jingchao & Kotani, 2011 and Osiolo, 2010). Poorer households especially in developing countries adopt firewood, plant residues, animal dung and other biomass cooking fuels, where as wealthier households usually adopt cooking fuel from more modern sources like; electricity, gas and others.

A relationship also exists between the type of occupation of the household head and the nature of the cooking fuel source to be adopted by the household. Empirical studies conducted by Eakins (2013); Ozcan et al. (2013) and Heltberg (2005) proved that those in white collar jobs (executives, big entrepreneurs) tend to adopt modern cleaned energy, while those in blue collar jobs (such as farming and trading) tend to adopt firewood and other biomass fuels. Home ownership which is also one of the indicators of the economic status of households affects their decision on the type of cooking fuel sources to adopt. Those who live in their owned house adopt more cleaned cooking fuel source as established by previous studies (Couture et al., 2012; Laureti & Secondi, 2012). Also price of the fuel has a negative relationship with the fuel consumption. When the price of a particular fuel source is high, households switch to other alternative fuel available, this is in line with law of demand and also has been established by so many previous studies (Nlom & Karimove, 2014; Lee, 2013; Ganchimeg & Havrland, 2011 and Jingchao & Kotani, 2011; Osiolo, 2010).

2.2 Socio–Demographic Factors of Households

The type and composition of socio–demographic factors of households influence their cooking fuel switching and consumption behaviour. These factors include; marital status, gender, level of education and age of the household's head, gender composition in the household (female/male ratio), and size of the household. Whereas

most of the previous studies such as; Nlom and Karimove (2014), Jumbe and Angelsen (2010), Osiolo (2010), Suliman (2010) and Mekonnen and Kohling (2008) proved no significant relationship exist between the gender of the household head and its cooking fuel consumption behaviour. However, Mensah and Audu (2013) found that households tend to adopt more cleaned energy when the head of the household is female. Age of the household head was found to have a negative relationship with the adoption of cleaned fuel (Nlom & Karimove, 2014; Mensah & Audu, 2013; and Suliman, 2010). Households adopt biomass fuels when the head is older. Level of education of the household head has a positive relationship with cleaned fuel adoption. The higher educated is the household head, the more he realises the negative impact of biomass fuels and therefore the less it will be adopted. This assertion was found to be true by previous studies (Nlom & Karimove, 2014; Eakins, 2013; Mensah & Audu, 2013; Ozcan et al., 2013; Laureti & Secondi, 2012; Suliman, 2010 and Heltberg, 2005).

As the ratio of female to male members of household increases, the household adopts biomass cooking fuel source. This statement was supported by previous studies (Suliman, 2010 and Heltberg, 2005). The number of a household's members (i.e household size) also affects the household's decision on the type of cooking fuel to adopt, the larger the size of a household, the lesser the possibility of adopting modern source of cooking fuel. This assertion is supported by previous studies (Ozcan et al., 2013; Mensah & Audu, 2013; Laureti & Secondi, 2012; Jingchao & Kotani, 2011; Suliman, 2010; Heltberg, 2005).

2.3 House Characteristics

The characteristics of the building in which the households live, also affect their energy choice behaviour. Factors such as; location of the house, nature of the house, the size of the residence, number of rooms in the house, share of dwellings (i.e. more than one households living in the same building), as well as the period when the home was built also have significant influence on households fuel consumption. For instance, the location of the home in which the households live have serious impact on their fuel consumption decision. The households that are located in urban areas adopt more cleaned fuel than their rural counterparts. This was proved to be true by some previous studies such as; Eakins (2013), Ozcan et al. (2013) and Mensah and Audu (2013).

In addition, the type of the house (i.e. nature of the building) exacts some influence on household fuel use behaviour. For instance, Eakins (2013), Ozcan et al. (2013) and Laureti and Secondi (2012) empirically found that living in detached house have significant positive relationship with the adoption of gas, electricity and liquid fuel. The sizes of the residence in which households live also influence their energy consumption behaviour. Most of the previous studies such as; Couture et al. (2012), Laureti and Secondi (2012) and Song et al. (2012) found that the larger the size of the building, the higher the adoption of fuel wood, all things being equal.

Furthermore, the number of rooms in the house is one of the building characteristics which influence households' energy consumption choice. For instance Eakins (2013) and Herltberg (2005) found this variable to have a positive significant relationship with the household use of Liquefied Petroleum Gas (LPG). Share of dwellings (i.e. more than one household living in the same building) is one of the factors which also shape the fuel consumption behaviour of households. Couture et al. (2012) found that this factor has a positive relationship with the adoption of modern cleaned fuel.

2.4 Environmental and Exogenous Factors

Another important category of factors that influence fuel choice are the exogenous factors. These are the factors which lie outside the domain of households but have effects on the household fuel choice. These include; physical environment, energy policies and regulations and availability. The physical environment such as; the level of organisation and development of the fuel market, weather temperature, the specific country context and how its location is, affects the fuel consumption behaviour. Furthermore, the level of urbanisation plays a positive impact on cleaned energy adoption (Risseeuw, 2012). Change of climate temperature has also been shown to have influence on household fuel adoption.

Moreover, availability of a particular fuel source can affect household behaviour of fuel adoption. Households often choose fuel source that is cheaper and nearer for consumption purposes. Empirically, Mensah and Audu (2013) found a positive relationship between household fuel consumption and the availability of the concerned fuel. That is why Heltberg (2003) argued that as households have access to cheap electricity, the consumption of traditional biomass as the major cooking fuel choice decreases.

3. Materials and Methods

Because this paper is a study of households at micro level, this section contains the description of the methods used in data gathering as well as the model used by the study as the tool of data analysis.

3.1 Sampling and Data Source

Being a pilot study, the total sample size utilised in this study are thirty households only. A total of fifteen households were selected from one of the urban areas of the state and another fifteen households were chosen from one of the rural areas of the state. This gives a total number of thirty households (30) utilised for this pilot analysis. Questionnaire method was used as the instrument of data collection. This instrument was used because it is easy and cheap means of gathering data from the targeted respondents.

3.2 Model Specification

Since households have a choice of either adopting biomass cooking fuel or otherwise, logit regression model was used to analyse the expected impacts of the variables on the household adoption of biomass cooking fuel in Bauchi state, Nigeria. When the dependent variable take only a binary value 0 or 1, the logit model can be expressed as:

$$\ln\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n$$

Where: P_i is the probability that a household adopts modern fuel source for cooking and $P_i/(1\text{-}P_i)$ is the odd of adopting modern cooking fuel in relation to the adoption of biomass cooking fuel sources. The β_s represent the various coefficients of the model and the Xs are the variables to be estimated. Logit model has been used by many previous studies of household behaviour (Link et al., 2012; Wang et al., 2011 and Pundo & Fraser, 2006). Table 1 shows the descriptive statistics of the variables analysed in the model.

Table 1: Means and Standard Deviations of the Variables

Variables	Number	Means	Deviation	Minimum	Maximum
Cfuelmainsource	30	0.37	0.49	0	1
Gender	30	0.80	0.41	0	1
Age	30	37.50	13.12	23	60
Marital Status	30	0.73	0.45	0	1
Homeappliances	29	19.55	13.94	5	73
Ncfuel	30	0.53	0.51	0	1
lnHomesize	30	3.92	0.37	3.00	4.70
Hholdsize	25	11.8	5.92	2.00	28.00
lnHholdsize^2	25	5.74	2.51	0.48	11.10
Income	30	59916.67	42392.27	15500	120000
Nrooms	30	5.70	2.58	2	11
homnature	29	2.72	2.15	0	7

Source: Authors' Field Survey, 2015

Table 1 contains the summary statistics of the variables used in this study. The data were sourced from the field survey of thirty households conducted in Bauchi State, Nigeria in June, 2015.

3. Results and Discussion

In order to assess the validity of the variable items that are considered by this pilot analysis to be related to the adoption of household cooking fuel source, the coefficient of the Cronbach's alpha was estimated using STATA software. Cronbach Alpha describes the extent to which variables measure a concept. It is connected to the inter-relationship of the variables in the test. According to Santos (1999) Cronbach's alpha examines the average correlations of variables in a survey instruments to gauge its reliability. The value of Cronbach's alpha ranges between 0 – 1, the closer the value is to 1 the better the result. Gliem and Gliem (2003) give a rule of thumb that any value of a Cronbach's alpha below 0.5 is unacceptable. Moreover, Santos (1999) agrees that any value of Cronbach's alpha from 0.7 is acceptable though lower threshold values are used in the literature sometimes. Table 2 below contains the result of the estimated Cronbach's alpha for this pilot study.

Table 2: Croanbach's Alpha Values of Variables Related to Household Cooking Fuel

ITEMS	OBSERVATIONS	ALPHA
Gender	30	0.7136
lnAge	30	0.7147
Marital Status	30	0.7133
Education	30	0.7128
Household size	25	0.6926
Occupation	30	0.7091
lnIncome	30	0.7105
Homeownership	30	0.7132
Homesize	30	0.6707
$lnHomesize^2$	30	0.6749
Nrooms	30	0.6884
Dwellshare	30	0.7161
Homnature	29	0.7114
Cfuelmainsoure	30	0.7138
Ncfuel	30	0.7157
Homeappliances	29	0.5932
$lnHomappliances^2$	29	0.6666
lnfirewoodqty	17	0.7112
lnKeroqty	19	0.7116
lnUnitpricefirewood	18	0.7077
lnUnitpricekero	16	0.7099
Test Scale		**0.7127**

From Table 2, the average calculated Cronbach's alpha value is 0.71 this shows that the data to be obtained on the variables included in this pilot study may be good, reliable, and acceptable for a valid study and analysis on household cooking fuel adoption in Bauchi state Nigeria.

Moreover, this paper utilises a logit model to examine the result of the assessment of some factors influencing households' adoption of cooking fuel in Bauchi state, Nigeria which may serve as a clue for the mother analysis. Table 3 below contains the results of the estimated models respectively.

Table 3: Results of the Estimated Logit Models

VARIABLES	MODEL1	MODEL2	MODEL3	MODEL4	MODEL5
Gender	-1.310343		-3.134219*	-3.754188*	
	(1.286876)		(1.660827)	(2.249242)	
Age	-.1501135**				
	(.0716169)				
Marital status	3.734502**				
	(1.659571)				
Homeappliances		-.1845982***			
		(.0681308)			
Ncfuel		-1.123905			
		(.9559574)			
lnhomesize		3.040426*			
		(1.591197)			
Hhsize			-4.661921*	3.16093**	-.5004676**
			(2.511335)	(1.588318)	(.1964245)
$lnhhsize^2$			7.74999*	-.2398706**	
			(4.375664)	(.1157607)	
Income				.0000279*	-2.232116

				(.0000164)	(1.450182)
Nrooms					.9234719*
					(.4847863)
Homnature					.8636981
					(.4502023)
Constant	3.256363*	-8.809357	8.147866**	-5.397749	20.72658
	(1.978092)	(5.57734)	(3.839492)	(4.311574)	(13.73277)
Pseudo R^2	0.25	0.23	0.50	0.55	0.49

Note: Standard errors are in parenthesis while the asterisks * ** and *** denote statistical significance at 10%, 5% and 1% levels respectively.

Table 3 contains the results of the estimated logit models based on the pilot data. The table contains about five different logit models, consisting different combinations of variables. This is because the total sample size is only 30, therefore the available observations are also 30 and there are many variables that are expected to have influence on household cooking fuel source. That is why, only 3 or 4 variables are included in each model for the estimation to be possible and also to comply with Roscoe (1975) and Sekaran (2003) that a sample size that is as ten times as the number of variables is accepted for a multivariate regressions.

Gender: This variable represents the gender of the household head which is a binary variable, 1 for male, otherwise 0. This variable was found to have a negative relationship with the households' odd of adopting non biomass cooking fuel. This implies that household who is headed by a female has a higher odd of adopting modern cooking fuel by more than 3% compared to a male headed household. This is because normally females are in charge of cooking food at home in Bauchi state, when using biomass cooking fuel they suffered more, that is why they have more wish to adopt modern cooking fuel source which are more efficient. This variable was found to be statistically significant at 10% level. This finding corresponds to the findings of Mensah and Audu (2013).

Age: This variable represents the age of the household head measured by number of years. This variable was found to be statistically significant at 5% level and was also found to be negatively related to the odd of adopting modern cooking fuel source by households. As the household head becomes older by about say ten years, the odd of adopting modern cooking fuel source reduce by about 15%. This finding conforms to a priori expectations because when people developed the interest of using a commodity for a longer period of time, they find it difficult to change the pattern of their consumption when they become older. This finding conforms to the findings of some previous studies (Nlom & Karimove, 2014; Mensah & Audu, 2013; and Suliman, 2010).

Marital Status: This variable means the marital status of the household head. This variable is a dichotomous variable coded as 1 for a married household head otherwise, 0. Based on the result of the estimated logit model, this variable was found to be statistically significant at 5% level and was also found to have a positive relationship with the household odd of adopting modern cooking fuel. The household who is headed by a married individual has a chance of adopting modern cooking fuel 3 times higher than the otherwise, all things being equal. This is because based on the culture of people of the study area, normally individuals get married when economically strong and being economically strong implies that the chance of avoiding biomass cooking fuel is higher.

Homeappliances: This variable represents the number of energy use devices such as fans, air conditioners, refrigerators and others, possessed by the household. This variable is measured by the number of unit quantity of these items possessed at home. Based on the result of the estimated logit model, this variable was found to be statistically significant at 1% level and also was found to have a negative relationship with the adoption of modern cooking fuel source. A one unit increase in energy consumption devices at home reduces the odd of adopting modern cooking fuel by about 0.18 all things being equal. This conforms to the findings of some previous studies (Eakins, 2011).

lnHomesize: This variable represents the size of the house in which the households live, measured by the number of feet of the plot size in which the house is built. This variable was found to be statistically significant at 10% level and was found to have a positive relationship with the adoption of modern cooking fuel source. The larger the home size, the higher the odd of adopting modern source of cooking fuel all things being equal. This finding contradicts the findings of other previous studies in other areas (Couture et al., 2012).

Household Size: This variable represents the number of individuals per head in the family. In other words, it refers to the size of the family. This variable was found to be statistically significant at 5% level and was found to have a negative relationship with the odd of adopting modern cooking fuel source. When the size of the family

members is large the odd of adopting modern source of cooking fuel decreases. This conforms to a priori expectation and also in line with the findings of some previous studies (Ozcan et al., 2013; Mensah & Audu, 2013; Laureti & Secondi, 2012). Furthermore, the square of this variable was also estimated in order to ascertain the extent of the non linear relationship that may exists between household adoption of modern cooking fuel and the house hold size, it was also found to be statistically significant at 5% level.

Income: This variable represents the total monthly income of the household measured in Naira value. This variable was found to be statistically significant at 10% level. Based on the result of the estimation this variable has a positive relationship with the odd of adopting modern cooking fuel, when the income increases households adopt modern cooking fuel instead of biomass fuels. This conforms to a priori expectation and is in line with the findings of Mensah and Adu (2013); Ozcan et al. (2013) and Couture et al. (2012).

Number of rooms: This variable represents the number of rooms in the house in which the household lives. This variable is statistically significant at 10% level and was found to have a positive relationship with the odd of adopting modern cooking fuel. This is in line with the findings of Eakins (2013) and Herltberg (2005).

4. Conclusions and Recommendations for Further Studies

This paper is a preliminary analysis conducted to examine the determinants of households' choice of cooking fuel in Bauchi state, Nigeria. Being a preliminary study, the main aim is to carry out a feasibility analysis of the pilot data obtained in order to ascertain the possibility of conducting a mother study on the factors influencing household cooking fuel choice in the study area. Based on the estimated Cronbach's alpha coefficient, the results show that a full study on household adoption of cooking fuel source using the same variables as used in this pilot study may produce a good, reliable, accepted and valid study. Hence a study to analyse the determinants of household cooking fuel choice in Bauchi state is feasible, worth conducting and may likely discover a valid conclusion that may benefit particularly, the people of Bauchi state, Nigeria.

Furthermore, the estimated logit regressions based on the pilot data show that marital status of the household head, income, number of rooms, nature of the home building and size of the house are the variables that significantly and positively related to the odd of adopting modern cooking fuel sources. Therefore, policies to increase and expand these factors will encourage households in Bauchi state to adopt modern and cleaned sources of cooking fuels. On the other hand, variables like; age of the household head, gender of the household head and home appliances are negatively and significantly related to the odd of adopting modern cooking fuel sources. Therefore policies to discourage these factors; will encourage the households in Bauchi state to reduce the use of traditional biomass fuels for cooking purpose. Lastly, as a limitation, this study is only a preliminary analysis based on only a sample size of 30 households, the number which is insufficient to represents the true picture of households of Bauchi state, Nigeria, therefore there is a need for another studies on the same issues that will cover a reasonable sample size that may well represent the population of households in Bauchi state, Nigeria.

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