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The Impact of Innovation on Economic Growth in Nigeria

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Abstract: *A country's innovative capability remains a yardstick of its global competitive advantages, for a country to have an upper hand in a dynamic and competitive world it has to be innovative. Nigeria is not among the developed and or developing nations due to its innovative incapability and hence retards her developmental goals. The country's abandoned resources (wealth) and human capital gave her a little advantage over fellow African countries. This study examines the relationship between innovation and economic growth In Nigeria using the vector error correction model (VECM), and determines both shortrun and longrun causal relationships. Based on the result, there exists a longrun relationship between innovation and economic growth, so also the study found no shortrun but a longrun causal relationship between the study variable. Hence the study suggests enhancing innovation activities in virtually all sectors of the Nigerian economy.*

Keywords: Economic growth, Innovation, Vector error correction model.

1. Introduction

Innovation is vital to the development of any given nation be it developed or developing, as it entails the ability to utilized natural resources. The role of innovation cannot be over-emphasized as it depicts the level of countries' development. Switzerland, Sweden, united states of America are the top three countries with high level of innovation on based on global innovation index 2019 (GII 2019) and are both categories as high-income countries. South Africa which tops the African countries in the ranking came at the 63rd position, followed by Kenya at 77th and Mauritius at 88th position. Nigeria was placed at the 114th position. The GII ranking has shown that in a global and dynamic world, the economies that can remain flexible, adaptive, and innovative will reap the benefits of world trade, because the global competitiveness of any economy depends on its science, technology and innovation (STI) capabilities (Philip H. F. et al 2016). The relationship between innovation and economic growth can be trace back to early theories proposed by scholars such as Schumpeter 1942 where he argued that evolving institutions entrepreneurs and technological changes were at the heart of economic growth. Innovation which creates new products, generates new solutions to economic problems, enhances efficiency of resources allocation, and boosts productivity (martins I. and naAllah A. 2014) is vital to the growth and progress of an economy. However, the challenges of diffusion of technology in Nigeria remains eminent, as there is no motivation to technological innovation, the country also lack the protection mechanism for innovators, inadequate research facilities and funding as well as disastrous environment and infrastructures for modern technology and foreign direct investment hence that ultimately affect productivity and general economic progress. This is where the contribution of this paper comes by examining the relationship between innovation and economic growth in Nigeria.

The remainder of the paper will be presented as follow; section two cover the literatures on concept of innovation, as well as theoretical and empirical literatures, section three cover methodology, section four is presentation of result and lastly section five cover conclusion remark

2. Theoretical and Empirical Literature Review

Innovation and economic growth can be driven by a growth in production inputs (namely labor and capital), by a higher efficiency in their allocation across sectors of the economy, or by improvements in productivity. Improvements in productivity are in turn largely underpinned by innovation. (Florent S. and Plekhanov A. 2015)

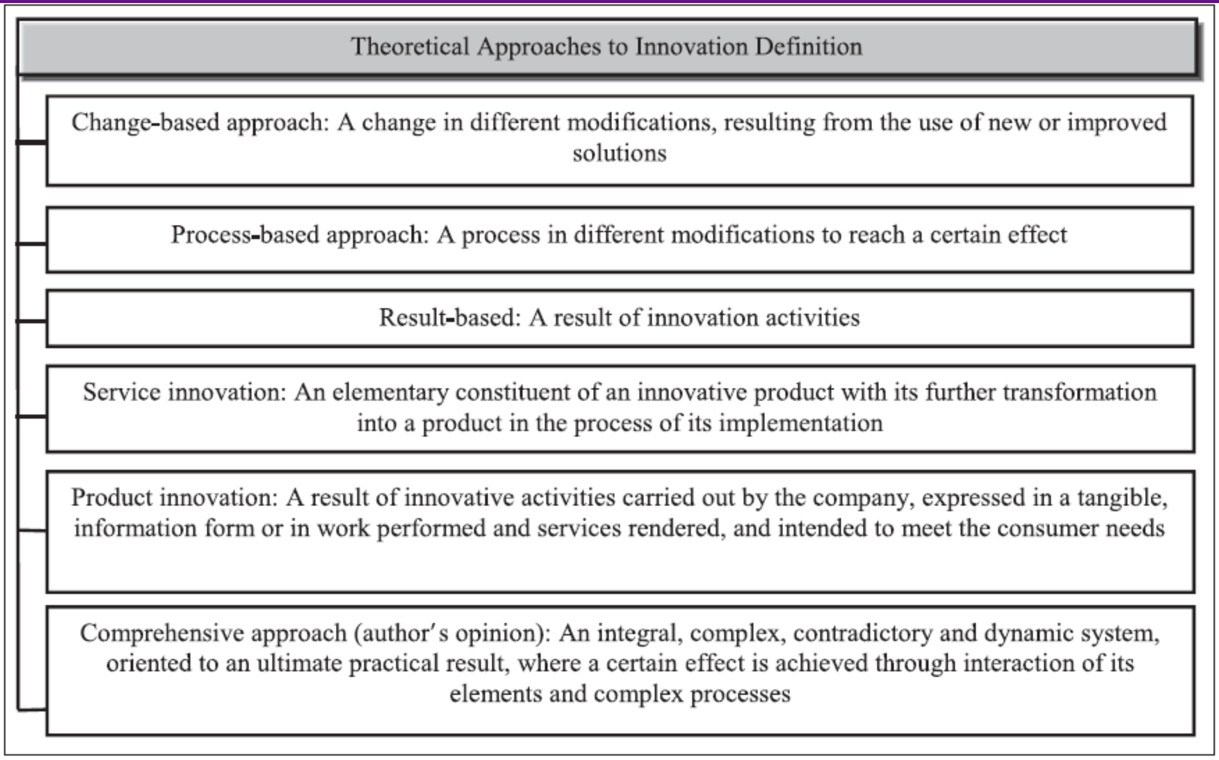

Figure 1: innovation definition
Source :(Manuylenko V., V., et al 2015)

Economic growth closely depends on the synergies between knowledge and human capital, which is why large increases in education and training have accompanied major advances in technological knowledge in all countries that have achieved significant economic growth (Philip H. F. et al 2016).The introduction of new products or process helps to improve the efficiency with which various factors of production are combined and thus raise total factor productivity, the unexplained residual in the neoclassical growth theory framework. (Florent S. and Plekhanov A. 2015)

Economic growth models examine the evolution of a hypothetical economy over time as the quantities and/or the qualities of various inputs into the production process and the methods of using those inputs change. The basic model of economic growth is the Nobel prizewinning work by Robert Solow that does not include resources at all. In this model, a constant-sized labor force using manufactured capital produces output in terms of gross domestic product (GDP). The model assumes that output increases at a decreasing rate as the amount of capital employed rises. (Stern 2004). The primary missing ingredients in growth theory (and for that matter in much of macroeconomic theory) is the role of natural resources, materials, energy and work. (Ayres, 2005). There is an inbuilt bias in mainstream production and growth theory to downplay the role of resources in the economy, though there is nothing inherent in economics that restricts the potential role of resources in the economy. The Solow model subsequently was extended with nonrenewable resources, renewable resources, and some waste assimilation services. These extended models, however, have only been applied in the context of debates about environmental sustainability, not in standard macroeconomic applications.

A somewhat competing explanation, however, emerged in models of endogenous growth that are otherwise referred to as “new growth theory”. The new growth theory offered a fresh take on what engineers’ economic prosperity. It emphasizes the importance of entrepreneurship, knowledge, innovation and technology. Competition squeezes profit, so people have to constantly seek better ways to do things or invest new products in order to maximize profitability. The theory argues that innovation and new technology do not occur simply by random chance. Rather, it depends on the number of people seeking out new innovations and technologies and how hard they are looking for them. In addition, people alps have control over their knowledge capital- what to study, how hard to study, etc. if the profit incentive is great enough, people will choose to grow human capital and look harder for new innovations.

A significant aspect of this theory is the idea that knowledge is treated as an asset for growth that is not subject to finite restrictions or diminishing returns like other assets such as capital or real estate. Knowledge is an intangible quality rather than physical, and can be a resource grown within an organization or industry. previous studies on innovation and economic growth nexus examine a contradicting relationship, especially on the causal relationship between innovation and economic growth as well as the direction of the causality, generally speaking, four hypotheses were formulated namely supply-leading hypothesis, demand-following hypothesis, feedback hypothesis, and neutrality hypothesis.

The supply-leading hypothesis shows unidirectional causality from innovation activities to economic growth (Maradana R., P., et al 2017). This hypothesis can be justified from the work of Pradhan et al. (2016), The demand following hypothesis reflects unidirectional causality from economic growth to innovation activities (see, for instance, sadraoui et al (2014)), the feedback hypothesis reveals bidirectional causality between economic growth and innovation activities (see for instances pradhan et al (2016)). Lastly the neutral hypothesis which postulate the independent relationship between economic growth and innovation activities (see, for instance, cetin (2013)). The lack of consensus between the postulated hypothesis and aim to apply a robust technique in examining the relationship as well as causal direction between economic growth and innovation activities is the main motivation of this paper.

2.1. Data sources and description

The research employed annual data from the period 1981 to 2018. The availability of data throughout the study period is what warrants the choice of this scope. The data was obtained from World Bank human development indicators and the central bank of Nigeria. Based on the theoretical framework, economic growth is a function of macroeconomic, institutional and structural factors, including physical and human capital, the level of technology (which embodies innovation) and the degree of openness. Consequently, economic growth was measured by and computed as annual percentage change in real GDP per capita, in line with standard practice; macroeconomic factors were proxied by government size computed as the ratio of total government expenditure to GDP; institutional factors were captured by contract intensive money, computed as the difference between broad money supply and currency held outside circulation as a proportion of broad money supply; trade openness was proxied by the ratio of total trade to GDP; structural factors were measured as the ratio of the share of agriculture to GDP; innovation (reflecting technological transfer, diffusion and knowledge spillover) was measured by expenditure on imported machinery and equipment; human capital was captured by government recurrent expenditure on education. All the variables employed were first transformed into logarithms to account for non-linear properties and heteroscedasticity. This is employed from the work of (martins I. and naAllah A. 2014) because this paper adopts the same theory of new growth theory.

3. Model Specification and Estimation Procedure

To achieve the stated objectives of the study the research will employ martins I. and naAllah A. (2014) methodology "Taking inference from the empirical findings and theories, which has been derived from the theoretical exposition of the new growth theories. If economic growth is taken as an independent variable then the model can be stated as:

$EGt= \beta_0 + \beta_1 lNNOV + \beta 2HKt + \beta_3 lNSt+ \beta_4 STRt + \beta_5 GSt+ \beta_6 OPN + \varepsilon\, t$

Where:EG=Economic growth, INOV=Innovation. HK=human capital, INS=Institutional quality, STR=Structure of the economy, GS=Government size, OPN=Degree of openness, Et=White noise disturbance term

3.1. Unit root

According to the Engle and Granger (1987) if independent series are stationary then the series are said to be co-integrated. To investigate, whether the given time series are stationary, there are several procedure found in the econometric literature. It is evident that each test has its own merits and demerits (Masuduzzaman M, 2012). The study used two tests in this regard; these are, Augmented Dickey Fuller (1979) and Phillips Peron (1988) tests to avoid the criticisms of individual test. The study performed the ADF and PP tests based on the following models respectively:

$$\Delta y_t = \alpha_0 + \alpha 1yt - 1 + \sum_{i=1}^{n} \alpha_1 \Delta y_i + \varepsilon_t$$

Where: Δ is the first difference operator, n is the optimal number lags, ε_t is the disturbance term consider as white noise, y is the time series,

$$\Delta y_t = \alpha_0 + b yt - 1 + \varepsilon_t$$

Δ Is the first difference operator, α_0 is the constant, ε_t is the disturbance term consider as white noise, y is the time series

3.2. The Co-integration Test and VECM

For co-integration test(johanssen) it is required that the chosen time series to be integrated of the same order, when this condition satisfy then we can move into examine the existence of long run co-integration relationship of the chosen time series. The study employs Juselius and Johansen (1990) Co-integration test. The presence of a co-integrating relation forms the basis of the VECM which measure the short-run and long-run relationship. Johansen method indicates the maximum likelihood procedure to identification of existence of co integrating vectors for chosen non-stationary time series data. The Johansen methods allow us to determining the number of co-integrating vector. These tests directly investigate the integration in Vector Auto-regression (VAR) model. The most popular method for Granger causality tests is based on the VECM if variables are cointegrated. The VECM can

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avoid shortcomings of the VAR based models in distinguishing between a long- and a short-run relationship among the variables. Theoretically, cointegration implies the existence of causality between variables, but it does not indicate the direction of the causal relationship.

Given a VAR(p) process

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + u_t$$

is stable if the polynomial defined by $\det\left(I_K - A_1 z - \cdots - A_p z^p\right) = 0$ has no roots in and on the complex circle. But "equilibrium relationships are suspected between many economic variables" (Lutkepohl, 2005). Thus, if there are roots on the unit circle then some or all of the variables in $y_t$are I(1) and they may also be cointegrated. There are two different likelihood ratio test proposed by johansen which are trace test and maximum Eigen value test

Trace test

$$\lambda trace = -T \sum_{j=r+1}^{k} \ln(1 - \lambda j)$$

Maximum Eigen value test

$$\lambda max = -T \sum \ln(1 - \lambda r + 1)$$

Where:

T=sample size λj=estimated values of characteristics roots ranked from largest to smallest. However, trace test tests the null hypothesis of co-integrating vector against the alternative hypothesis n co-integrating vectors. So also, maximum Eigen value test, test the null of r co-integrating vector against the alternative hypothesis of r+1 co-integrating vectors. If y_t is cointegrated then the VAR representation is not the most suitable representation for analysis because the cointegrating relations are not explicitly apparent. The co-integrating relations then, become apparent if the levels VAR is transformed to the vector error correction model (VECM)

$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-2} + \cdots + \Gamma_{p-1} \Delta y_{t-p+1} + u_t$

Such that,

$\Delta y_t = \alpha\beta' y_{t-1} + \Gamma_1 \Delta y_{t-2} + \cdots + \Gamma_{p-1} \Delta y_{t-p+1} + u_t$,

Where:

$\Gamma_i = -\left(A_{i+1} + \cdots + A_p\right)$, For $i = 1, \ldots, p-1$is the matrix product $\alpha\beta'$with α and β being of dimension $(k \times 1)$ and of rank *r*. And that matrix β is called a *cointegration vector* and α is sometimes called the *loading matrix*. The factorization $\Pi = \alpha\beta'$ only identifies the space spanned by the cointegrating relations, to obtain unique values of α and β requires further restrictions on the model.

The above VECM equation can be estimated by maximum likelihood (ML) taking the rank restriction for $\Pi = \alpha\beta'$ into account. According to Engle and Granger (1987), when a set of variables are I (1) and are co-integrated then short-run analysis of the system should incorporate error correction term (ECT) in order to model the adjustment for the deviation from its long-run equilibrium. The vector error correction model (VECM) is therefore characterized by both differenced and long-run equilibrium models, thereby allowing for the estimates of short-run dynamics as well as long-run equilibrium adjustments process.

4. Results and discussion

4.1. Vector Error Correction Model (VECM)

Vector error correction model involves three steps, first is lag selection criterion which allows the researchers to choose optimum lag to use in both johanassen cointegration and vector error correction model, second is johansen cointegration test to determine the longrun relationship between study variables, and lastly vector error correction model which explain the interrelationship between study variables as well as longrun and shortrun causal relationship.

Table 1: VAR Lag Order Selection Criteria

Lag	LR	FPE	AIC	SC	HQ
0	NA	2.5154	145.1259	145.4370	145.2333
1	332.2572	1.9850	135.6201	138.1087	136.4792
2	70.56722	1.3750	134.8918	139.5578	136.5025

3	90.07331*	6.8248*	130.7630*	137.6066*	133.1254*

From the above table, the sign (*) indicates the lag order selected by different criterion. Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz information criterion, Hannan-Quinn Information criterion (HQ) and LR recommend lag order three (3). "The lower the value the better the model", clearly all the criterion applies that rule. Hence the optimum lag order is three which can be used in both johansen and VECM test.

4.2. Johansen Cointegration Test

The next step in estimating vector error correction model (VECM) is johanseen cointegration test which measures the longrun relationship between study variable, and the precondition of estimating johansen cointegration is all the variable must be stationary at same order of integration when unit root test is applied

Table 2: Unit root test

	Augmented dickey fuller		Phillips-perron	
Variable	Level	1st difference	level	1st difference
Eg	0.6635	0.0081	0.6303	0.0099
Innov	0.8907	0.0004	0.8839	0.0004
Hk	1.0000	0.0020	1.0000	0.0022
Str	0.2458	0.0000	0.0688	0.0000
Ins	1.0000	0.0001	0.9998	0.0000
Gs	0.5825	0.0000	0.5431	0.0000
opn	0.4052	0.0000	0.3794	0.0000

Both ADF and PP results shows that all the series are level nonstationary but stationary after first differencing indicating that the order of integrations of the series are I (1) ADF and PP. this warrant the test of johanseen Cointegration.

Table 3: Johanssen cointegration

Hypothesis: Number of cointegrating equations	Eigen value	Max- eigen stat	0..05 critical value	Prob. value	Trace statistics	0.05 critical value	Probability value
none	0.985029	147.0568	46.23142	0.0000	303.2736	125.6154	0.0000
Atmost 1	0.754094	49.09826	40.07757	0.0037	156.2168	95.75366	0.0000
Atmost 2	0.640150	35.77237	33.87687	0.0294	107.1185	69.81889	0.0000
Atmost 3	0.586576	30.91489	27.58434	0.0180	71.34617	47.85613	0.0001
Atmost 4	0.464763	21.87661	21.13162	0.0392	40.43128	29.79707	0.0021

Atmost 5	0.317724	13.38123	14.26460	0.0686	18.55467	15.49471	0.0167
Atmost 6	0.137407	5.173441	3.841466	0.0229	5.173441	3.841466	0.0229

The results of Johansen co-integration test shown above; where we find that the null hypothesis of no co-integration can be rejected using both the trace statistic and Max Eigen Value Statistics at 5% level. The results show at most six numbers of co-integrating equations: none* (r=0), at most 1* ($r \leq 1$) at most 2* ($r \leq 2$), indicating six co-integrating vector for trace and as well for the maximum eigenvalue test statistics.

The first null hypothesis from the trace statistics is no cointegration among the study variables, the guidelines for explaining the relationship under trace statistics is, if the trace statistics is more than critical values we reject null hypothesis of no cointegration. Our trace statistic here is 303.2736 which are greater than the critical value of 125.6154; hence we reject the null hypothesis. So also the probability values of 0.000 which is very significance and less than 5 %(0.05). The same rule can be applied to other null hypothesis yielding the same result. Trace statistics indicate at most four cointegrating relationships. As for the maximum eigen values same rule can be applied yielding the same result.

In summary, the calculated values are both greater than the critical values. This simply means that there is a long run relationship among study variables.

Table 4: Vector Error Correction Estimate

Variable	D(EG)	D(INNOV)	D(HK)	D(GS)	D(INS)	D(STR)	D(OPN)
ECT_{-1}	0.118581	4311545.	0.003508	0.003549	0.000307	2.69E-05	-349828.1
	(0.01938)	(1273606)	(0.04553)	(0.00308)	(7.3E-05)	(0.00022)	(406988.)
	[6.11946]	[3.38531]	[0.07705]	[1.15399]	[4.21991]	[0.12225]	[-0.85955]

The table above indicates that estimated lagged error correction term of growth. The magnitude of the error correction term is negative, its absolute value lies between zero and one, and it's statistically significant. This implies a long-run convergence of the model; it hereby implies that if any external shock is introduced into the model, the model would still converge with time. The speed of error adjustment of the model is quite impressive (about 85%), implying 85% of present error in the model would be corrected in the long-run. As for the optimum lags appears to be three which are recommended by AIC, HQ and FPE. It can be noticed from the result that the first values are the coefficient, the values in bracket are standard errors and lastly those in parenthesis are t-statistics, if we divide each coefficient with its standard error we get t-statistics.

We first concentrate on GDP which happens to be or dependent variable and get its probability values from the system equation to enable us determine the longrun causal relationship between other variables with the use of system equation model

Table 5: VECM Longrun causality

Dependent variable: GDP Included observations: 30 after adjustments

D(EG) = C(1)*(EG(-1) - 2.63265441693E-07*INNOV(-1) +
7.9159306517*HK(-1) + 4.71896391247*GS(-1) - 2.6039233604E
-07*OPN(-1) - 3792.50402759*INS(-1) - 130.83468134*STR(-1) +
1183.79864591) + C(2)*D(EG(-1)) + C(3)*D(EG(-2)) + C(4)
*D(INNOV(-1)) + C(5)*D(INNOV(-2)) + C(6)*D(HK(-1)) + C(7)
*D(HK(-2)) + C(8)*D(GS(-1)) + C(9)*D(GS(-2)) + C(10)*D(OPN(
-1)) + C(11)*D(OPN(-2)) + C(12)*D(INS(-1)) + C(13)*D(INS(-2)) +
C(14)*D(STR(-1)) + C(15)*D(STR(-2)) + C(16)

	Coefficient	Std. Error	t-statistic	Prob.
C(1)	-1.107092	0.197891	-5.594451	0.0000
C(2)	-0.873650	0.229912	-3.799937	0.0012
R-squared	0.837249			
Log likelihood	124.0756			
F-statistic	292500.1			
Prob(F-statistic)	-207.7031			
Durbin-Watson stat	2.487517			

We first regress EG as dependent variable, enable us to see the causal (long run) relationship between EG and other variables. From the result above C (1) is the coefficient of the co-integrating model, error correction term of speed of adjustment towards equilibrium. If C (1) is negative in sign and significance in probability than there is long run causality running from study variables (innovation inclusive) to economic growth. From the estimate C(1) coefficient is negative which show long run causality from the independent variables such as innovation to GDP, meaning that independent variable have influence on the dependent variable in the longrun.

4.3. Shortrun Causality

To determine short run causality, we formulate hypothesis from the estimated regression equation by equating the coefficients of each variable to zero. The null hypothesis is there is no short run causality relationship. Wald test of causality is used to check the shortrun causality between each study variables, to check the shortrun causality between innovation and economic growth we equate the innovation coefficients to zero i.e., c (4) =c (5) =0 as null hypothesis (no short causality between innovation and economic growth). To calculate F statistic, we compare the calculated F-ratio from the estimation with the critical value of F in the F table. If The F ratio associated with (x,y) degrees of freedom is equal of larger than the critical F-value, than the result is significant at stated level of probability

Table 6: Wald Test:

Equation: Untitled

Test Statistic	Value	Df	Probability
F-statistic	2.886214	(2, 19)	0.0804
Chi-square	5.772428	2	0.0558

Null Hypothesis: C(4)=C(5)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(4)	1.20E-08	5.03E-09
C(5)	2.81E-09	3.53E-09

Restrictions are linear in coefficients.
The null hypothesis is, the innovation coefficients are equals to zero, meaning innovation does not granger cause economic growth in the shortrun. The computed F-statistic =2.886214 associated with (2,19) degree of freedom is less than the F-critical value of 3.24, also the probability value is insignificance at 5% level so we accept null hypothesis meaning that there is no shortrun causality.

5. Conclusions

The summary of the model based on the results of the analysis shows a longrun relationship between economic growth and other study (independent variable) such as innovation which was proxied by expenditure on imported machineries and equipment, this is in consistent with other findings in this area, so also the result shows a longrun causality running from innovation to gross domestic product which depicts a unidirectional causal relationship. So also, there exists no shortrun causality between innovation and gross domestic product. The result clearly depicts a unidirectional causality running from innovation to economic growth; this confirms the postulated hypothesis of supply-leading hypothesis suggesting that innovation is a component in growth. Hence applications of knowledge factor in economic activities should be encourage in enhancing economic growth, virtually all sectors of Nigerian economy require innovation activities, therefore, enhancing innovation capabilities will enhance larger percentage of the sector of the Nigerian economy hence economic development. There is virtually no sector of the Nigerian economy that does not need innovation. With time as we continue to enhance our innovation capabilities, a larger percentage of the sectors of the Nigerian economy will become strong pillars of economic development in Nigeria

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