**ECONOMIC GROWTH RESPONSE TO FINANCIAL DEVELOPMENT AND ICT DIFFUSION IN NIGERIA**

**INTRODUCTION**

The process of diffusion of information and communication technology (ICT) in Nigeria has been slow despite recent advancement in technology. This has greatly impacted financial development, which in turn has affected the overall economic of the country. Access to reliable and effective financial services is crucial for economic growth, however, the lack of ICT diffusion poses a significant obstacle. There are factors at play such as limited infrastructure and high levels of poverty, which make it difficult to achieve widespread adoption of ICT and improve financial inclusion. Therefore, it is necessary to explore strategies for accelerating the diffusion of ICT and increasing financial development in Nigeria to drive economic growth and improve the standard of living for its citizens.

Both good and bad results have been found in studies that look into the link between money and economic growth. Some reasons for this are more financial crises or fewer publicly traded companies to encourage growth, as well as partnerships that don't follow a straight line. ICT is one of the main reasons why economies are growing faster, and its effect on growth has been the subject of a lot of research in recent years. Through electronic encoding and virtual movement, ICT makes it easier for information to get around. This changes the way many businesses grow and use technology, as well as the way the economy works.

ICT has a big impact on economies and societies because it makes it easier for people to get information and different kinds of knowledge. This gives people more power and makes them more involved in social and economic life (Lechman & Marszk, 2019). Digital technologies can be used to create new platforms that help the economy work better, particularly within rural areas. For example, online banking and digital investment can help the financial sector, and online entrepreneurs can help the retail sector. This means that technological innovations have a good chance to improve the way markets work by making up for insufficient facilities and economic restrictions (Hernandez et al. 2016).

The financial industry's rapid adoption of technological innovations has made it possible for the world's financial system to go virtual (Lechman & Marszk, 2019). With the ease of access to digital financial services and the decrease in transaction costs, ICT can potentially increase human involvement in the financial system (Pradhan et al., 2018). This demonstrates how ICT can improve market efficiency and boost financial market efficiency.

However, despite the theoretical literature's broad expectations that increased use of ICTs will spur economic growth, empirical research has yielded contradictory outcomes. Some research has identified positive effects, but other investigations have found little, unclear, or unfavorable associations.

Against this backdrop, this study sets up to empirically examine effects of ICT diffusion and financial development on economic growth in Nigeria with respect to mobile network coverage, internet subscribers per 100 persons, mobile phone subscribers per 100 persons, ATMs (automated teller machines) per 100000 adults, and bank branches per 100000 people.

**LITERATURE REVIEW**

As firmly established in the works of Seifallah and Mohamed (2013) and Salahuddin and Gow (2015), the finance-growth theses and the modification of the endogenous growth model to account for ICT diffusion provide the theoretical foundation for this investigation. Using the supply-leading and demand-following theories, the theoretical connection between finance and growth is demonstrated. These theoretical frameworks describe the diverging relationship between finance and growth in an analytical framework. The former traces the causal relationship between finance and growth, while the latter links growth to developments in the financial sector.

A well-developed financial sector that reduces transaction and monitoring costs and asymmetric information is a requirement for economic growth, according to the supply-leading thesis, which contends that financial development influences economic growth (Adeyeye et al., 2015; Fosu, 2013; King & Levine, 1993; Odhiambo, 2008; Schumpeter, 1911).

In the second instance, the demand-following theory charts the path of causality from financial development to economic growth, whereby advancements in the economy increase the need for financial services, hence strengthening the financial sector (Caldreron & Liu, 2002; Singh, 1999). This theoretical framework implies that economic growth raises the overall level of macroeconomic activity, which in turn drives the need for financial sector expansion.

ICT diffusion's influence on scientific uncontrolled change in the neoclassical growth theory establishes its place in the modeling paradigm. Development is a result of investments in human capital and technological advancement, according to the endogenous growth theory (Aghion & Howitt, 1998; Barro, 1998; Lucas, 1988; Romer, 1986; Romer, 1990).

The current model can be changed to see ICT as promoting economic growth by means of increased productivity brought about by technological advancements, which raises a nation's economic growth rate and creates new job opportunities (Czenich et al., 2011; Salahuddin & Gow, 2015, Seifallah & Mohamed, 2013). ICTs are predicted to accelerate economic growth by encouraging the adoption and development of innovative processes. According to the authors, concepts and the creation and dissemination of knowledge are important forces behind economic growth in endogenous growth models (Aghion & Howitt, 1998; Lucas, 1988; Romer, 1990). As a result, increased ICT use may have an impact on the economy's capacity for innovation through the generation of knowledge spillover, new goods and processes, and business models that foster expansion. Accordingly, the use of these ICTs may promote competition for and the creation of new goods, procedures, and business models, as well as speed up the dissemination of ideas and information, all of which could contribute to macroeconomic growth (Czenich et al., 2011).

More specifically, ICT diffusion lowers the primary market frictions, namely information and transaction costs, and thus strengthens the effect of financial development on economic growth, according to Seifallah and Mohamed (2013). Moreover, the authors contend that the growth of ICT infrastructure facilitates corporate management and monitoring, two crucial roles of financial intermediaries (Seifallah & Mohamed, 2013). Additionally, effective ICT infrastructure improves corporate responsiveness and decreases pricing volatility and information asymmetries. In passing, considering that financial development stimulates economic growth through two channels—technological innovation and capital accumulation (Levine, 1997)—it is clear that the quick spread of ICT plays a significant role in driving economic growth through the technological innovation channel since it fosters innovation and the creation of new goods and procedures (Salahuddin & Gow, 2015).

The literature on the connection between financial development and growth and ICT diffusion dates back to the writings of Schumpeter, Gurley, McKinnon, and Shaw. The idea states that the rise of the banking industry is beneficial to economic expansion because it boosts saving, enhances the effectiveness of resource allocation, and fosters technical innovation. It is conceptually expected that mobile network coverage, internet subscribers per 100 persons, mobile phone subscribers per 100 persons, ATMs per 100000 adults, and bank branches per 100000 people would have a positive causality to economic growth.

In theory, there seems to be a strong correlation between the spread of ICT and economic expansion. ICT is an uncontrollable, external force that arises from corporate or governmental initiatives and manifests itself in real economic activity through increases in productivity. For economists, economic growth is a hotly debated and constantly changing topic. Smith acknowledged in 1776 that increasing labor productivity is a direct effect of economic technology advancement in his ground-breaking theory of economic development. The neo-classical theories proposed growth through an expanded workforce and productivity through technical advancement, whereas the classical theory placed an emphasis on specialization to boost production. Productivity is therefore raised by emphasizing the development of human capital and funding health and education initiatives. Romer (1986) introduced the AK model of growth, which included technological knowledge as an endogenous element, in opposition to the then-dominant neo-classical growth theories.

Economic growth and ICT diffusion are causally related, according to four assumptions. The first is the supply leading hypothesis, which suggests that ICT dissemination drives economic growth in a one-way fashion (Alimi and Adediran, 2020; Pradhan et al., 2018, 2021; Sawng et al., 2021). This argument rests on the idea that more investment in ICT infrastructure and, in turn, more ICT use increase job opportunities and business productivity, both of which support economic growth.

Expanding ICT infrastructure boosts economic growth by generating new digital businesses and additional jobs. According to the demand-following theory, the second school of thinking, ICT diffusion is caused by economic progress. According to this hypothesis, a nation can invest more in ICT infrastructure as its economy grows, enabling it to service a wider spectrum of people and enterprises.

Therefore, in order to keep their competitive edge in the global market, advanced economies are depending more and more on the digital economy. They have thereby accelerated the creation of more sophisticated ICT infrastructure. Salahuddin and Gow (2016), Lee (2011), and Beil et al. (2005) are among the studies that examine these connections. Furthermore, the feedback hypothesis is supported by Chakraborty and Nandi (2011), Ramlan and Ahmed (2009), and Shiu and Lam (2008), who show that there is a bidirectional causal relationship between the variables. Lastly, some research suggests that there is no causal relationship between the factors (Dutta, 2001; Shiu and Lam, 2008; Veeramacheneni et al., 2007).

Theoretically, there may be a connection between the growth of the financial sector and economic expansion that dates back to Gurley and Shaw (1955), Schumpeter and Backhaus (2003), and Thornton and Poudyal (1990), who proposed that the establishment of financial institutions like banks could maximize resource allocation and speed up technological development in manufacturing, thus promoting economic expansion.

Additionally, financial development promotes financial inclusiveness, lowers monitoring expenses, lessens information symmetry, and minimizes transaction costs (King & Levine, 1993). Allocative efficiency and the financial sector's contribution to financial inclusion were the main topics of the early endogenous theories. Nonetheless, King and Levine (1993) supported financial development because it improves liquidity, diversifies portfolios, lowers risks, and stimulates demand, which in turn accelerates economic growth.

Conflicting theories have been proposed on the relationship between financial development and economic growth (Franciskovic and Miralles, 2021; Guru and Yadav, 2019; Jalil and Ma, 2008; Salahuddin and Gow, 2016; Saqib, 2015). First, according to the hypothesis of financial development-driven economic growth, financial development initiatives generate economic growth. According to the theory, economic agents that have access to credit and other financial services are better able to maximize social welfare. Economic growth accelerates as a result of increased industry competitiveness, which raises salaries generally and especially for formerly neglected people.

Second, the hypothesis that financial development is driven by economic growth (Asongu and Odhiambo, 2019; Hsueh et al., 2013; Sehrawat and Giri, 2016) is predicated on the notion that a growing economy will require the introduction of new financial services that will be used by a wider range of people. Increasing access to financial services as a result of these factors encourages more people to engage in the economy. As the nation's wealth grows, more investment should follow, which will ultimately result in the delivery of more sophisticated financial services that increase socioeconomic reach and wealth. Thus, it is expected that strong economic growth will support financial development initiatives. However, another body of literature provided data in support of the feedback theory (Bangake and Eggoh, 2011; Erlando et al., 2020; Kar et al., 2011).

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Chatterjee (2020) investigated the impact of financial inclusion and ICT on GDP in 41 nations. He discovered that the internet and mobile phones may both boost GDP. However, the interaction term significantly and favorably affects the economy's growth process. This suggests that in order to improve the economic performance of industrialized nations, ICT and financial inclusion must be combined, just as they are for poor nations. Adeleye et al. (2020) examined how ICT commerce affected 53 African nations' economic growth between 2005 and 2015. They discovered that the impact of ICT varies greatly among sub-regions and that ICT enhances the influence of commerce on growth by using mobile phones and fixed telephone subscriptions as ICT indicators. This suggests that the use of ICT greatly fosters inclusive and economic growth. Therefore, in order to stimulate economic growth, governments, regulators, and policymakers must enact laws that encourage more trading.

Raheem et al. (2020) examined the connection between GDP, ICT diffusion, and financial development in the G7 between 1990 and 2014. They demonstrate that the relationship between ICT diffusion and financial development has a mixed impact on GDP, meaning that it is favourable in the near term but negative in the long term, using the pooled mean group (PMG) estimator. Oladimeji and Folayan (2018) examined the growth advantages of the ICT sector and its effects on the Nigerian economy. They hypothesised that the growth rate is a mechanism for the advancement of economies in developing nations such as Nigeria in the twenty-first century. Market expansion, lower transaction costs, and improved efficiency and management in Nigeria's public and private sectors are all made possible by ICT and ICT-related facilities. They made assumptions about the various effects of ICT in the four main areas of the Nigerian economy and the potential of wireless technology platforms to promote social and economic impact for the general public.

According to Ouma et al. (2017), who evaluated the effect of mobile phones on savings in a few SSA nations, mobile phones improve financial services and increase household savings. Using Arab nations as a case study, Hodrab et al. (2016) investigated how the factors that contribute to economic growth may be divided into the following categories: population growth, gross capital creation, openness, inflation, and information and communication technology (ICT) in developing nations. Utilising econometric research, they investigated the impact of the proposed determinants on the economic growth of 18 Arab countries between 1995 and 2013. The study's findings indicated that ICT and other proposed factors have a favourable impact on the economic growth of the 18 Arab countries.

Over a 27-year span (1990–2014), Albiman and Sulong (2016) investigated the long-term effects of ICT on economic growth in the SSA area. They discovered that ICT proxies, including the Internet, mobile phones, and fixed phone lines, had a direct linear impact on economic development that is both positive and statistically significant. They discovered, however, that widespread use of ICT proxies appears to impede economic growth in the SSA region when taking into account a nonlinear effect analysis.

**METHODOLOGY**

This study employed secondary data in investigating the effect of ICT diffusion and financial developments on the economic growth in Nigeria. The sample size was very much dependent on data availability as published by the Central Bank of Nigeria (CBN) statistical bulletins and World Bank datasheets at the time of conducting this study. To determine the impact and link between the variables of interest in the study, the exploratory research design was used based on the study's hypotheses and theoretical framework. Twenty (20) observations, or annual panel/pooled data, from 2005–2024 were used in the study. The dependent and independent variable selections were restricted to the proxies used in this study, and the study was restricted to the years in which data were selected for analysis: gross domestic product growth rate (GDPGR), ICT diffusion which is the independent variable was proxied by internet subscribers per 100 person (ISP), mobile network coverage (MNC) and mobile phone subscribers per 100 person (MPS), and financial development which was also the independent variable was proxied by automated teller machines per 100,000 adults (ATMS) and bank branches per 100,000 people (BBP).

The econometric model after the autoregressive distributed lag (ARDL) model was specified into an equation in line with the dependent variable. Theoretically, it is expected that ICT diffusion and financial development measures should positively impact gross domestic product growth rate of Nigeria (β1, β2, β3, β4, β5 > 0) as a priori expectations, ceteris paribus. The ARDL methodology was applied because its technical efficiency is better studied with time series construction. The study employed the summarized unit root test, and the ARDL (long-run and short-run) tests in order to analyze the data collected using E-Views 11.0 computer software. The ARDL method has many benefits when compared with other co-integration techniques, and can be used notwithstanding if the underlying variables are wholly 1(0), 1(1) or jointly co-integrated, and can also be estimated with little sample features as stated beneath:

$GDPGR\_{it}=∝\_{10}$+$∝\_{1∝ }ΔGDPGR\_{it-ϑ}$+$∝\_{2∝}ΔATMS\_{t-ϑ }$+$∝\_{3∝ }ΔBBP\_{t-ϑ}$+$∝\_{4∝ }ΔISP\_{t-ϑ}$+ $∝\_{5∝}ΔMNC\_{t-ϑ}$ + $∝\_{6∝}ΔMPS\_{it-ϑ}$+β6$GDPGR\_{Ct-i}$ + β7$ATMS\_{t-i}$ + β8$BBP\_{t-i}$ + β9$ISP\_{t-i}$ + β10$MNC\_{t-i}$ + β11$MPS\_{t-i}$+ ∈2it

 The F-statistics was used to establish the association of the series of the model in the long run. Hence, the hypothesis stated in the null and alternate form is as follows:

𝐻0: 𝜌1 = 𝜌2 = 𝜌3 = 𝜌4 = 𝜌5 = 0

𝐻1: 𝜌1 ≠ 𝜌2 ≠ 𝜌3 ≠ 𝜌4 ≠ 𝜌5 ≠ 0

The t-statistics critical and the tabulated values are compared as a decision criterion.

**Results and discussions**

The summarized group unit root test of stationarity was adopted in order to ascertain at what order of integration the variables of interest are found to be stationary in this study. The group unit root test was performed in order to determine whether the relevant variables are stationary. If variables are non-stationary, it may cause spurious ARDL model analysis. There are two types of group unit root tests, when the persistent parameters are common across cross section, this type of process is called a common unit root test. Levin, Lin and Chu (LLC) (2002) developed a common unit root process by using this assumption. Otherwise, when the persistent parameters freely move across cross-sections, then this type of unit root process is called an individual unit root process. The Im, Pesaran and Shin W-stat, ADF-Fisher Chi-square and PP-Fisher Chi-square tests are based on this form.

The summarized group unit root test results as shown in Table 1 revealed that the variables were non-stationary at levels, that is, the measurement of the group unit root in the data revealed that all the variables in the group were not jointly integrated in all the methods under examination, that is, not all the variables were found to be jointly stationery at 1 per cent, 5 per cent and 10 per cent significance at levels. Therefore, in order to lessen the swings in the data set, the variables were put through additional stationarity analysis. Therefore, the null hypothesis was rejected since, when differenced once, the variables were shown to be stationary in all techniques and to have no unit root at the 1 percent, 5 percent, and 10 percent levels of significance.

**TABLE 1**

**Summarized group unit root test**

|  |  |
| --- | --- |
| Series: GDPGR, ATMS, BBP, ISP, MNC, MPS |  |
| Sample: 1998 2024 |  |  |
| **AT LEVELS** |
| Method | Statistic | Prob.\*\* | Cross-sections | Obs |
| Null: Unit root (assumes common unit root process)  |
| Levin, Lin & Chu t\* | -3.34498 |  0.0004 |  6 |  109 |
| Null: Unit root (assumes individual unit root process)  |
| Im, Pesaran and Shin W-stat  | -1.42686 |  0.0768 |  6 |  109 |
| ADF - Fisher Chi-square |  17.1661 |  0.1435 |  6 |  109 |
| PP - Fisher Chi-square |  14.7350 |  0.2563 |  6 |  114 |
|  |  |  |  |  |
| **AT FIRST DIFFERENCE** |
| Null: Unit root (assumes common unit root process)  |
| Levin, Lin & Chu t\* | -10.3255 |  0.0000 |  6 |  106 |
| Null: Unit root (assumes individual unit root process)  |
| Im, Pesaran and Shin W-stat  | -8.96548 |  0.0000 |  6 |  106 |
| ADF - Fisher Chi-square |  101.972 |  0.0000 |  6 |  106 |
| PP - Fisher Chi-square |  123.569 |  0.0000 |  6 |  108 |



Fig. 1: Cointegration graph

Given that each cointegration equation's R-squared value is greater than 0.5 (R2 > 0.5) and that the AIC and SC criteria have relatively small values, representing appropriate and reasonable model estimation, the ARDL cointegration relation result, as illustrated in figure 1, demonstrated that the cointegration equations of the model had a goodness of fit (fitting appropriately into the ARDL model). Although there was a significant fluctuation within the parameters of this study, an examination of the ARDL cointegration relation graph in Figure 1 showed that the zero average line indicates the presence of a long-term stable equilibrium connection in the model. This suggests that there was a notable deviation from the long-term equilibrium connection in the short-term period signals. The short-term change may be caused by preferences for the implementation of appropriate financial development and ICT diffusion measures.

**ARDL long-run, error correction and short-run estimates**

Because the ARDL has estimated improved small sample qualities, it can be used regardless of whether the underlying variables are solely I(0), I(1), or mutually co-integrated. This study aims to verify the claim that there is a chance of a long-term cointegration between/among the variables of the same unique order of integrations, with reference to the unit root test order of integrations "I(1)". Given the result in equation 1, the overall effect of ICT diffusion and financial development on economic growth in Nigeria will be positive but non-significant in the long-run. Specifically, the ARDL long run estimates revealed that, all things being equal, a percentage increase in ATMs per 100000 adults (ATMS) will lead to a non-significant positive effect on economic growth in Nigeria in the long-run. On the other hand, the remaining variables (BBP, ISP. MNC and MPS) individually would lead to a non-significant negative effect on economic growth in Nigeria.

EC = GDPGR - (-1.7157\*ATMS + 1.6405\*BBP + 17.0468\*ISP + 0.7694\*MNC + 0.0233\*MPS - 55.5430) Equ. 1

**TABLE 2: ARDL error correction and short-run estimates**

|  |  |  |
| --- | --- | --- |
| Dependent Variable: GDPGR |  |  |
| Method: ARDL |  |  |  |
| Model selection method: Akaike info criterion (AIC) |
| Dynamic regressors (2 lags, automatic): ATMS BBP ISP MNC MPS   |
| Selected Model: ARDL(1, 2, 1, 1, 2, 2) |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.\*   |
|  |  |  |  |  |
|  |  |  |  |  |
| GDPGR(-1) | -0.044390 | 0.267243 | -0.166105 | 0.8786 |
| ATMS | -1.128306 | 0.669837 | -1.684448 | 0.1907 |
| ATMS(-1) | 0.256545 | 0.709721 | 0.361473 | 0.7417 |
| ATMS(-2) | -0.920058 | 0.501937 | -1.833013 | 0.1642 |
| BBP | 0.328199 | 1.219702 | 0.269081 | 0.8053 |
| BBP(-1) | 1.385082 | 1.379299 | 1.004193 | 0.3893 |
| ISP | -50.51988 | 29.85691 | -1.692066 | 0.1892 |
| ISP(-1) | 68.32337 | 26.33034 | 2.594854 | 0.0807 |
| MNC | 0.660042 | 0.197819 | 3.336603 | 0.0445 |
| MNC(-1) | 0.348254 | 0.285229 | 1.220960 | 0.3093 |
| MNC(-2) | -0.204738 | 0.261692 | -0.782363 | 0.4911 |
| MPS | 0.018728 | 0.113758 | 0.164629 | 0.8797 |
| MPS(-1) | 0.183168 | 0.133883 | 1.368123 | 0.2647 |
| MPS(-2) | -0.177572 | 0.108070 | -1.643114 | 0.1989 |
| C | -58.00859 | 50.01522 | -1.159819 | 0.3300 |
| CointEq(-1)\* | -1.044390 | 0.122999 | -8.491025 | 0.0034 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.971515 |     Mean dependent var | 4.194444 |
| Adjusted R-squared | 0.838585 |     S.D. dependent var | 3.025669 |
| S.E. of regression | 1.215608 |     Akaike info criterion | 3.103272 |
| Sum squared resid | 4.433105 |     Schwarz criterion | 3.845249 |
| Log likelihood | -12.92945 |     Hannan-Quinn criter. | 3.205581 |
| F-statistic | 7.308470 |     Durbin-Watson stat | 2.251487 |
| Prob(F-statistic) | 0.063622 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| \*Note: p-values and any subsequent tests do not account for model selection |

Additionally, the error term adjustment coefficient (COINTEQ-01) is negative and significant at the 5% significance level, as shown by the ARDL in Table 2. It may be concluded that there is a stable long-term cointegration relationship between the variables because a departure of 104.43 percent from the short-term imbalance is balanced in the long-term and was statistically significant.

Further analysis of the ARDL result in Table 2 revealed that the value of the intercept which is -58.00 revealed that gross domestic product growth rate decreased by 58.00 percent in the short run when all other variables (ATMS, BBP, ISP, MNC and MPS) are held constant and was statistically non-significant at five percent level of significance. Except for the examination of the ARDL short-run estimates revealed that changes in the values of bank branches per 100000 people (BBP) at various lags revealed non-significant positive effects on gross domestic product growth rate in Nigeria in the short-run. Further examination of the ARDL short-run estimates revealed that changes in the values of ATMs per 100000 adults (ATMS), mobile network coverage, internet subscribers per 100 persons, and mobile phone subscribers per 100 persons at various lags revealed varying non-significant effects on gross domestic product growth rate in Nigeria in the short run.



Fig. 2: Histogram normality test

**The histogram normality test**

The ARDL model's estimations are tested for normality using the histogram normality test. To ascertain whether or not the model's residuals were normally distributed, the Jarque-Bera statistics were used. In order for the model's residuals to be normally distributed, the Jarque-Bera statistics probability has to be greater than five percent (0.05). This is due to the null hypothesis, which asserts that the model's residuals follow a normal distribution. The Jarque Bera statistics of 1.186 with its corresponding probability of 0.5526 (55.26 per cent), more than 0.05 (5 per cent) as shown in figure 2, meant that the residuals of the model is normally distributed and this is desirable as this met the normality assumption of classical ordinary least square (OLS) framework.

**Conclusion**

In the light of the above findings, the following conclusions were made that the overall effect of ICT diffusion and financial development on economic growth in Nigeria was negative and non-significant in the short-run while the long-run effect will be positive. Specifically, variables such as internet subscribers per 100 persons, mobile subscribers per 100 persons, bank branches per 100000 people and mobile network coverage would influence economic growth in Nigeria negatively and non-significantly in the long-run, while had a non-significant positive impact on economic growth in Nigeria will be the effect of automated teller machines per 100000 adults in the long-run. Conclusively, except for BBP variable that was positive at various lags, the remaining ICT diffusion and financial development options captured in this study revealed mixed effects that were non-significantly towards economic growth in Nigeria at various lags in the short-run, ceteris paribus.

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