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Investigating the Link Between Human Health and Technical Efficiency: A Case Study of Oil Palm Processors in Nigeria

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***Abstract*— *The relationship between health status and technical efficiency cannot be over-emphasized although most researchers in the past have failed to recognize the possibility of an existing relationship between these variables. This study examined the cost implication of illnesses and their effect on the technical efficiency of oil palm processors in Edo State. A multistage sampling procedure was used to select 210 oil palm fruit processors in the study area. Data were analyzed using frequency counts, percentages, Cost-of-Illness estimation and Stochastic Production Frontier Analysis (SPF). Results revealed that the major illnesses experienced by the processors were malaria (100.0%), cough and catarrh (100.0%), back pain (98.8%), skin rash (78.9%) and nausea (76.6%). The estimated cost of illness was ₦165,338.80 with total time cost contributing 97.02% of this value for the period under consideration. SPF revealed that the mean technical efficiency of the oil palm processors was 0.75. Furthermore, palm fruits (β = 0.662, p<0.01), the volume of water used (β = 0.180, p<0.05), labor (β = 0.415, p<0.01) and processing experience (β = -0.110, p<0.05) increased the production of palm oil, while days of incapacitation (β = 0.445, p<0.01) increased technical inefficiency. The study concluded that illnesses had a negative influence on the technical efficiency of oil palm processors. The study recommended that stakeholders should create awareness of a healthy lifestyle and practical ways to maintain good health while ensuring continuous production.*

***Keywords*— Cost-of-Illness, Economic Burden of Disease, Oil Palm Processors, Stochastic Frontier Analysis, Technical Efficiency**

I. INTRODUCTION

1.1 Background of the Study

The primary source of palm oil is the oil palm (Elaeis guineensis) and most people believe that the tropical rainforest region of West Africa is where the oil palm originated (Ekine and Onu, 2008). The main regions for oil palm cultivation, according to the Food and Agriculture Organization (FAO), are Southeast Asia, the West Coast of Africa, and Latin America. Oil palm can be found in plantations and wild groves throughout Nigeria (FAO, 2005). According to Carrere (2001), oil palm is a native to the coastal plain of Nigeria and is integral to the way of life for millions of NigeriansOmoti (2003) supported this viewpoint when he said that Nigeria used to be the top producer and exporter of palm oil, accounting for 43.0% of global production before declining to roughly 7.0% of overall output since 1974. It stopped making a difference in the commodity's export trade, mostly because of rising domestic demand for palm output and declining local production. In Nigeria, dispersed smallholders who gather semi-wild plants and employ manual processing methods account for 80% of production (Carrere, 2001; Olagunju, 2008). Numerous million smallholders are dispersed across an estimated 1.67 million hectares in the southern region of the nation, according to Carrere (2001) and Olagunju (2008). Small-scale producers typically employ obsolete equipment and conventional or semi-mechanized methods to extract the oil from fresh fruit bunches, which exposes the processors to a variety of health risks (Omereji, 2005; Olagunju, 2008).

The health status of oil palm processors is key to ensuring unhindered production and the hazards associated with palm oil processing can significantly affect the health of the processors. It becomes pertinent that proper measures to ensure the protection of processors' health from the negative impact of their hazardous environment be taken. Health is defined as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (Tsepav *et al*., 2011). The goals of occupational health should include: promoting and maintaining the highest level of physical, mental, and social well-being for workers in all occupations; preventing illnesses brought on by their working environments; shielding employees from risks related to factors that are harmful to their health; placing and maintaining the worker in an occupational environment that is suitable for his or her physical and psychological capabilities; and (Michael and Kwasi, 2013).

1.2 Problem Statement

The traditional method of processing oil palm exposes the processors to a variety of health risks that either directly or indirectly lower their level of productivity (Orewa *et al*., 2009). Human labor output is greatly influenced by how people live (including their awareness of their health status) and the state of their working environment (in this case, agricultural productivity). Thus, knowledge of the connection between these variables would aid in efficient resource management, which in turn would improve worker productivity. The majority of processors are somewhat aware of the health risks connected to processing activities, especially those who lean toward using traditional methods, yet they must continue producing to satisfy their financial commitments. The main issue, though, continues to be a failure to consider the detrimental effects this may have on their technical effectiveness. Given that local processors who employ the traditional technique of processing provide the majority of the palm oil sold in markets, education on the realities of diminishing productivity due to poor health becomes important (Olagunju, 2008).

The broad objective of this study is to examine the cost implication of ill health conditions and the corresponding effect on the technical efficiency of oil palm processors in Edo State, Nigeria. The specific objectives examined were to:

- identify the prevailing ill health conditions among processors,
- estimate the cost of illnesses among the processors in the study area,
- determine the effect of health status on the technical efficiency of the processors.

1.3 Justification and Novelty

Since human capital is a crucial element of agricultural processing, consideration must be given to factors that may have an impact on how well it performs, including the different health issues that may affect the processors. Understanding the prevalent illnesses as well as their financial impact (represented as the cost of illness) becomes important in light of this. For workers in Nigeria and all of Africa, being ill is a big burden. The World Health Organization (WHO) reported that an average household spends between ₦726 and ₦9,075 per month on disease treatment and between ₦5,445 and ₦7,260 per month on prevention, indicating that there are several expenditures associated with poor health. According to the study on the financial impact of poor health on agriculture by Anderson *et al*., (2012), back injuries have an annual direct cost of ₦13,431,000 and an indirect cost range of ₦53,361,000 to ₦108,900,000. Olatunji *et al*., (2013) noted that a range of health issues, including malaria, musculoskeletal illnesses, yellow fever, diarrhea, respiratory ailments, and skin disorders, had an impact on productivity. Understanding the relationship between sickness burden and technical efficiency as they relate to oil palm processors becomes crucial.

Most studies in Nigeria consider the economics of oil palm processing, investigating the profitability and other economic indices. But they have failed to investigate the role of health status on the overall performance of this enterprise since the industry is mostly dominated by traditional processors who are highly exposed to health challenges facing this industry. This study contributed to the existing body of literature by exploring the impact of illness occurrence on the performance, i.e., technical efficiency of oil palm processors.

1.4 Review of Previous Studies

Barnett and Whiteside (2001) assert that poor health and the associated expenses to households can damage livelihoods and increase deprivation. Concerns about the connections between poor health and performance have made health the focal point of development agencies' strategies and targets for reducing poverty (World Bank, 2000), and they have strengthened the case for significant investments in the health sector to increase access for the world's poorest people (WHO, 2001). The state of healthcare in Nigeria has significantly deteriorated. The result of this is that, particularly in rural areas, there are not enough facilities (health centers, staff, and medical equipment). Cost of illness studies is used to determine the financial impact of a disease (or disorders) (Chima and Goodman, 2003). This is a rough estimate of how much could be gained or saved if a disease were to be wiped out. Researchers have conducted studies on the cost of disease over the years, and the bulk of these studies have demonstrated enormous value in policy development, especially concerning public health, as they highlight the burden of poor health on society as a whole (Rice, 2000). The cost of various illnesses can help the government determine whether health issue constitutes a severe threat to the economy since it demonstrates the financial impact of illnesses on government programs like the Nigerian Health Insurance Scheme, according to Finkelstein *et al*., (2003). (NHIS). McIntyre and Thiede (2003) compared the findings of studies that attempted to calculate the financial costs of illness for people and households but ran into problems because their definitions of cost, methods for calculating cost, and units of analysis were different from those used in other studies. Because different cost elements are included in different research, it can be challenging to compare the direct costs of illness across them. For instance, while all studies evaluate medical expenses, some neglect non-medical expenditures like transportation. Studies have also employed a variety of analytical techniques, evaluating both household and individual expenses in some cases (including the patient and caregiver).

Because there are differences in the breadth of indirect costs considered and the methods used to assess the loss of productive time, indirect illness costs are even harder to compare between studies. First, different studies include different people in their measurements of lost time: some only include "economically active" family members and exclude children or the elderly (Attanayake *et al*., 2000); others include children's days off from school or, if they do work, give weight to their lost activity days based on estimates of productivity (Aikins, 1995). Furthermore, the scope of indirect expenses varies, but for the most part, it includes the time spent by the patient and caregiver seeking treatment as well as the morbidity period during which the patient or caregiver reduces or stops their productive activity (Chima and Goodman, 2003). A third comparative difficulty derives from the diverse approaches utilized to place a monetary value on time wasted. Although the average wage rate is the most popular, alternative methods have included average daily income, average daily output per adult, and real output and income lost for each respondent. Luce *et al*., (2006) proposed that although cost-of-illness studies are only one aspect of analysis, they can nevertheless offer a framework for the cost estimation in these analyses. Cost-of-illness studies give us information on cost-effectiveness and cost-benefit analyses. According to Hodgson (1988), cost-of-sickness studies can be used to estimate the potential savings of preventing an illness. Hence, it aids in cost-effectiveness analysis, cost-benefit analysis, or illness prevention analysis as it gives a foundation cost of maintaining the status quo.

Econometric modeling of stochastic frontier methodology associated with efficiency estimation has been an important aspect of economic research in recent times (Olarinde, 2011). The requirement to quantify the effects of inefficiency is the main driving force behind frontier research. Due to the parametric nature of the stochastic frontier, a functional form is imposed on the production, and assumptions are made regarding the data. The disturbance term in the stochastic frontier production function is a composite error made up of a symmetric and an unsymmetric component. The symmetric component Vi captures the random effects due to measurement error, statistical noise and other influences outside the control of the firm and it is assumed to be normally distributed also the one-sided (non-negative) component Ui, with Ui ≥ 0 captures technical inefficiency relative to the stochastic frontier (Aigner et al., 1977).

By definition, the stochastic frontier production function is defined as:

$$Yi = F(Xi, B) \exp(Vi - Ui) \quad (1)$$

Where:

i = 1, 2, 3…n

Yi = output of the ith firm

Xi = vector of the quantities of input used by the ith firm

B = vector of the unknown parameter to be estimated

Vi = error term associated with random factors outside the control of firm or management; and

Ui = non-negative error term which captures the effects of technical inefficiency.

The technical efficiency of the individual firm is defined as the ratio of the observed output to the corresponding frontier output, conditional on the levels of inputs used by the firm. Therefore, the technical efficiency of an individual firm can be obtained as:

$$\text{TE} = {}^{y_i}/{Y_i} \quad (2)$$

Where:

TE = technical efficiency

yi = actual output

Yi = potential output

Potential output is the maximum possible when u = 0. A technically efficient firm produces output that is on the stochastic production frontier that is subject to random fluctuations captured by Vi. However, because of several factors, actual performance deviates from the frontier. Since, $u \geq 0$, $0 \leq e^{-u} \leq 1$, and e^{-u} are a measure of technical efficiency. Thus, technical inefficiency is measured by 1- e^{-u}, where e-u is technical efficiency bounded by 0 and 1. In other words, technical efficiency lies between 1 and 0 technical inefficiencies are bounded between 0 and 1.

The practitioners' health status is impacted by natural agriculture processing in a variety of ways. Cough, catarrh, and other respiratory issues (caused by prolonged smoke exposure), broken limbs, serious scrapes, and bruising from processing tools and equipment are only a few of the negative health effects. Other health complications include lower back discomfort, itchy eyes, malaria, and neck pain. The adverse health condition resulting from both occupational and non-occupational sources has a negative impact on production in terms of how inputs are combined to produce output (technical efficiency).

II. METHODS

2.1. Study Area, Sampling and Sampling Procedure

This research was carried out in Nigeria's Edo State. On August 27, 1991, Bendel State was divided into two states—Edo and Delta—as part of a state-creation exercise that also gave rise to Delta State. The geographical coordinates of Edo State are Latitude 05° 44' North and 07° 34' North, and Longitude 05° 04' East and 06° 43' East of Greenwich. With Benin City as its capital, it is bordered in the north by Kogi State, in the south by Delta State, in the west by Ondo State, and in the east by Kogi and Anambra States (Erhabor and Emokaro, 2007).

Edo State has been divided into three agricultural zones by the Edo State Agricultural Development Programme (EDADP). These are Edo North, Edo South and Edo Central. These three zones consist of a total of eighteen (18) blocks with Edo North, South and Central having six (6), seven (7) and five (5) blocks respectively. A multi-stage sampling procedure was adopted for this study. In the first stage, proportionate sampling was used to select approximately three (3) blocks from each zone giving a total of nine blocks. A pilot survey revealed that the selected blocks were the major oil palm processing areas in the zones; hence the blocks were purposively selected based on the mass production of palm oil. In the second stage, four (4) cells were randomly selected from each block, giving a total of thirty-six (36) cells. Finally, balloting was adopted in the random selection of six (6) processors from each cell. This gave a total of 216 respondents. Due to the completeness and data integrity, data analysis was done on 210 sets of questionnaires.

2.2. Analytical Techniques

Parameters used to describe the health status of the processors include the prevalence of various forms of illnesses (malaria, catarrh, back pain, waist pain and injuries), number of episodes of various ill-health and time lost to various illnesses.

The cost of illness procedure adopted by Sauerborn *et al.*, (1996) was used to capture the economic burden of diseases and is specified as:

The financial cost of illness:

$$\text{Fc} = \sum_{i=0}^{n}(Fd + Fm + Ft) \quad (3)$$

Where:

Fc= total financial cost of health care (₦)

Fd = financial cost of drugs, herbs, etc (₦)

Fm= financial cost of medical consultancy (₦)

Ft= financial cost of travel (₦)

The time cost of illness:

$$\text{Tc} = \sum_{i=0}^{n}(Tsi * asi * w) + (Tci * aci * w) \quad (4)$$

Where:

Tc =total time cost (number of days of forgone production)

Tsi = time cost of a sick person (number of days of forgone production)

asi = age coefficient of a sick person (number)

w = daily wage rate (₦)

Tci= time cost of caregiver(s) (number of days of forgone production)

aci = age coefficient of caregiver (number)

n= number of illness episodes (number)

The economic cost of illness:

$$E = \sum_{i=0}^{n}(Fc + Tc) \quad (5)$$

Where:

E = economic cost of illness (₦)

Fc and Tc = as previously defined

In this study, a modification was done by adding to the model in equation (5) prevention cost Pc (such as mosquito net). This is to take care of the costs not considered in the original model. Therefore, the economic cost of illness adopted for this study is stated thus:

$$E = \sum_{i=0}^{n}(Fc + Tc + Pc) \quad (6)$$

Where:

E, Fc and Tc = as defined previously

Pc = prevention cost (₦)

The time cost of illness is measured in terms of labor days, which were calculated using an average male adult work schedule of around 8 hours per day to determine the number of days of production activities that must be forgone (Akinbode *et al.*, 2011). Accordingly, the actual number of hours worked was translated to the equivalent of a male adult by multiplying the hours worked by a male by 1, a female by 0.75, and a child by 0.5, all while assuming that working conditions were generally average. According to Sauerborn *et al.*, (1996) productivity coefficients "a" were assigned to represent the level of productivity across age groups, and they claimed that an individual's economic productivity increases from their early twenties to about age 40 and then gradually declines after that. Age coefficient so adopted the following values for the analysis's purposes:

Table 1: Productivity Coefficient across Age Groups

Age Range	Coefficient
≤17years	0.5
18-40	1
41-55	0.75
56-65	0.67
>65	0.5

Sauerborn *et al.* (1996)

To estimate the production function and forecast the technical efficiencies of the processors in the study area, the study used the stochastic production function, in particular the Cobb-Douglas functional form. This model was chosen because it accepts technological imperfection and the possibility that output may be impacted by unpredictably occurring shocks.

The empirical model of the stochastic production frontier function is specified as follows:

$$\ln Ti = \beta0 + \beta1\ln R1 + \beta2\ln R2 + \beta3\ln R3 + \beta4\ln R4 + \beta5\ln R5 + Vi - Ui \quad (7)$$

Where:

T = quantity of palm oil (litres)

R1 = fruit (bunches)

R2 = fuel (litres)

R3 = labor (labor days)

R4 = water (litres)

R5 = transport (hours)

β0, β1, β2, …, β5 = Parameter estimates

The technical efficiency of the individual processor was computed as an index and the average technical efficiency of the system was determined. Using several socio-economic factors and the indicator for health status as explanatory variables and the efficiency index as the dependent variable, the inefficiency model was estimated. The model assumes that the inefficiency effect Ui is independently distributed with mean ui and variance σ2. Days of Incapacitation Due to Illness were used as an indicator for measuring the health status of the respondents. The model is specified as:

$$\mu i = do + d1z1 + d2z2 + d3z3 + d4z4 + d5z5 + d6z6 + e \quad (8)$$

Where:

μ = inefficiency (number)

Z1 =age of processors (years)

Z2 = household size (number of persons)

Z3 = education level of processors (1 = formal education; 0, otherwise)

Z4 = processing experience (years)

Z5 = incapacitation due to illness (days)

Z6 = sex of the farmer (1 = male; 0, otherwise); do, d1,d2,d3,…,d6 = regression estimates

III. RESULTS AND DISCUSSION

3.1. Distribution of Respondents by Illness Experience

Table 2 displays the illnesses that the processors suffered over the six months under consideration. The majority of the processors (83.3%) have experienced health issues, the most common of which are malaria (100.0%), cough and catarrh (100.0%), back pain (98.9%), skin rash (78.9%), and nausea (76.6%). Other ailments experienced include diarrhea (58.3%) and respiratory conditions (65.7%). This supports the findings of Micheal and Kwasi (2013) that common illnesses suffered by oil palm processors were eye problems (21.5%), respiratory issues (17.7%), headaches (17.7%), coughing (12.7%), and malaria (10.1%). The study by James (2015), found malaria (52.2%), cough (23.8%), low back discomfort (9.0%), neck pain (7.5%), and eye itching (7.5%) as the ailments suffered by oil palm processors, also supported this finding.

Table 2: Distribution of Respondents by Illness Experience

Variables	Frequency	Percentage
Illness Experience		
Yes	175	83.3
No	35	16.7
Total	210	100.0
Illnesses (n=175)*		
Back Pain	173	98.9
Malaria	175	100.0
Cough and Catarrh	175	100.0
Nausea	134	76.6
Diarrhea	102	58.3
Skin Rash	138	78.9
Respiratory Disorders	115	65.7

3.2. Cost of Illness Estimation

The economic burden of disease was calculated using the cost of illness method. The Centers for Disease Control and Prevention (CDCP) identified this estimation technique as one that gave the financial equivalent of the economic burden of disease. The cost of disease can be separated into direct and indirect costs, with the complexity and subjectivity of indirect costs being its limitations, according to Akinbode *et al*., (2011) (a component that is subject to error). According to Table 3, the average cost of the processors' illnesses as economic losses over the six-month study period was ₦165,338.80 (±1,194.59). The cost of the respondents' illnesses was primarily driven by their total time cost (97.02%), with the time cost of the sick individual playing a significant role (56.99%). This outcome is consistent with Akinbode *et al*., (2011), who found that the time cost of illness was a significant factor in the economic cost of illness.

Table 3: Estimation of Cost of Illness

Costs	**Amount (₦)**	**Proportion**	**SD**
Financial Cost of Drugs	4,692.86	2.84	
Financial Cost of Medical Consultancy	130`	0.08	
Financial cost of travel	105.57	0.06	
Total Financial Cost	**4,928.43**	**2.98**	
Time Cost of Sick Person	94,222.49	56.99	
Time Cost of Care Giver	66,187.88	40.03	
Total Time Cost	**160,410.37**	**97.02**	
Economic Cost	**165,338.80**	**100.0**	**1,194.59**

3.3. Factors Influencing the Technical Efficiency of Oil Palm Processors

Table 4 displays the findings of the Maximum Likelihood Estimates (MLE) of the Cobb Douglas Stochastic Frontier Production Function (SFPF) and the inefficiency model. Sigma squared was statistically significant in the results ($\delta^2 = 1.33$, $p<0.01$), supporting the given assumption about the distribution of the composite error term as well as the goodness of fit. The percentage of the total divergence from the frontier that can be attributed to the processors' inefficiency is shown by the gamma (γ). It demonstrates that the technical inefficiency of the processors was responsible for around 71.0% of the output shortfall below the frontier.

The findings also showed that, although the processors used a variety of inputs, palm fruits ($\beta = 0.66$, $p < 0.01$), water ($\beta = 0.18$, $p < 0.05$) and labor ($\beta = 0.42$, $p < 0.01$) were the main inputs that had the greatest impact on the output of each oil palm processing enterprise in the study areas. The outcome demonstrates a considerable increase in palm oil production of 0.66 liters per unit increase in oil palm fruit. Processors should consequently pay close attention to the quantity and quality of fresh fruit bunches processed each time. The state of these fresh fruit bunches is crucial since the quality of the fruit (including its rancidity, oil content, and look) is equally significant. Additionally, a unit increase in the amount of water utilized during processing resulted in a considerable increase in output of 0.18 litres, underscoring the significance of this input in the processing of palm fruits. Knowing the precise water requirements for each production is essential. The output of palm oil was also greatly boosted by 0.42 litres per additional man-day of labor. The amount and quality of labor used by any producing company have a significant impact on the production of that company. To guarantee that labor is used effectively, the proper precautions must be taken. Specialization in the workforce should not be disregarded because it will increase labor productivity. All forms of labor have a role concerning production and processors should ensure that this factor of production (labor), both skilled and unskilled is efficiently utilized. The output of the processors was not considerably impacted by additional inputs like fuel and transportation. The conclusions of Muhammad-Lawal *et al.*, (2009), Amaza and Maurice (2005), and Oniah *et al.*, (2008) that the coefficient of labor was positive and significant and that an increase in labor consumption would lead to an increase in output levels are supported by this result.

The influence of variables such as sex, age, education level, processing experience, household size, and days of incapacitation on the technical efficiency of oil palm processors was examined using the inefficiency model, as shown in Table 4. Processors' inefficiency was considerably influenced by their processing experience ($d = -0.11$, $p < 0.05$). This implies that the technical inefficiency diminishes as the processors gain expertise in the processing industry, hence improving their technical efficiency. This result defies Usman's (2012) findings, which suggested that the technical efficiency of rice farmers in Niger State was not greatly impacted by their experience. Processors' productivity was significantly impacted by the number of days they were incapacitated owing to illness or injury ($d = 0.45$, $p < 0.01$). This shows that the technical efficiency of the processors declines as the number of days missed due to incapacitation rises. This conclusion is consistent with the findings of Akinbode *et al.*, (2011) who reported that the technical efficiency of rice producers in Nigeria was negatively correlated with days missed due to illness.

Table 4: Determinants of Oil Palm Processing Output and Efficiency

Variables	Coefficient	t-value	P- value
Constant	0.798	1.47	0.850
Fruits	0.662***	6.86	0.002
Water	0.180**	2.04	0.022
Fuel	0.056	0.65	0.754
Transport	-0.061	-0.88	0.262
Labour	0.415***	3.65	0.003
Inefficiency Model			
Sex	0.344	0.29	0.676
Age	-0.041	-0.56	0.201
Educational level	1.489	1.04	0.300
Processing experience	-0.110**	-2.97	0.049
Household size	0.120	0.48	0.879
Days of incapacitation	0.445***	3.61	0.003
Variance Parameters			
Sigma squared	1.328***	11.22	0.000
Gamma	0.711***	5.67	0.000
Log-likelihood	-156.353		

***Significant at 1%; **Significant at 5%;

IV. CONCLUSION AND RECOMMENDATION

It is impossible to overstate the connection between technical efficiency and human health. This study has revealed that a significant increase in the awareness of sound health will significantly aid to promote higher levels of production. According to this study, the processors' main health issues included malaria as well as cough and catarrh. It would be much easier to put steps in place to reduce the likelihood of particular occurrences, experiences, or conditions if people were aware of the financial costs associated with them.

This study looked at the financial impact of various health issues, both those resulting from the processing industry (i.e., work-related) and those resulting from other sources. The study found that time-related costs result in significant financial losses. This study also demonstrated that, even though most processors were technically efficient in terms of how they used the majority of their inputs, there was still room for advancement.

Based on the findings of this study, the following recommendations were made:

- Programs for agricultural development should be set up to support the growth of fresh fruit bunches with high yields. This would guarantee the use of high-quality fruits. This is due to fruits significantly increasing the output of the processors.
- The union of oil palm processors should make an effort to arrange seminars where a forum will be created to inform processors about the reality of health challenges (the existence of diseases and their cost implications) as well as appropriate measures to take to mitigate the negative impact of the occurrence of these health issues on their business. They should be made to recognize the existing relationship between their health and production. On a larger scale, the government ought to follow the lead of these unions and develop health promotion initiatives.

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