A SUSTAINABLE INVESTMENT IN GRINDING AND BLENDING CEMENT UNITS IN TAMIL NADU - A PATHWAY TO COSTEFFICIENCY USING DATA ENVELOPMENT ANALYSIS TECHNIQUE

CHELLASAMY P[*1] AND LIGE KV[2]

1: Professor, School Of Commerce, Bharathiar University, Coimbatore

2: Research Scholar, School Of Commerce, Bharathiar University, Coimbatore

[*]Corresponding Author: Chellasamy P: E Mail: ligestaison1980@gmail.com

ABSTRACT

Cement industry plays a dominant part in construction sector and all infrastructural projects. This industry takes up an important role in the Indian economy because it has strong relationship with other sectors like construction, Transportation, Coal and Power. Even though more than 500 cement plants which includes international, national and local brand are working in the country, cost of cement is increasing day by day. In such situation, Local brands with affordable prices are promoted with good quality focusing on low and middle income group customers when majority of customers felt that too high price for the branded cement. Thus the curiosity in measuring the efficiency of Grinding and blending cement units grows to identify the righteousness of utilizing scarce economic resources in a most efficient manner. Efficiency analysis considered as important tool to measure the performance of the firms in cut throat market. The more efficient firms are usually mentioned as benchmarking units for the development. In this study, efficiency scores are obtained using the non-parametric Data Envelopment Analysis (DEA) technique for 3 grinding and blending cement units situated in Tamil Nadu. The data was accumulated from the annual report published in ROC. The DEA is used to calculate weights for inputs and outputs by assigning the maximum efficiency score for a selected firms under assessment. The significant determinants behind the inefficiency found in

this analysis include mainly the manager's improper decision making in procurement of raw materials in respective sector, electricity cost increase due to peak time production and workers productivity.

Keywords: Efficiency analysis; Variable returns to scale; constant return to scale; Annual report; ROC; Input oriented approach

INTRODUCTION:

Cement is the critical raw material for construction of buildings and infrastructure development. The construction industry in India is tremendously active and the growth in cement consumption is estimated high. As per report, even though the large quantity of cement production is carried out all over India especially in south India both in private and public sectors, still there is space for small investors to invest in Grinding and Blending cement units in South India especially in Tamil Nadu. Tamil Nadu also confounded with major minerals namely Limestone, Magnetite, Graphite, Bauxite, Iron Ore, Vermiculite, minor minerals like Granites, Clay, Silica sand, Lignite, fuel minerals such as Petroleum and Natural Gas and atomic minerals such as Monazite, Rutile, Ilmenite. Tamil Nadu is considered to be the leading and largest cement producers in the country after Andhra Pradesh and Rajasthan. In Tamil Nadu, many grinding and blending cement units are working which is incorporated by small investors. Among these firms, 3 firms has been selected for the studies. They are Kaarpaga Cements, Andal Cements and Vamana Cements.

The common cement or Portland cement was prepared and Patented by **Joseph Aspdin** in 1824. In the later part of the 19th century, cement production was taken up by many countries, many decades after the first patent was taken by Aspdin in England. India entered into the Cement Era in 1914, when the Indian Cement Company Ltd. started manufacturing Cement in Porbundar in Gujarat. However, even before that a small cement factory was established in Madras in 1904 by a company named South India Industrial Ltd.

Indian Cement Company Ltd produced only one type of cement which was designed by the British standing committee as "Artificial Portland Cement". This company marketed its product in Mumbai, Karachi, Madras and other parts and became a financial success. At that time India had to import cement from England. The price of the imported cement was higher. Some other factors such as an increase in domestic demand, reduction in supply from abroad (due to war), availability of Indian Capital, ample

raw material, Cheap labor, support of the government etc. made it a leading industry in India in a short period of time. Later on two more cement units in Rajasthan and Madhya Pradesh was started.

During the First World War period control of all these industries was taken by the government. In 1948, many expansion schemes were introduced to increase the production. In 1950-51, many operating units established with an installed capacity of 3.3 million tons. During the first five year plan it was targeted to raise the production capacity to 5.4 million tons and it was achieved. Next it has planned to increase the capacity of 100 million tons during the 11th five year plan. At present the Cement production reached 329 million tones (MT) in FY20 and is projected to reach 381 MT by FY22. However, the consumption stood at 327 MT in FY20 and will reach 379 MT by FY22. The cement production capacity is estimated to touch 550 MT by 2020. The Indian cement industry is dominated by a few companies. The top 20 cement companies account for almost 70 per cent of the total cement production in the country. A total of 210 large cement plants account for a cumulative installed capacity of over 410 MT, with 350 small plants accounting for the rest. Of these 210 large cement plants, 77 are in the states of Andhra Pradesh, Rajasthan and Tamil Nadu. Due to the increasing demand in various sectors such as housing, commercial construction and industrial construction, cement industry is expected to reach 550-600 million tonnes per annum (MTPA) by the year 2025.

Tamil Nadu also confounded with major minerals namely Limestone, Magnetite, Graphite, Bauxite, Iron Ore, Vermiculite, minor minerals like Granites, Clay, Silica sand, Lignite, fuel minerals such as Petroleum and Natural Gas and atomic minerals such as Monazite, Rutile, Ilmenite. Tamil Nadu is considered to be the leading and largest cement producers in the country after Andhra Pradesh and Rajasthan.

Concept of DEA tool:

The major merit of using DEA over other methods which is previously adopted is Efficiency can be measured easily if the number of input and output is one. But the challenges occur if there are multiple-inputs and multiple-outputs. Data Envelopment Analysis is considered as a best method to satisfy the needs. DEA is a linear programming model to measure Overall technical efficiency under the assumption of constant returns to scale, introduced by Charnes named after Charnes, Cooper, and Rhodes (1978) to obtain efficiency measures under CRS assumptions, The measure of

efficiency provided by CCR model is known as overall technical efficiency (OTE).The CRS assumption is appropriate only for the firms that are operating at an optimal scale. If the firms are not operating at an optimal scale the technical efficiency measure will be mixed with scale efficiency. Hence, to separate the two inefficiency scores it is opted for applying variable returns to scale. The measure of efficiency provided by BCC model is known as Pure technical efficiency (OTE), BCC model, named after Banker, Charnes and Cooper (1984) and Pure technical efficiency is measured under the assumption of variable returns to scale.

Scale efficiency can be measured using the formula SE = OTE/PTE

Scale efficiency explains whether a firm is operating at its "optimal size." or too large or too small to operate.

Efficiency estimates are standardized between 0 and 1, with the value 1(0) assigned to the most (least) efficient firm.

Generally two type of DEA tool is used one is Input oriented approach and the other one is output oriented approach.

Input oriented approach:

This approach helps to know "By how much can inputs be reduced while keeping the same level of output?" This model emphasize on the measurement of the changes in input use and thereby increase the efficiency which can be achieved by minimizing inputs proportionally holding outputs constant.

Output oriented approach:

This approach helps to know "By how much can output be increased while maintaining the level of inputs constant?" This model focuses on the measurement of changes in output produced and thereby increases the efficiency which can be achieved by maximizing outputs proportionally holding the input quantities constant.

Model variables:

This paper takes into account five inputs and two outputs used in Grinding and blending units. It can be explained as follows:

Input Variables:

Fixed assets, material, electricity, labor and non-industrial costs considered as input variables.

Output Variables:

Sales and profit considered as output variable.

Table: 1 Description of Variables used in the study

Variables	Classification
Fixed assets	Input
Raw Materials	Input
Electricity Cost	Input
Labor cost	Input
Non industrial Cost	Input
Sales	Output
Profit	Output

Rules to be followed why applying DEA tool:

1. Value of input and output should be positive

2. It should possess isotinicity property

3. There should be at least 3 firms

4. It must have homogeneity set of entities

Review of literature:

1. **Feroze, P. S., & Sheeba, M. B. (2019)** tried to explore the stock efficiencies on selected large capital securities by selecting the sample size of 15 securities where data for stocks selected for analysis taken for multi periods from 2008-2018 by employing DEA tool. This tool is used to measure the efficiency of selected stocks. Efficiency refers to the ability of the firm to produce maximum output with minimum input. The study identified that only three stocks found to be DEA efficient which includes Maruti, Hindustan Unilever and Eicher motors.

2. **Arindam, B. (2018)** conducted his study on measuring the efficiency of Indian cement companies utilizing Data Envelopment analysis (DEA) during the Pre and Post recession period. The secondary Data was gathered through CMIE database. The researcher has considered profit and sales as output variable and direct materials, direct Labor and Direct expenses as input variables in his study. Linear program has been used to find the efficiency and super efficiency scores of the different companies. Spearman correlation technique has been employed to find out the impact of recession on cement industry. It is found that five companies out of nine cement companies are working at super efficiency level and their efficiency score is greater than 1 at the time of Pre recession period and during the Post recession period only two out of nine cement companies are working less than efficiency level and their score is less than 1.

3. **Othman, F. M., Mohd-Zamil, N. A., Rasid, S. Z. A.,** *et al* **(2016)** made an attempt to measure the relative efficiency of Banks using DEA tool. The efficiency of selected banks is measured through the ability of individual banks to reach optimum output provided at a certain level of input. The study also suggested that for the efficient bank operation economic and political condition of the banks also considered equally important.

4. **Das, P., Basu, R., & Halder, A. (2017)[15]** carried out their research on Employment wage and Productivity: an analysis of Trend and Causality in Indian manufacturing industries for the period from 1998 to 2013. The data was gathered from the Annual survey of Industry. They determined the stochastic behavior of economic time series based on Dickey and Fuller test. The result investigated the relationship between Labor productivity and wage rate and its presumption for employment outcomes of all the registered manufacturing industries in India.

5. **Priya Rathna, R., *et al*., (2017)[18]** made a comprehensive analysis on operational efficiency of Indian cement Industry. The study used secondary data published in annual reports of selected 23 companies comprised of large, medium and small scale industries using Augmented Dickey filler test, Co integration test and firm's efficiency scores. The study period spanned from 2006-2016. The result revealed that all the selected variables played a significant role in increasing the operating efficiency of the Indian cement companies without any discrimination.

Statement of the problem:

The Tremendous growth in Indian manufacturing sector is a prime reason for the country's growth. The imbalances in regional demand and supply situation created a huge change in price level and provide supremacy to the leading large cement manufacturers to administer the price policy. Today, the cement industry stands for 7% of the world's total carbon dioxide emissions. Due to ongoing urbanization and growth developments, demand for cement increases. Henceforth in order to frame new solutions to produce cement in a more eco- friendly manner and also to meet the growing requirement of society and industries, many investors have chosen grinding and blending cement unit as a good choice. But it is necessary to examine whether these Grinding and blending cement units possess cost efficiency in manufacturing cement.

Objective:

1. To determine the Cost-Efficiency of the selected Grinding and blending units in Tamil nadu

Scope of the study:

The development of an economy is linked with structural changes marked by a fine increase in the share of manufacturing

industry in total output. Cement industry expects about 10 to 18 per cent increase in demand in Telangana and Andhra Pradesh, 5 percentage in Tamil nadu, 2 to 5 Percent in Karnataka. Hencethe present study focus to analyze the cost efficiency of selected 3 Mini-cement plants under private sector in Tamil Nadu from annual report published in ROC

Methodology:

Sources of data:

The study is based on purely secondary data. It is collected from the annual reports of private limited companies in cement manufacturing sector which has been published in ROC and other relevant information are collected from journals, articles, magazines and websites.

Sampling design:

For the present study, 3 Grinding and blending cement units in Tamil Nadu which is a private limited companies are taken for secondary data analysis. They are Kaarpaga cements, Andal cements and Vamana cements.

Period of the study:

The study covers a period of seven years from the year 2014 -15 to 2019-2020.

Operational Concepts:

Cost efficiency:

The firm is said to be cost efficienct when it is able to produce the goods at minimum input cost to achieve desired level of Output.

Investment:

GRINDING AND BLENDING UNITS:

Cement Grinding:

Cement clinker is a solid material produced in the manufacture of Portland cement as an intermediary product. Clinker occurs as lumps or nodules, usually 3 millimeters to 25 millimetres in diameter. It is produced by sintering limestone and alumino silicate materials such as clay during the cement kiln stage.

Clinker is grinded and gypsum is added to make finished cement which is called OPC means ordinary Portland cement. These factories have no rotary kilns. Clinker stored in clinker tank is transported to the cement mill hopper by belt conveyors. A required quantity of clinker as per ratios taken and gypsum is fed into our closed-circuit ball mill which incorporates with a high-efficiency separator. OPC is manufactured by the inter-grinding and blending of 95% clinker with 5% gypsum to a fineness of 280 m^2/kg.

Cement Blending:

PPC means Portland Pozzalano cement is a kind of blended cement and it is produced by the inter-grinding and blending of 65% OPC clinker with 30% fly ash and 5% gypsum to a fineness of 320 m^2/kg. It is a variation of Ordinary portland cement. When Pozzalonic

material like fly ash is added to OPC it becomes PPC. Fineness is a required parameter for cement to make sure better hydration and strength development. Ground cement is then stored in a water-proof concrete silo for packing.

Significance of the study:

Cement is a critical raw material for construction of buildings and infrastructure development. But production of cement emits huge amount of carbon during clinkerisation process. This is very dangerous and affects the environment. It increases the temperature of the earth's atmosphere and causes global warming. So as a part of new solutions to produce cement in a more eco- friendly manner and in order to meet the growing willingness of society and industries and to protect limestone reserves, small investors in Tamil Nadu can come forward to invest in grinding and blending cement units. It would be a good choice. This enable the state to create vast employment opportunities within the state, to increase the revenue of the government in the form of taxes, to ensure cost efficiency, Provides high scope for Young educated youths to step into industrial sector with high return on investment, low risk and also Zero emission of CO_2 can be achieved to a greater extent. Investment in Grinding and blending units also enables the manufacturer to

have maximum capacity utilization and ensure energy efficiency and product quality. Apart from increasing the quantum of quality cement produced, it also gainfully uses a waste product, the disposal of which is a serious environmental problem today.

Limitations of the study:

1. The period of the study covers only 5 years and 6 years from 2014-15 to 2019-20 and since the data is available only for the continuous period of 6 years.

2. The secondary source of data is gathered from the annual reports published in ROC and thus its findings depend completely on the accuracy of available data.

Analytical study:

Average Efficiency Score for the Period 2014-15 to 2019-20

In this paper sales and profit is considered as output variable and fixed assets, material, electricity, labor and non-industrial costs are considered as input variables. In this study Input oriented approach has been adopted. The efficiency score 1 denotes the technically fully efficient industry. While calculated, efficiency scores of lesser than 1 shows less efficient industry. In case of input-oriented model, fixed output is obtained by utilizing the different set of inputs. So, for minimizing the inefficiencies, use of inputs should be reduced for getting the same level of output. Here the

efficiency score in selected firms in Tamil Nadu measured using DEA for input oriented

under CRS and VRS assumption.

Table 2: Average efficiency scores of Kaarpaga cements

YEARS	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	AVERAGE
TECHNICAL EFFICIENCY	1.000	0.689	0.710	0.885	0.836	0.838	0.828
PURE TECHNICAL EFFICIENCY	1.000	0.720	0.710	0.884	0.837	0.838	0.830
SCALE EFFICIENCY	1	0.956	1	1	1	1	0.997

Table: 2(a) Average inefficiency scores of Kaarpaga cements

YEARS	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	AVERAGE
TECHNICAL INEFFICIENCY	0	0.311	0.290	0.115	0.164	0.162	0.171
PURE TECHNICAL INEFFICIENCY	0	0.280	0.290	0.126	0.163	0.160	0.169
SCALE INEFFICIENCY	0	0.016	0	0	0	0	0.002

INTERPRETATION:

Table :1depicts the Technical, Pure technical, Scale and Cost efficiency scores of Kaarpaga cements and also its inefficiency scores individually for the period of 6 years and average scores based on Model 1. The firm showed 100% efficiency during the starting period but later on instability occurs and average score of the firm remains to be more than 83%. And its inefficiency score tends to be 17%. In the year 2015-16, it has to reduce the input cost by Rs. 10907070 in fixed assets, Rs. 3784979 in Raw Materials, Rs. 1131811 in Electricity cost and Rs.231990 in labor cost and Rs.157139 Non industrial cost respectively. In the year 2016-17, Rs.10222843 in fixed assets, Rs. 5928386 in Raw Materials, Rs.945200 in Electricity cost

and Rs. 573722 in labor cost and Rs. 278716 in Non industrial cost respectively In the year 2017-18, Rs. 4980074 in fixed assets, Rs.3627112 in Raw Materials, Rs.477740 in Electricity cost and Rs.114975 in labor cost and Rs. 148894 Non industrial cost respectively In the year 2018-19, Rs.7407017 in fixed assets, Rs. 4947113 in Raw Materials, Rs. 705934 in Electricity cost and Rs. 169000 in labor cost and Rs.263514 Non industrial cost respectively. In the year 2019-20 Rs. 7671723 in fixed assets, Rs.5293795 in Raw Materials, Rs. 792275 in Electricity cost, Rs.177249 in labor cost and Rs. 218334 Non industrial cost respectively. The firm should be cautious in cutting down the input cost to reach 100% efficiency. Kaarpaga cements proved 100% efficiency during the beginning period

afterwards variations felt and towards the end of the study period its Pure technical efficiency scores seemed to be 84% and overall efficiency remained to be 83% efficient and 17% inefficient. Kaarpaga cements found to have 100% scale efficiency during the starting period and later on very slight ups and downs experienced but towards the end of the study period they attained 100% efficiency with average score of more than 99% and 0.002% inefficiency thus the firm proved to work to its maximum capacity.

Table 3: Average efficiency scores of Andal cements

YEARS	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	AVERAGE
TECHNICAL EFFICIENCY	-	0.825	0.830	0.980	1.000	1.000	0.925
PURE TECHNICAL EFFICIENCY	-	0.860	1.000	0.990	1.000	1.000	0.970
SCALE EFFICIENCY	-	0.946	0.835	0.984	1	1	0.953

Table 3(a): Average inefficiency scores of Andal cements

YEARS	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	AVERAGE
TECHNICAL INEFFICIENCY	-	0.175	0.170	0.020	0	0	0.075
PURE TECHNICAL INEFFICIENCY	-	0.140	0	0.01	0	0	0.029
SCALE INEFFICIENCY	-	0.054	0.165	0.016	0	0	0.047

INTERPRETATION:

Table:2 depicts the Technical, Pure technical, Scale and Cost efficiency scores of Andal cements and also its inefficiency scores individually for the period of 6 years and average scores. Andal cements considered being the most technically efficient firm with the average efficiency score of 92.5% and its inefficiency score found to be 7%. The firm can overcome this inefficiency by reducing the input cost in the following way, in the year 2015-16, cutting input cost by Rs. 1594901 in fixed assets, Rs. 2516093 in Raw Materials, Rs.778777 in Electricity cost, Rs.131765 in labor cost and Rs. 1705123 in Non-industrial cost respectively. In the year 2016-17, Rs.1224070 in fixed assets, Rs. 2389090 in Raw Materials, Rs. 912061 in Electricity cost, Rs. 16074 in labor cost and Rs. 623725 in Non-industrial cost respectively.

In the year 2017-18, Rs. 163917 in fixed assets, Rs. 825375 in Raw Materials, Rs. 89509 in Electricity cost, Rs.9199 in labor cost and Rs.81334 in Non-industrial cost respectively. The firm proved to be one of the largest Purely technical efficient firm with the average efficiency score of more than 97% and its inefficiency score is 3% only. Andal cements proved to have better scale efficiency in the starting but later on small deviation

noticed and finally it seemed to have 100% efficient with average score of 95% efficiency

and 4.7% inefficiency.

Table 4: Average efficiency scores of Vamana cements

YEARS	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	AVERAGE
TECHNICAL EFFICIENCY	0.583	0.676	0.813	1.000	0.854	1.000	0.821
PURE TECHNICAL EFFICIENCY	1.000	0.676	0.903	1.000	0.890	1.000	0.914
SCALE EFFICIENCY	0.583	1	0.879	1	0.971	1	0.903

Table 4(a): Average inefficiency scores of Vamana cements

YEARS	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	AVERAGE
TECHNICAL INEFFICIENCY	0.417	0.324	0.187	0	0.146	0	0.179
PURE TECHNICAL INEFFICIENCY	0	0.324	0.087	0	0.110	0	0.085
SCALE INEFFICIENCY	0.427	0	0.121	0	0.029	0	0.096

INTERPRETATION:

Table 4 presents the Technical, Pure technical, Scale and Cost efficiency scores of Vamana cements and also its inefficiency scores individually for the period of 6 years and average scores based. Vamana cements proved to be least efficient during its beginning period but in upcoming years it has proved high by scoring 100% efficiency and average score of the firm's remains to be more than 82%. And its inefficiency score seems to be 17.9% and can be improved by reducing the input cost in the year 2014-15, by Rs. 20882256 in fixed assets, Rs.29608 in Raw Materials, Rs. 455607 in Electricity cost, Rs.14911 in labor cost and Rs. 5189 Non-industrial cost respectively. In the year 2015-16, Rs.16790818 in fixed assets, Rs.7553772 in Raw Materials, Rs. 707173 in Electricity cost, Rs. 437041 in labor cost and Rs. 2955387 Non-industrial cost respectively. In the year 2016-17, Rs. 9370236 in fixed assets, Rs. 7335549 in Raw Materials, Rs. 672594 in Electricity cost, Rs. 463555 in labor cost and Rs. 348226 in Non-industrial cost respectively. In the year 2018-19, Rs.4027455 in fixed assets, Rs.4317428 in Raw Materials, Rs. 260539 in Electricity cost, Rs.106169 in labor cost and Rs. 206158 Non-industrial cost respectively. The firm also considered to be one of the Purely highest technical efficient firm with the average efficiency score of more than 91.4% and its inefficiency score is 8%.The firm tries to have best managerial efficiency too. Vamana cements found to have better scale efficiency in the beginning period afterwards slight variations noted and finally

the firm remained to have 100% efficient with average score of 90.3% and 9.6% inefficiency.

Findings:

The research assesses the Multi period efficiency scores of 3 mini cement plants. The study was made with the help of DEA tool to analyze the efficiency scores which includes Overall technical efficiency, Pure technical efficiency and Scale efficiency to understand the cost efficiency of these firms. In this study, it was found among all the three firms Andal cements found to have high efficiency in Overall technical efficiency with 92% and 8% inefficiency, Pure technical efficiency 97% score and its inefficiency percentage found to be 2.9% and Scale efficiency seemed to have 95% efficiencies and 4% inefficiencies. Since Andal cements proved to be DEA efficient it is considered as benchmark unit for other units. Vamana cements stand second in efficiency score with Overall technical efficiency with 82% and 18% inefficiency, Pure technical efficiency 91% score and its inefficiency percentage found to be 8.5% and Scale efficiency seemed to have 90% efficiencies and 9.6% inefficiencies. Kaarpaga cements occupies third position in the efficiency scores with Overall technical efficiency 82% and 18% inefficiency, Pure technical efficiency 83% score and its inefficiency percentage found to be 17%. It has to take considerable

effort to reduce input cost through proper managerial decisions and Scale efficiency noticed to have 99% efficiencies and 0.02% inefficiencies These two firm has to reduce the input of raw materials, electricity and labor cost and must be cautious in minimizing input cost maintaining same level of output to become DEA efficient especially Overall technical efficiency. Firms should take wise decision in the selection of raw materials and its proportion to be used. Labor efficiency can be obtained by proper training and using maximum productivity.

CONCLUSION:

Grinding and blending unit in Tamil Nadu proves to have excellent cost efficiency. Only Kaarpaga cements shows moderate efficiency with 83% pure technical efficiency which can reach 100% efficiency through accurate managerial decisions. Tamil Nadu has its own advantages in clinker grinding due to availability of clinker within state as well as from neighboring states. Also there is a possibility for import of raw materials from Middle East countries to reduce the cost of raw materials. Apart from that NTPC project, Mettur, salem district of Tamil Nadu have ample quantity of flyash is available. Mineral gypsum. Salt gypsum and Chemical gypsum is also available in Tamil Nadu. Henceforth all the required raw material can be procured at

competitive prices shall profitably be grinded to manufacture good quality cement. Labor cost can be reduced by providing frequent trainings on the upgradation matter so as to make them productive labors. And another cost which increase the input cost is electricity cost. This cost can be reduced by installing solar panels and by working at correct schedule.

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