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On Environmental Cost Accounting of Cement Enterprises

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Abstract

Because cement enterprises are featured by heavy pollution and high energy consumption, it is significant to account their environmental cost. Different from traditional cost accounting, this paper, after the analysis of the work flow of cement, adopts activity-based costing to sum up environmental expenses and allot the expenses to the products for the purpose of uncovering the real product cost. With a case study, this paper illustrates the feasibility of activity-based costing, providing the decision makers of cement enterprises with reliable statistics.

Key words: Cement; Enterprise; Environmental cost; Accounting; Activity-based costing

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INTRODUCTION

China is the largest producer of cement in the world. In the recent ten years, the cement output in China increases by over 10% every year on average, while the influence of the environment pollution caused by cement industry is quite terrible. It is estimated that particulate emission from cement industry accounts for 15%~20% of the total particulate emission, with dust emission accounting for 30% of the total. In addition, cement industry is also an important pollution source of greenhouse gas. It is introduced by experts that the CO_2 emission per unit in cement industry is the head of various industries, about 7.5 times the national average value (Insight & Info Consulting Ltd., 2013 June 26). With the worsening of environmental problems and the strengthening of environmental regulations, enterprises tend to pay more for environmental protection, so it is of great importance how to correctly account and control the environmental cost, and thus coordinating the development and environmental protection and providing accurate judgment basis for decision making.

At present, most cement enterprises in China still adopt the traditional cost accounting in cost accounting. With respect to the production characteristics of cement enterprises, the traditional cost accounting is discovered to have the following problems:

a) The environmental cost drivers cannot be reflected accurately, because the environmental expenses is included in the environmental cost directly with the ins and outs unknown, thus not separating effectively from the environmental cost;
b) The environmental cost information may not be embodied accurately, because only the direct environmental expenses are calculated usually, which may cause the environmental cost undervalued and even affect the production decision of cement enterprises;
c) The recognition of financial results is affected, because the cement enterprises usually have unbalanced environmental expenses in the production process and only the actual environmental expenses will be recognized in the cost, thus making the current income and expenses in an unreasonable proportion and even misleading the users of financial statements. This paper hereby proposes new ideas for cement cost accounting.

1. RESEARCH REVIEW

With respect to the production decision-making and environmental policy of an enterprise, it is how to appropriately account the environmental cost that matters. At present, the study on environmental cost accounting mainly focuses on three aspects: one is based on the theory of life cycle (Wang, 2003; S. Y. Liu, Y. H. Liu, T. Liu, & Huang, 2011); the second is under the activity-based costing (Li, 2013; Zhuang, 2013); the third is based on the material flow costing (Fu, 2013; Luo & Xiao, 2011). See Table 1.

Table 1
Research on Environmental Cost Accounting for Enterprises at Home and Abroad

Research on environmental cost accounting for enterprises	Representative author	Leading opinion
First	Wang Mengxue (2013)	The basic frame of environmental cost accounting is constructed on the life cycle, which solves quantification of both the enterprise and the external environmental costs as well as the reasonable allocation of the enterprise environmental cost. It is shown that life cycle can be applied to the environmental cost accounting.
	Liu Siyue (2011)	By analyzing the classification of environmental cost, the research subject and research motivations, and comparing the two different environmental cost accounting methods based on life cycle, it is believed that the environmental cost accounting based on life cycle will be more practical and promising if subject to the environmental impact assessment results.
Second	Li Qiong (2013)	Given that the environmental cost is directly included in the manufacturing cost in the traditional costing and then allotted by products, which usually causes the cost distortion, the activity-based costing is adopted to establish the cost pool, so as to use the cost drivers to appropriately allot the environmental costs, thus effectively making the product cost real.
	Song Ziyi (2011)	As an advanced method of cost accounting and management, the activity-based costing is adopted to collect and allot the environmental cost, which may find the activity consuming environmental cost by tracing to its source from the environmental cost drivers, thus greatly improving the belongingness of environmental cost.
	Zhuang Xiqing (2013)	Given that the indirect charges accounting for the majority of the environmental cost and uneven occurrence time in cement enterprises, the activity-based costing is adopted to sum up environmental expenses, which may analyze the environmental cost more clearly and thus correctly sum up the environmental cost.
Third	Fu Feifei (2013)	The "environmental benefit & economic benefit" dual environmental management and evaluation system is established on the basis of MFCA, which may screen out 18 indexes expressing the effect of environmental management, with the analytic hierarchy process used to set the index weights and the index evaluation method used to calculate the evaluation system reflecting MFCA environmental benefit; from the perspective of the management cost benefit, the increase and decrease of economic benefit produced by the environmental management with MFCA, and the cost benefit evaluation method is adopted to calculate the incremental benefit cost ratio by implementing MFCA increment.
	Luo Xiying (2011)	MFCA is further deepened with the material flow model with data and the flow-cost matrix, which will make the enterprise to achieve a win-win situation in both economic performance and environmental performance.

To sum up, this paper, subject to the characteristics of the cement industry, takes one cement plant as an example and adopts activity-based costing to profoundly and comprehensively account the environmental cost of the cement enterprises, which is of a certain practicality and feasibility.

2. ENVIRONMENTAL COST ACCOUNTING OF CEMENT ENTERPRISE BASED ON ABC

Activity Based Costing (ABC) is a cost calculation method to recognize and measure all activities consuming enterprise

resource centered on activity, and then to accurately include the consumed resource cost in the activity, thus finally allotting the activity costs to the calculation objects (products or services) with the cost drivers.

2.1 Analysis of Cement Production Process

The cement production process mainly includes seven links: crushing and pre-blending, preparation of unprocessed materials, blending of unprocessed materials, preheating and decomposition, preparation of processed materials, cement grinding and cement packing. When ABC is adopted to sum up the environmental cost of cement, the activities in each link and their impacts on environment resources shall be known. See Figure 1 for details:

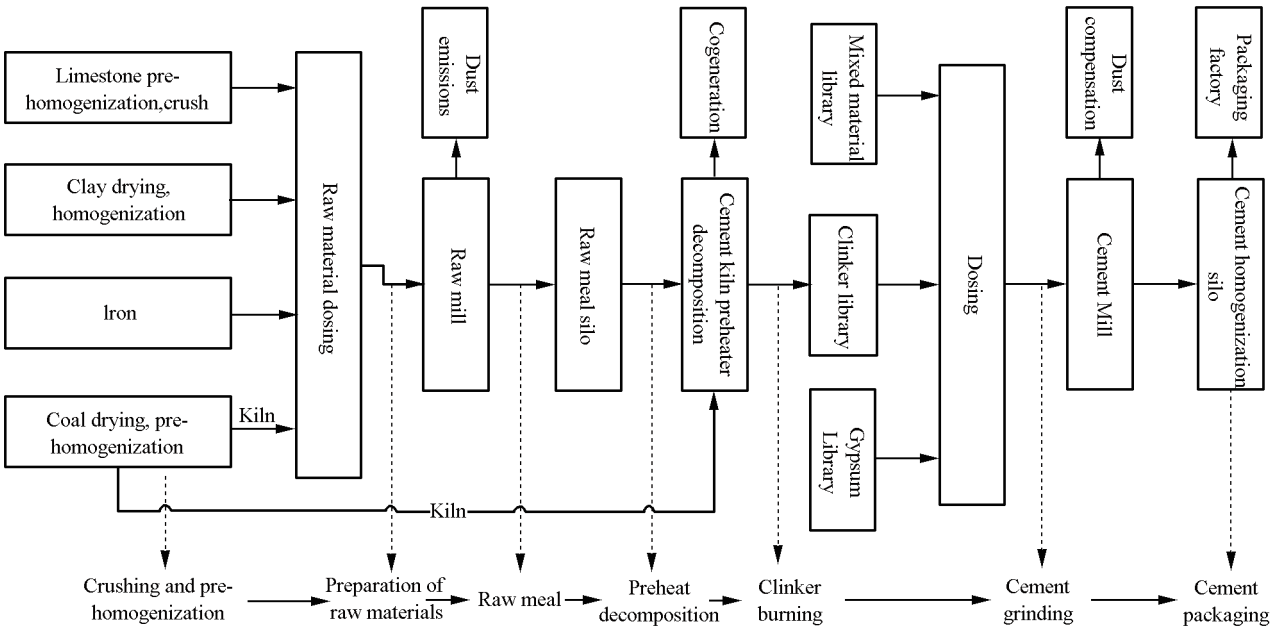

Figure 1
Cement Production Process

It can be seen from the analysis above that the cement production process may lead to corresponding environmental problems. In the crushing and pre-blending, natural resources are consumed and a direct environmental cost occurs; the preparation of unprocessed materials may generate large amounts of dust pollution, which shall be governed and compensated by enterprises, and the detecting and processing devices employed hereby belong to the environmental costs; in the preparation of processed materials, coal burning may emit a large amount of CO_2 leading to environmental problems, and the cogeneration equipment employed will cost a lot; in the process of cement grinding and cement packing, the dust pollution is serious and influences the local environment, which takes a lot of enterprises and also belongs to the environmental cost. In addition, in the production process enterprises shall train their employees with environmental knowledge, and contribute to the local people and government for environment management, both belonging to environmental cost. Therefore, the control of environmental cost is essential to cement enterprises.

2.2 Settings of Environmental Cost Accounting for Cement Enterprises

After the analysis of the cement production process and the confirmation of environmental cost, in combination with the production and operation characteristics of cement enterprises, the environmental cost can be classified into the following ones: first, spending on environmental assets, namely the natural resources consumed; second, pollution control cost, namely the pollution discharge fees collected by the state for the normal and excess emissions of waste gas, waste water and industrial residue; third, recycling fee, namely the spending on the reuse of waste materials and the cogeneration devices; fourth, compensation for environmental pollution, namely the damages for environmental pollution caused by cement enterprises; fifth, environment management cost, i.e., the spending for environment management institutions and personnel, including environmental education and training expenditures; sixth, other environment-related expenses, including contributions to support social environmental protection activities, etc. See Table 2 for details:

Table 2
Settings of Accounting Items for Environmental Cost

Accounting subjects	Amount (RMB)
Spending on environmental assets	...
Pollution control costs	...
Recycling fee	...
Compensation for environmental pollution	...
Environment management cost	...
Other environment-related expenses	...
Total (environmental cost)	...

3. ENVIRONMENTAL COST ACCOUNTING OF CEMENT ENTERPRISES BASED ON ABC

Environmental cost accounting may be executed in two stages and six steps under ABC. The first stage is to allot environmental expenses to homogeneous activity cost pool (i.e., the activity center), and calculate the allocation rate of each cost pool; the second stage is to use the allocation rate to allot the environmental expenses to products, and to calculate the environmental cost. The actual operation steps are as follows:

a) Definition, identification and selection of major activities;
b) Allocation of environmental expenses to homogeneous cost pool;
c) Selection of cost drivers as the computational benchmark for allocation rate;
d) Calculation of allocation rate of cost pool, Allocation rate of cost pool = activity ÷ activity drivers;
e) Allocation of environmental cost to products, environmental cost = allocation rate of cost pool × the number of activity drivers;
f) Calculation of environmental cost, environmental cost = ∑environmental cost of all activities in the cost pool. See Figure 2 for details:

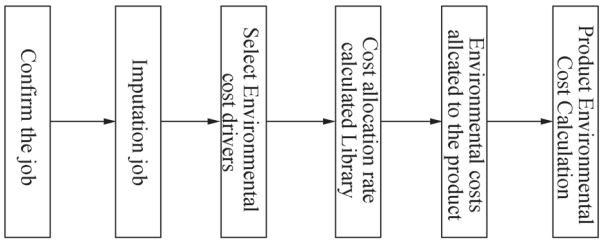

Figure 2
Environmental Cost Accounting Procedure of Activity-based Costing

3.1 Definition, Identification and Selection of Major Activities

It is required to analyze the consumption of environmental cost and determine the activity before adopting ABC to allot the environmental expenses. Attention shall be paid to the following two cases when the cement enterprises determine the activity: First, if the expenses of one environment resources can be determined to be consumed by only a specific product, the expenses may be directly recognized in the product cost; second, if case one may not be satisfied, the environmental resources shall be allotted to each activity under an appropriate quantitative basis. Subject to the settings of environmental cost subjects, the activities causing environmental expenses in the cement production process may be associated with the corresponding subjects as follows:

a) Spending on environmental assets, according to the definition of environmental assets, belonging to direct environmental expenses, ore of building materials and soft coal consumed in cement production are non-renewable natural resources usually taking a certain cost, of which the value may be measured against the cost, where raw material purchase is regarded as an activity;
b) Pollution control costs, mainly used for pollution discharge of waste gas, waste water and industrial residue, where pollution discharge is regarded as an activity;
c) Recycling fee, mainly used for the investment in cogeneration devices, where recycle is regarded as an activity;
d) Compensation for environmental pollution, mainly used for the pollution to local environment, where compensation is regarded as an activity;
e) Environment management cost, mainly used for employees' training with environmental knowledge and personnel in the decision-making department, where environment management is regarded as an activity;
f) Other environment-related expenses, mainly including the contributions to support local environment protection, where contribution is regarded as an activity. See Table 3 for details:

Table 3
Accounting Subjects and the Corresponding Activities of Environmental Cost

Accounting subjects	Activities
Spending on environmental assets	Raw material purchase
Pollution control costs	Pollution discharge
Recycling fee	Recycle
Compensation for environmental pollution	Compensation
Environment management cost	Environment management
Other environment-related expenses	Contribution

3.2 Allocation of Environmental Expenses to Homogeneous Cost Pool

Without prejudice to the generality of statements above,

the environmental expenses may be allotted to six cost pools, respectively: spending on environmental assets, pollution control costs, recycling fee, compensation for environmental pollution, environment management cost, and other environment-related expenses.

3.3 Selection and Analysis of Cost Drivers

Cost drivers, also called cost drive factors, are the causes of cost, namely the inducement of cost. Cost driver is the basis of cost allocation. Ore of building materials and soft coal are the main raw materials to produce cement products, of which the consumption of a product may be determined directly and the environmental expenses caused hereby may be directly recognized in the product cost, so the raw material consumption may be regarded as one activity driver; however, pollution discharge, recycling, compensation, environment management and contribution may not be determined by the consumption of a particular product, to which the environmental expenses shall be allotted with an appropriate allocation basis, namely the product output here. See Table 4 for details:

Table 4
Activities and Their Drivers

Activities	Activity drivers
Raw material purchase	Consumption of raw materials
Pollution discharge	Product output
Recycle	Product output
Compensation	Product output
Environment management	Product output
Contribution	Product output

3.4 Calculation of Allocation Rate of Cost Pool

Allocation rate of cost pool = activity ÷ activity drivers, that is, allocation rate of Activity 1 = expenses on raw material purchase ÷ consumption; allocation rate of Activity 2 = expenses on pollutant discharge ÷ product output; allocation rate of Activity 3 = recycling cost ÷ product output; allocation rate of Activity 4 =compensation expenses ÷ product output; allocation rate of Activity 5= expenses on environment management ÷ product output; allocation rate of Activity 6 = contribution expenses ÷ product output.

3.5 Allocation of Environmental Cost

Subject to the number of activity drivers of various products, the environmental expenses of all activities in the cost pool will be allotted to products by the proportion of activity drivers, namely the environmental cost = allocation rate of cost pool × the number of activity drivers.

3.6 Formation of Environmental Cost Table

Based on the calculation and analysis above, the final environmental cost = ∑environmental cost of all activities in the cost pool, and the unit environmental cost = environmental cost ÷ output.

4. CASE STUDY

This paper analyzes the methods above by taking one cement plant as example. The enterprise has two production lines for 32.5 cement and 42.5 cement respectively. Table 5 and Table 6 below describe the details of production cost structure calculated with the traditional cost accounting. The discharge spending is RMB 185,394.12 in September. The investment in 2014 to establish the cogeneration project is about RMB 80,000,000.00, and the recycling fee is calculated with straight-line depreciation method as per the service life of 15 years and the ratio of remaining value of 5%: 80000000*(1-0.05)÷(15*12)=RMB 422222.22. The environmental pollution compensation and other environment-related expenses are allotted by month. The compensation for pollution of surrounding environment is about RMB 500,000.00 every year. The training in September takes RMB 25,000.00 for the purpose of improving the staff's environmental protection consciousness. In addition, the contribution to the local environmental protection association is about RMB 200,000.00 for one year under the contract.

Table 5
Production Cost of Unprocessed and Processed Materials (Unit: RMB. t)

No.	Item	Output (t)	Consumption of dry basis (t)	Unit price of materials	Production cost	Unit price
I	Total cost of unprocessed material	739,832.00			35,730,734.90	48.96
1	Wage				646,963.02	0.75
2	Welfare				124,085.63	0.17
3	Raw material				24,842,645.34	34.04
	Including: core of building materials		389,394.00	33.79	13,157,623.26	18.03
	…		…	…	…	…
4	Manufacturing expenses				3,663,205.35	5.02
	Including: depreciation				3,183,345.42	4.36

To be continued

Continued

No.	Item	Output (t)	Consumption of dry basis (t)	Unit price of materials	Production cost	Unit price
	…				…	…
Ⅱ	Total cost of processed material	475004.00			67938458.26	143.03
1	Wage				546963.01	1.15
2	Welfare				124085.63	0.26
3	Raw material				32330275.16	74.38
	Including: unprocessed material		725098.00	48.96	32330275.16	74.38
4	Fuels and energy				36231967.28	76.28
	Soft coal		58310.00	510.50	29767255.00	62.67
	Manufacturing expenses				4294832.82	（9.04）
	Including: depreciation				3580298.45	7.54
	…				…	…

Table 6
Production Cost of 325 Cement and 425 Cement (Unit: RMB. t)

No.	Item	Output (t)	Consumption of dry basis (t)	Unit price of materials	Production cost	Unit price
Ⅰ	Total of 325 Cement	98,902.00			14,085,411.52	142.42
1	Wage				127,579.43	1.29
2	Welfare				28,943.05	0.29
3	Raw material				11,913,730.31	120.46
	Processed material		38,045.00	137.01	5,212,559.60	52.70
	…		…	…	…	…
4	Manufacturing expenses				900,484.59	9.10
	Including: depreciation				418,431.76	4.23
	…				…	…
Ⅱ	Total of 425 Cement	625,841.00			98,669,269.95	157.66
1	Wage				807,309.61	1.29
2	Welfare				183,148.62	0.29
3	Raw material				83,724,694.12	133.78
	Including: processed material		408,615.00	137.01	55,539,648.94	88.74
	…		…	…	…	…
4	Manufacturing expenses				6,274,238.18	10.03
	Including: depreciation				2,801,194.84	4.48
	…				…	…

The cost calculated with the traditional cost accounting fails to reflect the real environmental costs, such as depreciation included in the manufacturing expenses. The depreciation expenses above include the depreciation of all devices such as the production equipment, the packaging equipment and the transportation equipment. The depreciation expenses of cogeneration devices are not listed separately, which makes the environmental cost undervalued, so ABC shall be used to sum up the environmental costs.

4.1 Allocation of Environmental Expenses to the Homogeneous Cost Pool

It is accounted with ABC. First of all, the environmental expenses are allotted to the homogeneous cost pool, in which, the spending on environmental assets includes the spending on ore of building materials and the soft coal, with the data taken from the schedules above. It can be seen from Table 5 that 1.53t (725098.00÷475004.00=1.53) unprocessed materials and 0.12t (58310.00÷475004.00=0.12) soft coal are required to produce 1t processed materials; 0.53t (389394.00÷739832.00=0.53) ore of building materials are required to produce 1t unprocessed materials. Therefore, in order to produce 1t processed materials, it is required 0.82t (1.53×0.53=0.82) ore of building materials and 0.12t soft coal. Through the relations of cement products consuming processed materials→processed materials consuming unprocessed materials and soft coal→unprocessed materials consuming ore of building materials, the expenses on ore of building materials and soft coal consumed by the two cement products are as shown in Table 7.

Table 7
The Expenses on Ore of Building Materials and Soft Coal Consumed by the Two Cement Products

	325 Cement	425 Cement
Output (t)	98902.00	625841.00
Consumption of processed material (t)	38045.00	408615.00
Including: Consumption of ore of building materials (t)	38045.00.×0.82=31196.90	408615.00×0.82=335064.30
Consumption of soft coal (t)	38045.00×0.12=4565.40	408615.00×0.12=49033.80
Spending on environmental asset (material consumption*unit price) (RMB)	31196.9×33.79+4565.4×510.50 =3384779.95	335064.3×33.79+49033.8×510.50 =36353577.60

The consumption of raw material belongs to the direct environmental cost, which is directly recognized in the environmental cost of the two cement products without allotting by the cost drivers. The environmental cost in other activity pools shall be allotted by the cost pools due to not being the direct environmental cost, see Table 8 for details:

Table 8
Environmental Expenses of All Cost Pools (Unit: RMB)

Cost pool	Activity	Environmental expenses of cost pool
Pollution control costs	Pollution discharge	185394.12
Recycling fee	Recycle	422222.22
Compensation for environmental pollution	Compensation	41666.67
Environment management cost	Environment management	25000.00
Other environment-related expenses	Contribution	16666.67

4.2 Calculation of Allocation Rate for Cost Pool

Calculate the allocation rate for cost pool with the environmental cost drivers in Table 4, see Table 9 in which the product output is the sum of that of 32.5 cement and 42.5 cement.

Table 9
Cost-driver Rate of Environmental Cost

Activity	Total of environmental cost (RMB)	Activity drivers	Cost-driver rate of environmental cost
Pollution discharge	185394.12	724743.00 (t)	0.26
Recycle	422222.22	724743.00 (t)	0.58
Compensation	41666.67	724743.00 (t)	0.06
Environment management	25000.00	724743.00 (t)	0.03
Contribution	16666.67	724743.00 (t)	0.02

4.3 Allocation of Environmental Cost

The environmental cost is allotted by product output: environmental cost of 32.5 Cement = Cost-driver rate × output of 32.5 Cement; environmental cost of 42.5 Cement = Cost-driver rate × output of 42.5 Cement, as shown in Table 10:

Table 10
Environmental Cost of Cement

Activity	Activity consumption (output) (t)		Environmental cost of cement (RMB)	
	325 Cement	425 Cement	325 Cement	425 Cement
Pollution discharge	98902.00	625841.00	25714.52	159679.60
Recycle			57363.16	364859.06
Compensation			5934.12	35732.55
Environment management			2967.06	22032.94
Contribution			1978.04	14688.63

4.4 Summary of Environmental Cost

Summarize to form the environmental cost table, as shown in Table 11:

Table 11
Total Environmental Cost of Each Cost Pool (Unit: RMB)

Environmental cost of each cost pool	325 Cement	425 Cement
Spending on environmental assets	3384779.95	36353577.60
Pollution control costs	25714.52	159679.60
Recycling fee	57363.16	364859.06
Compensation for environmental pollution	5934.12	35732.55
Environment management cost	2967.06	22032.94
Other environment-related expenses	1978.04	14688.63
Total	3472802.73	36950570.38

4.5 Calculation of Unit Environmental Cost

Unit environmental cost = Environmental cost ÷ output, as shown in Table 12:

Table 12
Unit Environmental Cost of Two Cement Products

Output (t)		Environmental cost (RMB)		Unit environmental cost (RMB)	
325 Cement	425 Cement	325 Cement	425 Cement	325 Cement	425 Cement
98902.00	625841.00	3472802.73	36950570.38	35.11	59.04

CONCLUSION

This paper, after the analysis of management characteristics of cement enterprises and the uneven environmental cost, adopts the activity-based cost accounting to calculate the unit environmental cost of cement products. Following conclusions have been drawn through the theoretical research and practical verification:

(a) Different from the traditional accounting, ABC separates the environmental cost from the indirect charges, associates the environmental cost with the source activities, and accurately allots the cost to the cost accounting objects carried by different products, thus solving the problem of incorrect cost information caused by the traditional allocation standards.

(b) In ABC, activity is set and centered on, and the intangible environmental cost is appropriately measured in the production process with cost drivers, which allows the cement enterprises to scientifically control and manage their environmental costs.

(c) It can be seen from the calculation of unit environmental costs for the two cement products that the environmental cost varies from the product, which provide a more powerful support for the cement enterprises to reasonably plan the production scheme;

(d) It can been seen from the environmental cost allotted by activity that the expenses on environmental assets accounts for the majority of environmental cost, 32.5 cement accounting for 97% and 42.5 cement accounting for 98% for example. Therefore, the raw materials shall be utilized more efficiently in cement enterprises, and maybe there will be alternatives in the future.

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