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Energy Analysis of Biodegradable Areca Leaf Plates Manufacturing in Nepal: A Case Study of Leaf Plus Pvt. Ltd

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Abstract: ***Energy cost is one of the major costs in biodegradable disposables manufacturing. Leaf Plus Pvt. Ltd. has been manufacturing biodegradable disposables made from areca leaves for three years in Nepal. This industry has been taken as a case study for our research. It was observed that energy cost can be reduced mainly through four methods: Construction of Natural Construction Green House Solar dyer for leaf drying, Construction of Leaf Holding Centers for reduction in leaf transportation fuel cost, installation of capacitor bank for decreasing demand charge & load shifting for reduction of electricity cost. The implementation of these strategies resulted in decrease in energy cost by 7 percentage resulting in decrease in product cost by 4 percentage.***

Keywords: Biodegradable, Areca, Leaf , Plate , ECRO, Product Cost, Payback, IRR, NPV

I. INTRODUCTION

The global market for disposable plates has increased a lot post 2012-2016 period [1]. Biodegradable plates are gaining popularity for their environment friendly properties and with ban on plastics in certain regions, there is a high growth opportunity for biodegradable plates.

Areca leaf Plates are one of the available biodegradable disposable alternatives that exist in the market. These plates are manufactured using areca nut leaves. Areca palm tree (Scientific Name: Areca Catechu) grows only in the tropical climate areas. India is the leading producer of areca nuts and has the most significant number of areca palm trees cultivated area. Countries like Nepal, Sri Lanka, Myanmar, Indonesia, Vietnam also produces areca nuts.

There are 38 million areca nut trees in Eastern Nepal [2]. The nut shells and areca tree leaves are major waste from areca nut farming. Each areca nut tree shades around 10 leaves per year. Thus, every year around 380 million leaves are getting wasted as an agro waste. Each leaf can be utilized to produce an average of 3 plates. Thus, there is a potential to produce upto 1.2 Billion areca leaf plates in Nepal by utilizing those leaves.

Thus, manufacturing of areca leaf plates from areca leaves has a huge prospect of small and medium scale enterprise in Nepal. It shall not only help in the reduction of plastic waste; it shall also contribute towards employment generation and development of sustainable national economy. To captivate the full potential, a number of such manufacturers are to evolve and it is definitely happening in coming days.

The more the number of industries, the more competitive shall be market be. Thus, manufacturers will need to look after the best efficient technology and methodologies for the manufacturing and energy cost will be one of the major costs. This study incorporates the energy perspective analysis of biodegradable areca leaf plates manufacturing. Leaf plus Pvt Ltd. has been converting areca nut leaves into biodegradable disposables (Plates, bowls and spoons) since last three years. The manufacturing unit of Leaf Plus have been taken as reference for this study.

A. Objective

To observe the potential energy saving, reduce the cost of energy in production & reduce the cost of biodegradable areca leaf plates manufacturing.

II. METHODOLOGY

The factory was visited, the energy data of existing manufacturing system was noted. Power Factor was measured with the use of Power Analyzer. Leaf Collectors were interviewed. Leaf Collection Centers were visited and the status was taken. Machine Operators were interviewed. Energy Cost Reduction Opportunities were identified and their financial viability was tested with the use of three indicators NPV, IRR and Payback Period.

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A. Current Status

Currently 21 percentage of the Product Cost is Energy cost & per unit product cost is Rs. 3.08.

Annual Electricity Cost (Nrs.)	1,261,663.90
Annual Fuel Cost (Nrs.)	67,904.80
Annual Leaf Labor Cost (Nrs.)	834000
Other Costs (Nrs.)	4,122,502.41
Total Product Cost(Nrs.)	6,286,071.11
Total Production (Pcs/Year)	2039700
Product Cost/Piece (Rs.)	3.08

Table 1 : Energy Data of Current Status of Factor

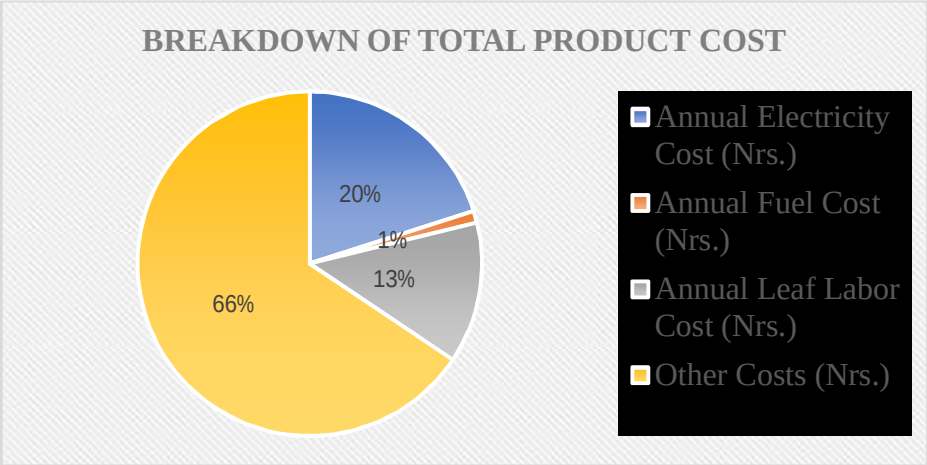

Figure 1: Breakdown of Total Product Cost

III. ENERGY COST REDUCTION OPPORTUNITIES (ENCRO)

A. ENCRO-1 Reduction in Leaf Drying Time

Twenty leaf collectors are collecting leaves for the factory so far. They are currently sun drying the leaves directly under the sun. The time taken for each leaf to dry according to season is 4.3 Days.

Natural Convection Green House Dryer with UV Plastic Covering was found the most economic option for the same based on the market availability of the material and its lower construction cost with utilization of local materials (bamboo). The total capital cost for each greenhouse dryer was Rs. 21,400.00. A greenhouse was constructed for experiment, with the use of Green House Solar Dryer, the leaf drying time reduced to 3.35 days. Thus, construction of 20 Green House Solar Dryer would result a yearly saving of 22 percentage in leaf drying cost which amounted to Rs.1,84,000.00.

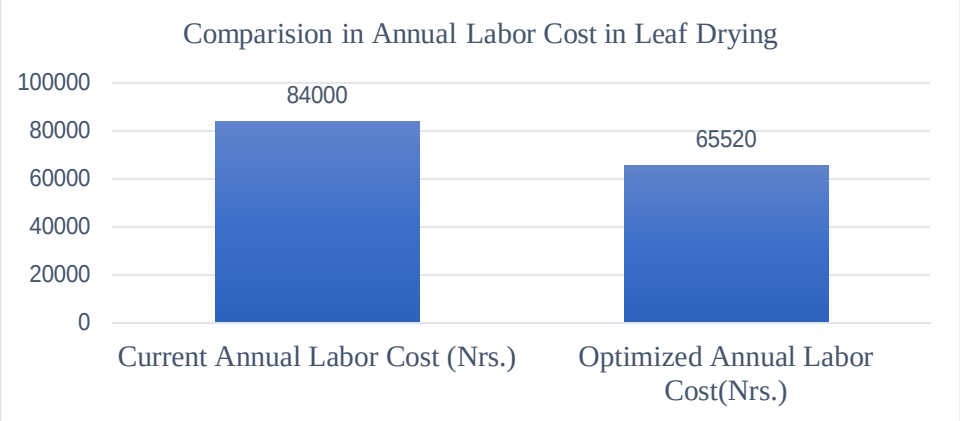

Figure 2: Comparison in Annual Labor Cost in Leaf Drying before and after Green House Dryer

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B. ENCRO-2 Fuel Cost of Leaves Transportation

Currently leaves collected from each collector is directly transported to the factory. Collectors are mainly from two village. Due to limitation in storage area, there is pressure from the collectors to pickup small volumes of leaves collected. On average, 2500 leaves per trip is being transported from each factory by the use of small pickup diesel vehicles. It was observed that Nrs.67,904.8 is being spent annually on fuel for transportation of the leaves to the factory. If we could construct leaf holding center in each village with leaf storage capacity of 18,000 leaves and use larger vehicles for transportation of leaves (capacity 15,000 leaves per trip) from holding center to factory, the Proportional fuel cost would decrease. The initial capital cost for the construction of leaf holding center was estimated to be Rs. 1,00,000.00 per holding center. Two holding centers each in each village was estimated for research. Resulting Fuel cost after construction of holding centers was calculated to be Rs. 28,858.51. Thus, use of leaf holding centers would result in a net saving of fuel cost of Rs. 39,046.34.

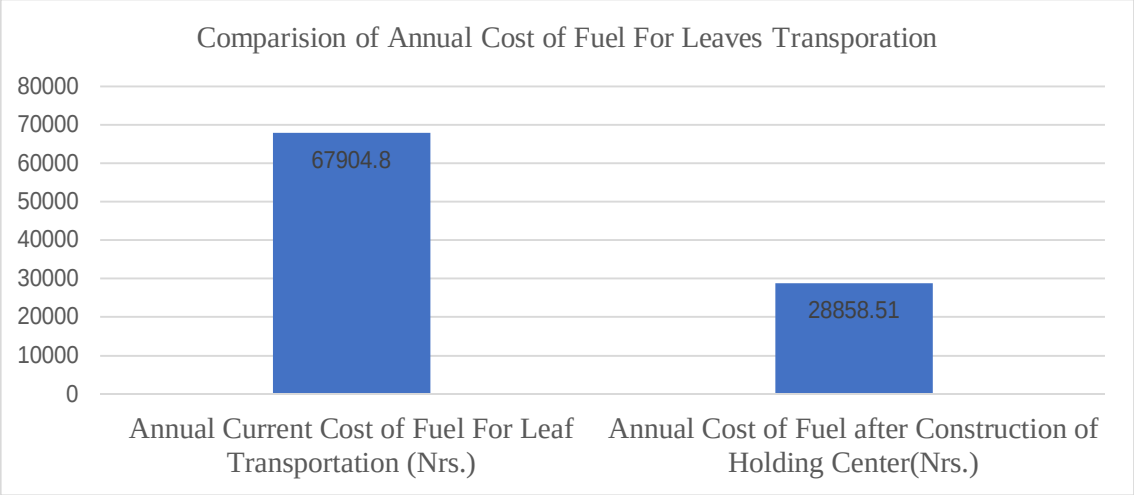

Figure 3: Comparison in Fuel Cost

C. ENCRO-3: Power Factor Improvement

The Current Power Factor of the Electrical System of the industry was found to be 0.75 while measured with the help of power analyzer. By improving the power factor, the total plant demand can be reduced, thereby saving the monthly electricity bill against the demand charge.

Existing System	
Current Power Factor	0.75
Total Active Power (KW)	53.08
Apparent Power (KVA)	70.77
Reactive power(kVAR)	46.81
After Power Factor Correction	
Capacitor Cost /kVAR per anum[3]	127.385
kVA demand charges per anum (Nrs/kVA)[4]	3000.000
Most Economical Power Factor	0.999
Total Active Power (KW)	53.080
Apparent Power (KVA)	53.128
Reactive power(kVAR)	2.256
Change in kVAR	44.556
Investment in Capacitor to change the kVAR	56757.949
Saving in Demand per month	17.645
Saving in demand charge per Anum	52936.252

Table 2 : Most Economic Power Factor

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The most economic power factor was calculated to be 0.999 and required a capital investment of Rs. 56,757.9 which would result in a yearly saving of Rs. 52,936.2 in demand charge.

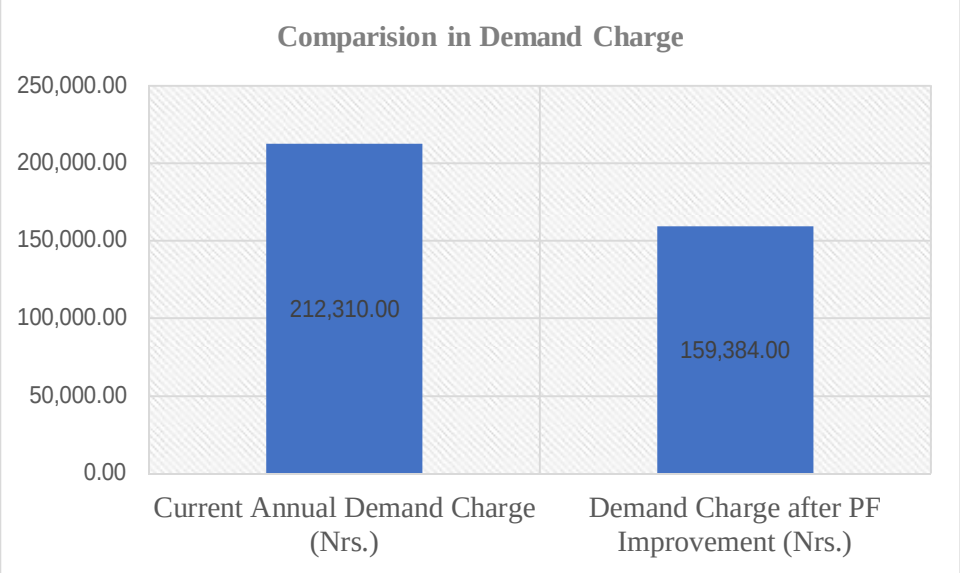

Figure 4: Comparison in Annual Demand Charge

D. ENCRO-4 Load Shifting

Nepal Electricity Authority has three different tariff rates during different time of the day which are classified as Peak Time (17:00 - 23:00), Off Peak Time (23:00 -05:00) & normal time (05:00-17:00) [4]. The current per unit electricity cost was found to be Rs. 10,49,353.9 per annum. Looking at the present status it was found that Induction Motors, Heater, Sealing Machine & Shrink-Wrapping Machine were being operated during peak time as well. These loads were shifted to normal time, which resulted in decrease in cost of electricity consumed per annum.

Load	Current time of Operation	Shifted Time of Operation
Hydraulic Motors	09:30 to 17:30	09:00 to 17:00
Heaters	09:30 to 17:31	09:00 to 17:01
Sealing Machine	14:00 to 18:30	12:00 to 16:30
Shrink Wrapping	16:00 to 18:30	09:00 to 11:30

Table 3 : Factory Electrical Loads & their Time of Operation

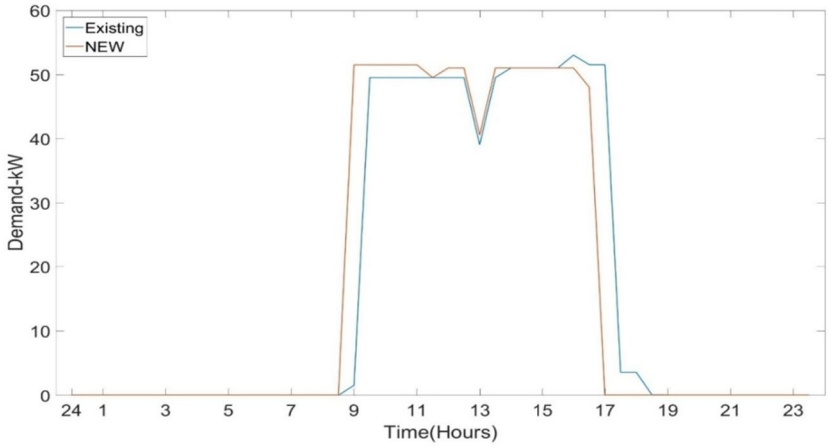

Figure 5 : Load Curve

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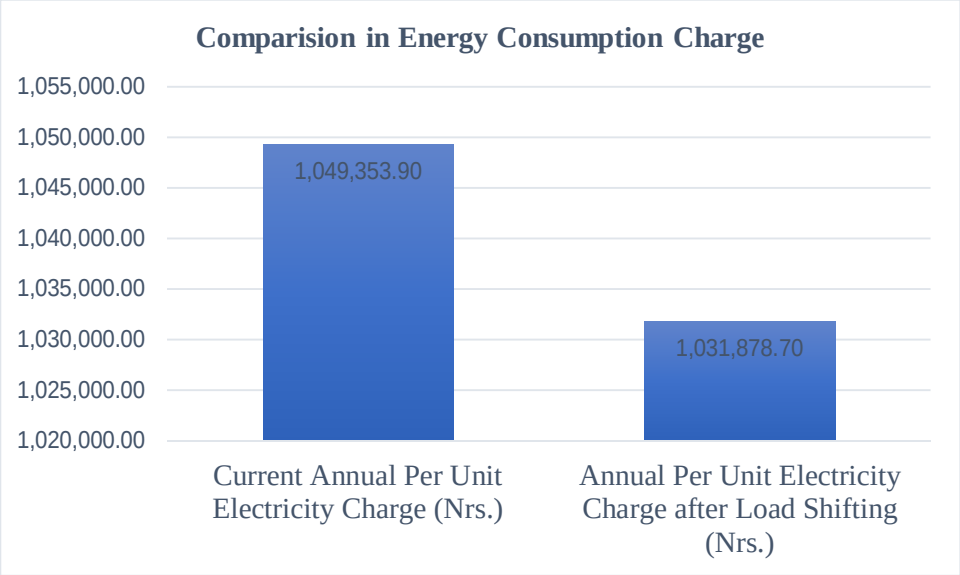

Figure 6 : Comparison in Total Energy Consumption Charge

Financial Analysis for Implementation of all Energy Cost Reduction Opportunities

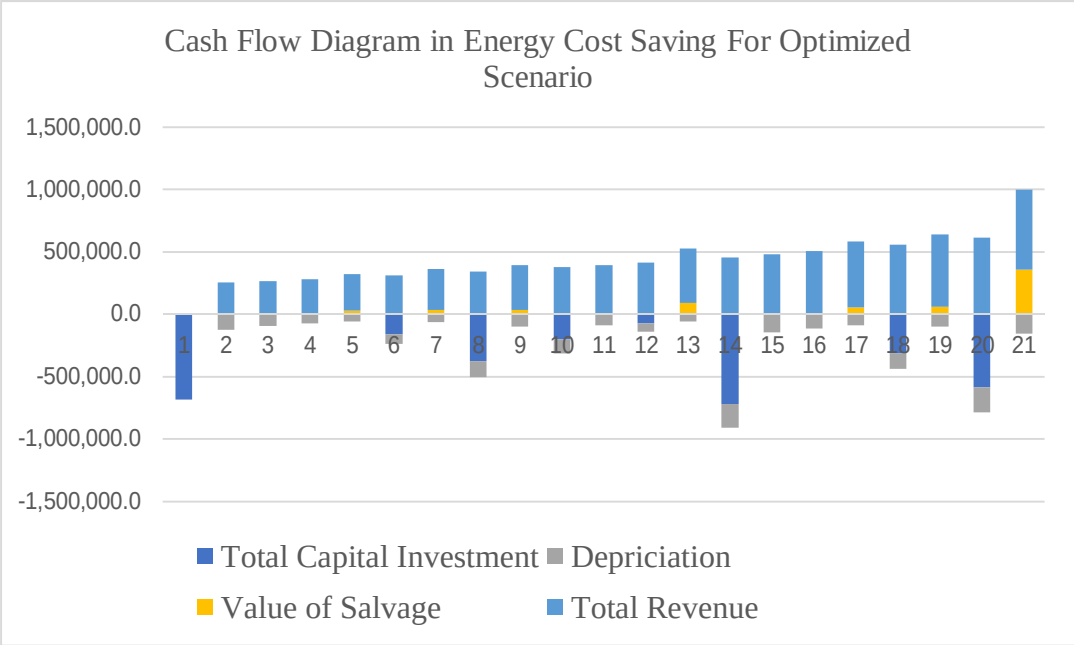

Figure 8 : Cash Flow Diagram For Implementation of Energy Cost Reduction Opportunities

Net Present Value (NPV)	947,649.2
Internal Rate of Return (IRR)	25%
Discounted Payback Period (Years)	5.25

Table 4 : Results of Financial Analysis

This shows that, the invesment made for reducing demand charge by the installation of Capacitor bank, investment made for the construction of Leaf Holding Centers for the reduction of Fuel Cost as well as Load shifting for the reduction in Peak Time electricity tariff yeilds very optimitic indicators i.e NPV of Rs. 9,47,649.20 (In words : Nine Lakh Fourty Seven Thousands Six Hundred Fourty Nine Rupees and Twenty Paisa Only), IRR of 25% & Discounted Payback period of 5.25 Years.

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IV. RESULTS

S.N	Item	Current	Optimized	Percentage Decrease
1	ENCRO-1: Leaf Labor Cost (Nrs.)	834000	650520	22%
2	ENCRO-2: Fuel Cost (Nrs.)	67,904.80	39,046.34	42%
3	Cost of Electricity (Nrs.)			
	ENCRO-4 : Per Unit Cost	1,049,353.90	1,031,878.70	2%
	ENCRO-3 : Demand Charge	212,310.00	159,384.00	25%
	Total Cost of Electricity	1,261,663.90	1,191,262.70	6%
4	Total Energy Cost	1,329,568.70	1,230,309.04	7%
5	Other Costs	4,122,502.41	4,122,502.41	
6	Total Product Cost (Nrs.)	6,286,071.11	6,003,331.45	4%
7	Total Pieces Produced/Year			2039700
8	Product Cost/Piece (Nrs.)	3.08	2.94	4%

Table 5 : Comparison in Product Cost

Thus, implementation of above-mentioned energy cost reduction opportunities will result in decrease in 7 percentage in energy cost consequently reducing the product cost by 4 percentage i.e per unit product cost shall reduce from Rs. 3.08 per piece to Rs. 2.94 per piece.

V. CONCLUSION

Thus, Implementation of mentioned energy cost reduction opportunities financially shows very attractive returns i.e. NPV of Rs. 947,649.2 (In words: Nine Lakh Fourty Seven Thousand Six Hundred Fourty Nine Rupees and Two Paisa Only), IRR of 54 percentage and a discounted payback period of 2.6 years. The product cost can be reduced from Rs. 3.08 per piece to Rs. 2.94 per piece.

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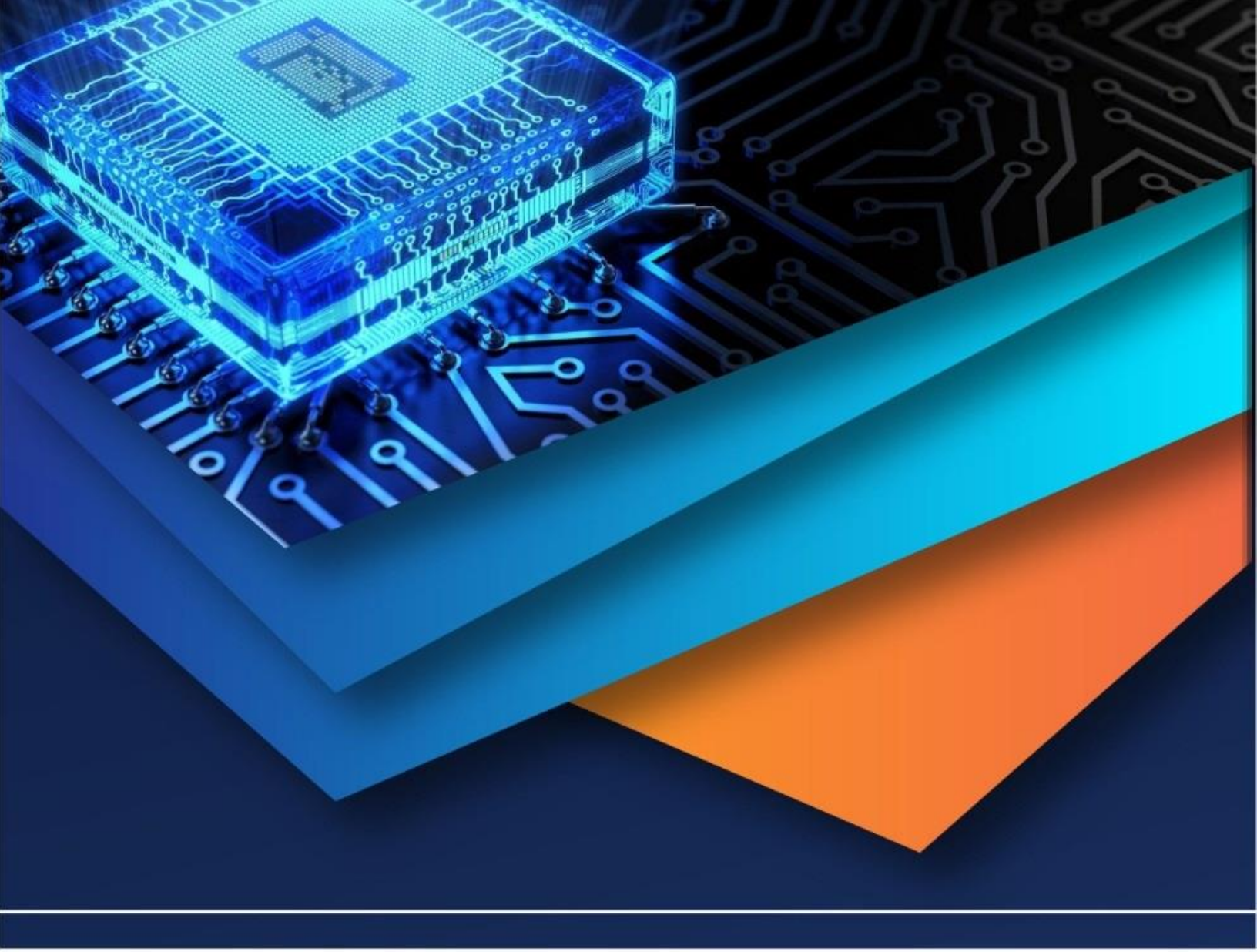

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