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Use of EOQ & BEP in Construction for Material Management

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Abstract: ***In construction industry the problem of exceeding the overall estimated budget often arises and it seems quite challenging to be precise all the time. Its need to overcome such problems for that the proper use of inventory control or material planning is needed which is achieved by inventory management. In any construction project the working capital consist of 60-70% material cost of the total cost of the project. A properly implemented materials management program can achieve the timely flow of materials and equipment to the job site and thus facilitate improved workforce planning, increased labor productivity, better schedules and lower project costs. The main objective of our study is to select the Qualitative analysis technique such as Economic order Quantity (EOQ), Break Even Analysis (BEP) and to maintain sufficient stock of raw material and Control investment in inventories and give pragmatic suggestion for Future work. Thus, the cost effectiveness can be achieved.***
Keywords: BEP, EOQ, Inventory Management, stock, cost effectiveness.

I. INTRODUCTION

Construction is second largest economic activity in India, next only to agriculture. The amount of money invested in and the jobs provided by construction industry are much larger than any other industry in India. Construction plays a critical role in all development sectors like agriculture, irrigation, energy, transportation, communication, manufacturing, housing, civil infrastructure and social services. The scope and volume of the construction industry can be directly linked with size and population of the country. In India, the construction industry employs a very large workforce probably next only to agriculture. Thus, the construction industry is an important industry for economic development.

In Construction Industry the problem of exceeding the estimated budget often arises and it seems quite difficult to be precise all the time. To overcome such problems the use of proper inventory control or material planning is needed which is achieved by inventory management. In any construction project the working capital of the material comprises of 60-70% of the total cost of the project.

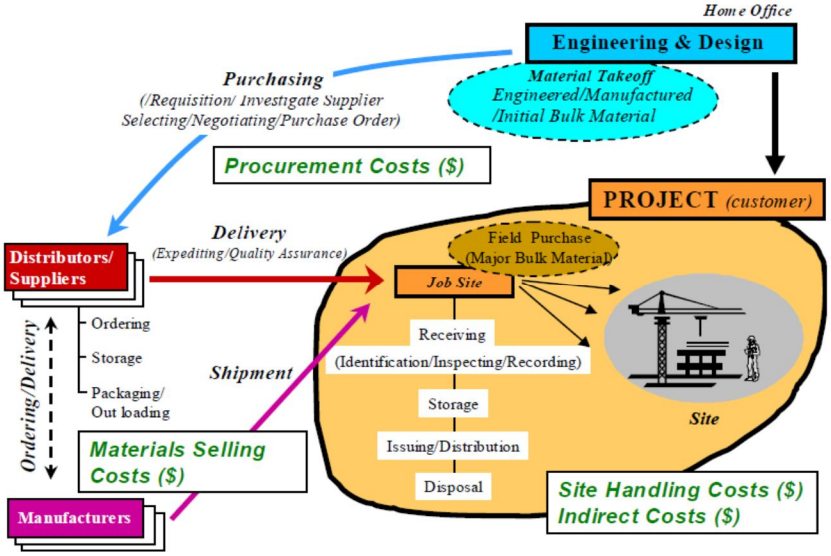

Fig. 1 Typical Material Management in Construction (Source Thabet, 2001)

What is the reason for Inventory? The question which may seem trivial, surprising enough however, is often overlooked. The answer to this question is critical in determining the control system, specifying costs and other factors to be considered.

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The following is a list of reasons n neither necessarily exhaustive nor mutually exclusive, though closely related:

1) Protection against uncertainties in Transit and handling
2) To give customer assurance of availability
3) To hedge against expected surges in sales
4) To await shipment to fill a definite order
5) To handle production variations
6) To make materials in economic lot sizes
7) To hold off increasing capacity.
8) To provide raw material storage

A. Economic Order Quantity

Wherever Economic order quantity (EOQ) is the order quantity of inventory that minimizes the total cost of inventory management. Economic order quantity (EOQ) is the ideal order quantity a company should purchase for its inventory given a set cost of production, demand rate and other variables. This is done to minimize variable inventory costs, and the equation for EOQ takes into account Storage, ordering costs and shortage costs.

$$EOQ = \sqrt{\frac{2 * S * Co}{Cu * i}}$$

Where,

S=Annual Consumption, Co= Cost of Order,

Cu=Unit price, i = Inventory Cost in %

B. Break Even Point

In simple words, the break-even point can be defined as a point where total costs (expenses) and total sales (revenue) are equal.

The origins of break-even point can be found in the economic concepts of "the point of indifference." Calculating the break-even point of a company has proved to be a simple but quantitative tool for the managers. The break-even analysis, in its simplest form, facilitates an insight into the fact about revenue from a product or service incorporates the ability to cover the relevant production cost of that particular product or service or not. Moreover, the break-even point is also helpful to managers as the provided info can be used in making important decisions in business, for example preparing competitive bids, setting prices, and applying for loans.

$$Break\ Even\ Point\ (N) = \left(\frac{\text{Fixed costs}}{\text{Price per unit} - \text{Variable costs}}\right)$$

II. NEED OF STUDY

Importance of materials management in construction can be accessed through the fact that about 60% to 70% of the total project cost goes the materials and its management. Survey shows that average material cost is 64% (50% to 65%) of the sales value and only 36% cost goes towards wages & salaries, overheads and profit etc. Thus, the importance of materials management lies in the fact that any significant contribution made by the materials manager in reducing materials cost will go a long way in improving the profitability and the rate of return on investment.

III. OBJECTIVES

A. To maintain sufficient stock of raw materials.
B. To Control investment in inventories.
C. To study about the ordering levels for the important components of inventory.
D. To achieve the cost effectiveness.
E. To take care of contingencies.
F. To stabilize Production.
G. To keep pace with changing market conditions.
H. Provide data to help decide whether to add or drop a product from the product line.

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IV. METHODOLOGY

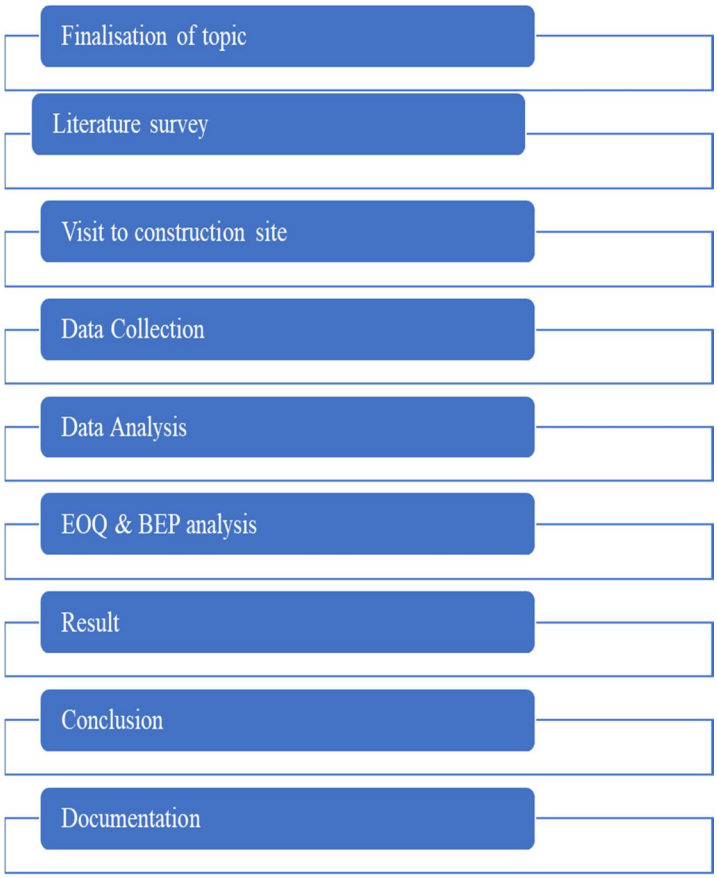

Fig. 2 Methodology Flowchart

V. DATA COLLECTION

Avoid The project research is divided into two groups viz: -

1) Primary Data

a) The data is collected from the firm.

b) The data which is used is of hospital & residential building which is under construction.

c) EOQ and BEP analysis can be performed on this data.

2) Secondary Data

a) The data that is used in this study is of secondary nature. The data is to be collected from secondary sources such as various websites, banks etc.

Below data shows the quantity of material required for bricks, cement, sand, coarse aggregate and steel: -

A. Project 1 (Hospital Building)

Table 1 Material Quantity required for project

Sr. No.	Material	Total Quantity
1	Cement	2349 Bags
2	Sand	221.5431448 Cu.M.
3	Coarse Aggregate	161.1041367 Cu.M.
4	Bricks	30407 No.
5	Steel	18630 Kg

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B. Project 2 (Residential Building)

Table 2 Material Quantity required for project

Sr. No.	Material	Total Quantity
1	Cement	1820 Bags
2	Sand	160 Cu.M.
3	Coarse Aggregate	115 Cu.M.
4	Bricks	98269 No.
5	Steel	12550 Kg

C. Data for BEP Calculation

Break Even point can be calculated for the Brick manufacturing by contractor to minimise the cost of construction. The data is collected as,

Table 3 Data for BEP

Fixed Cost	=	450000
Variable cost per unit	=	3
Selling price per unit	=	6
Required Min. Quantity of Bricks	=	153145

VI. DATA ANALYSIS

From the collected data we analyze it by using MS-Excel to calculate EOQ & BEP by using formulas by combining both projects material Quantity.

A. EOQ Analysis

EOQ Calculation for Cement: -

$$EOQ = \sqrt{\frac{2 * S * Co}{Cu * i}}$$

Where,

S = Annual Consumption=4461

Co= Cost of Order = 2200

Cu= Unit price = 330

I = Inventory Cost in % = 15%

$EOQ = \sqrt{\frac{2*4461*2200}{330*15\%}}$ =629.7089275

No. Of order = $\frac{S}{EOQ} = \frac{4461}{630}$ = 7.080952381 =7 Order in year

Duration of Order = $\frac{360\ Days}{No.of\ Order} = \frac{360}{7}$ = 52 Days

Cost of one Order = (EOQ * Cu) + Co

= (7 * 330) +2200

= 210100 Rs.

Total Ordering Cost = Cost of one order * EOQ

= 210100 * 7

= 1470700 Rs.

Following Table shows the calculation for EOQ of both projects

Table 4 EOQ Calculation table

	Cement	Unit		Sand		Unit	Aggregate	Unit		Bricks	Unit		Steel	Unit
S	4461	Bags	**S**	426	Cu.M	**S**	311	Cu.M	**S**	153145	No.	**S**	34178	Kg
Co	2200	Rs.	**Co**	1850		**Co**	1700		**Co**	2100		**Co**	1900	
Cu	330		**Cu**	1250		**Cu**	1075		**Cu**	6		**Cu**	45	
i	15%		**i**	12%		**i**	10%		**i**	14%		**i**	7%	
EOQ	**396533.3333**		**EOQ**	**10508**		**EOQ**	**9836.27907**		**EOQ**	**765725000**		**EOQ**	**41230603.17**	
	629.7089275			102.5085362			99.17801707			27671.73648			6421.106071	
Roundoff	630			100			100			27700			6450	
No. of Orders	7.080952381			4.26			3.11			5.528700361			5.298914729	
Roundoff	7			4			3			6			5	
Duration of Order	52 Days			90 Days			120 Days			60 Days			73 Days	
Cost of One Order	**210100**			**126850**			**109200**			**168300**			**292150**	
Total Ordering Cost	1470700			507400			327600			1009800			1460750	

1) Material Consumption -Cement

Table 5 Material Consumption of cement

no of order	Duration of order (Days)	Order quantity	cost of order (Rs,)	Consumption
1	52	630	210100	580
2	104	630	210100	680
3	156	630	210100	680
4	208	630	210100	680
5	260	630	210100	680
6	312	630	210100	680
7	364	630	210100	680

2) Graph for Consumption of Cement

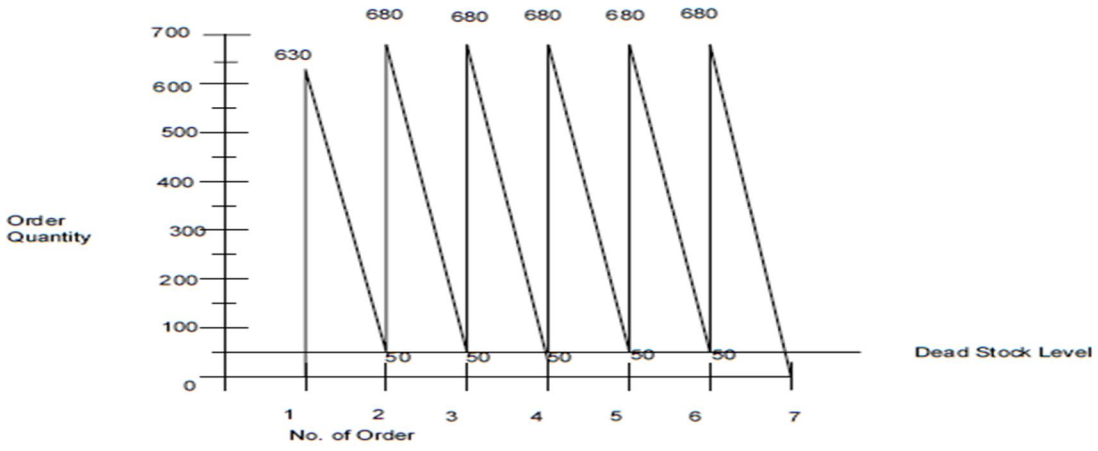

Fig. 3 EOQ graph for cement consumption

From the above EOQ analysis graph for cement it is know that economic order quantity which is 630 Bags & frequency of ordering 52 days and having dead sock of 50 bags which has overcome the problems of Stock out successfully.

B. BEP Analysis

As per given Data,

Fixed Cost = Rs. 450000

Variable Cost per unit = Rs. 3

Selling price per unit = Rs. 6

Required Min. Quantity of Bricks = 153145 No.

Break Even Quantity $= \frac{Fixed\ cost}{Selling\ price\ per\ unit - Variable\ Cost\ per\ unit}$

$= \frac{450000}{6-3}$

= 150000

Break Even Sales = BEQ * Selling price per unit

= 150000 * 6

= 900000

Margin of Safety = Required Quantity – BEQ

= 153145 – 150000

= 3145

Profit = 3145* 6

= 18870 Rs.

As contractor is in profit, he can manufacture the bricks for construction.

Following Table is for Break Even Point Analysis

Table 6 BEP Calculation

	Fixed Cost	Variable Cost	Total cost	Total Revenue
No. of units	Fixed Cost	Variable Cost per unit * No. of units	Fixed cost+ variable cost	Sales price * no. of units
10000	450000	30000	480000	60000
20000	450000	60000	510000	120000
30000	450000	90000	540000	180000
40000	450000	120000	570000	240000
50000	450000	150000	600000	300000
60000	450000	180000	630000	360000
70000	450000	210000	660000	420000
80000	450000	240000	690000	480000
90000	450000	270000	720000	540000
100000	450000	300000	750000	600000
110000	450000	330000	780000	660000
120000	450000	360000	810000	720000
130000	450000	390000	840000	780000
140000	450000	420000	870000	840000
150000	450000	450000	900000	900000
160000	450000	480000	930000	960000
170000	450000	510000	960000	1020000
180000	450000	540000	990000	1080000
190000	450000	570000	1020000	1140000
200000	450000	600000	1050000	1200000

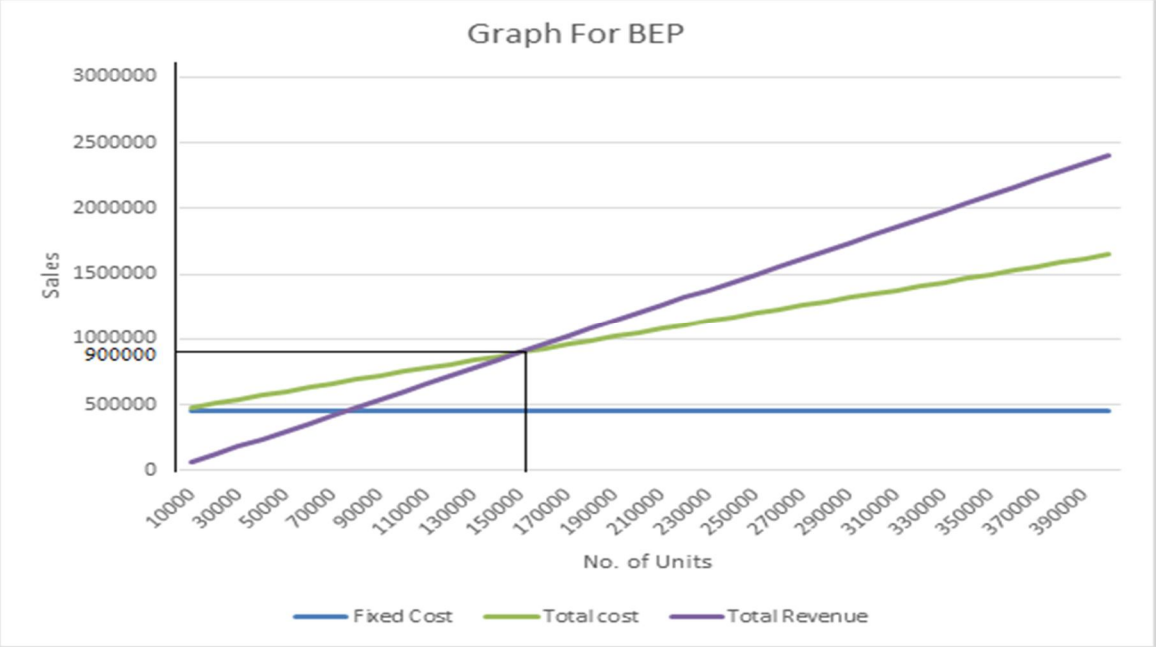

Fig. 4 BEP Graph For Material Production of Bricks

Total cost of bricks by buying from another site = Rs. 10,09,800
Total cost of bricks by manufacturing = Rs. 05,36,007
Profit to the contractor = Rs. 04,73,792
From above BEP calculation, we know that by manufacturing the bricks by contractor instead of buying from vendor, the contractor is in profit. So, he can manufacture the bricks.

II. RESULT

A. In the Quantitative Analysis study mainly focuses on inventory control techniques which includes EOQ Analysis to maintain sufficient stock of raw material during the period of short supply.

TABLE 7 SUMMARY OF EOQ ANALYSIS

Name of material	Annual Requirement	Order Quantity	Number of orders	Order cycle in Days
Cement	4461	630 Bags	7	52
Sand	426	100 Cu.M.	4	90
Coarse Aggregate	311	100 Cu. M.	3	120
Bricks	153145	27700 No.	6	60
Steel	34178	6450 Kg.	5	73

B. Also, from BEP analysis we know that Total Profit for the material Brick is up to 3% to the overall cost of bricks that indirectly minimise the total cost of construction.

VIII. CONCLUSION

After EOQ analysis for materials, it is concluded that economic order quantity & frequency of ordering has overcome the problems of Stock out successfully over the actual Site stock records.
The Total cost of inventory after adoption of EOQ analysis is less than without adopting EOQ.
Also, by knowing the demand of usage of materials, we can determine the reordering level by keeping some amount of safety stock such that there will be continuous supply of material and no delay of work.
By manufacturing bricks and applying break-even point analysis the contractor Save money up to 3% cost.

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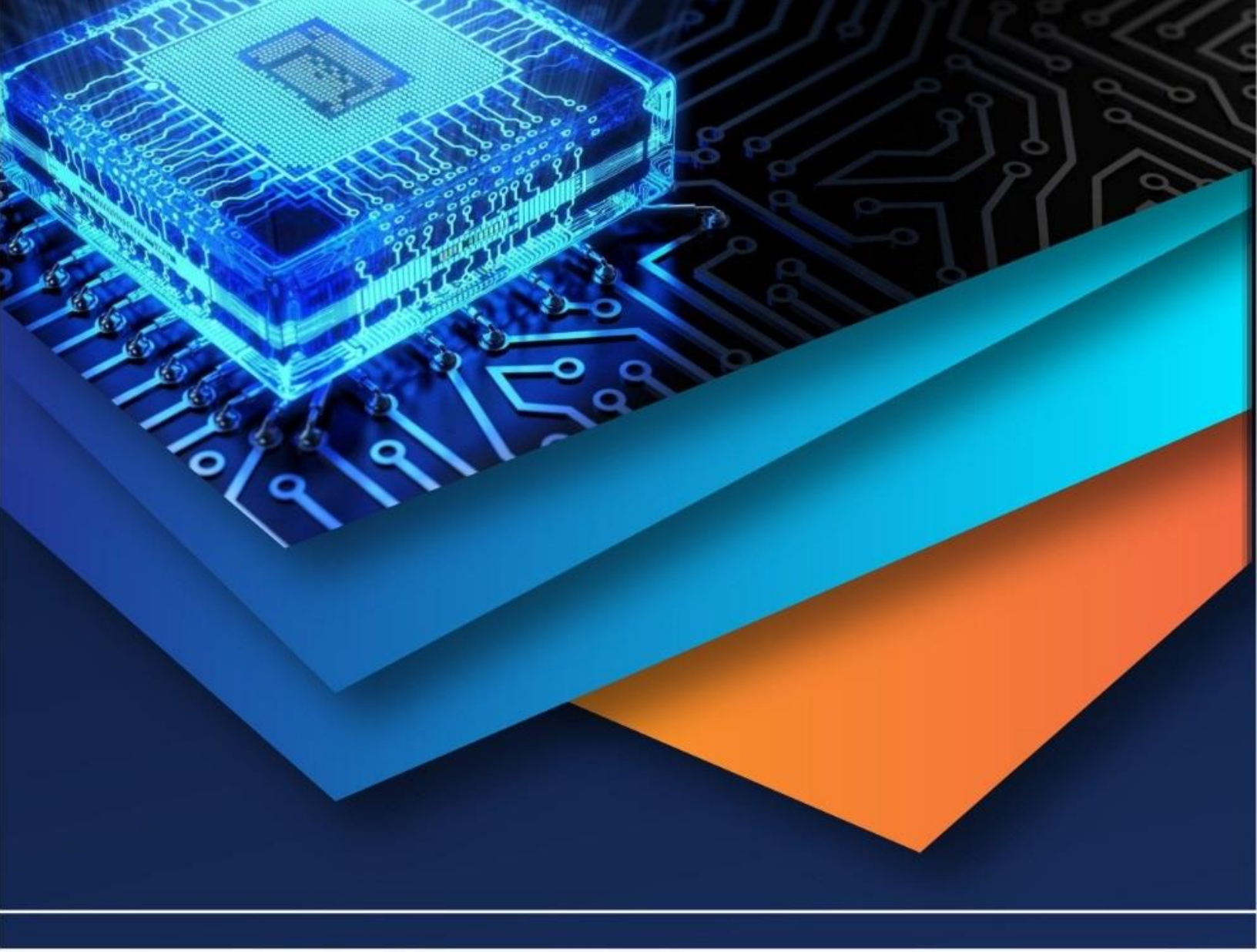

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