Contents

Introduction:

A warehouse is a place used for storing commodities on a large scale. It can either be owned or rented. A small manufacturing company is extending its business and require more storage space. They label five criteria and four alternatives are favoured, shown in Fig.1.

		Alternatives			
		A1 (Centre)	A2 (Suburb)	A3 (Shared)	A4 (Extend)
Criteria	**C1 (Public transport links)**	Good bus and rail links	Good bus links but no rail link	Poor bus links but good rail link	Excellent bus and rail links
	C2 (parking)	Poor	Good	Excellent	Moderate
	C3 (warehouse space)	Poor	Excellent	Good	Good
	C4 (security)	***	****	***	**
	C5 (cost)	£800,000	£600,000	£300,000	£250,000

Fig 1. Comparison table of alternative and criteria

Two methods AHP(Analytical Hierarchy Process) and TOPSIS (Technique for Order Preference by Similarity to Ideal Solutions) of MCDA (multi-criteria decision analysis) are used to identify an optimal solution for the company. The final results of the two methods are obtained and compared to identify the optimal solutions. This report summarises the assumptions and the analysis.

Methodology-AHP:

AHP is a pairwise comparison in a multi-criteria decision-analysis approach that evaluates every pair of alternatives and criteria and determines the better one.

Assumptions:

The prioritisation of the criteria is the foremost step of the process. Table 1 represents the criteria and their priority.

Criteria	Priority
Cost of building and extending	1
Warehouse Space	2
Parking	2
Security	3
Public Transport	4

Table 1. Priority Table

The investment is assumed to be slightly favoured over warehouse layout, parking as the investment is the primary criteria of a company. The preference of cost is moderately over security, more moderately public transport as the tightening of security can be tightened depending on the requirement and most of the deliveries take place by private trucks so, there is not much need of public transport except for a few orders where railways are preferred.

The preference for warehouse Space and Parking is the same as more the space more staff will work, more delivery will happen. The warehouse space is favoured slightly over security and moderately over public transport.

Parking is slightly more important than security and public transport, as more parking space creates more opportunities for faster delivery. The security of the warehouse is preferred slightly over the link to public transportation as security of the warehouse is vital over the link to public transportation. A comparison table(Table.1) is created based on these assumptions.

Weights:

The weights are the importance given to that criteria to the others. The weights are calculated by the pairwise comparison method for each criterion. AHP scale(Fig2) is used to convert the normal comparison to a qualitative comparison.

	C1 (Public Transport)	C2 (Parking)	C3 (Warehouse space)	C4 (Security)	C5 (Cost)
C1 (Public Transport)	1	0.5	0.3333	0.5	0.25
C2 (Parking)	2	1	1	2	0.5
C3 (Warehouse space)	3	1	1	2	0.5
C4 (Security)	2	0.5	0.5	1	0.3333
C5 (Cost)	4	2	2	3	1

Table 1.1 Pairwise comparison chart on criteria

The calculation of Eigenvectors is from the square matrix(same number of rows and columns) and, the table(Table.1) is assumed to be a square matrix. Weights of the criteria(represented in Table 2) are calculated using the Eigenvector method.

Criteria	Weights
C1(Public Transport)	0.081194521
C2(Parking)	0.201052923
C3(Warehouse space)	0.217133719
C4(Security)	0.122842232
C5(Cost)	0.377776606

Table 1.2. weights of the criteria

Conversion:

Scale 1	Scale 2	X (Scale 1 is X times better than scale 2)
Excellent	Good	3
Excellent	Moderate	4 or 5
Excellent	Poor	7
Good	Moderate	3
Good	Poor	5
Moderate	Poor	3

Table 2 Qualitative comparison values from AHP scale(Fig.2)

Based on Table 2, the values of criteria for each alternative have been scaled.

AHP Results:

The result is the summation of the products of weights and the values of each criterion of an alternative. According to the obtained results, the alternative shared (31.36%) is preferred over the others[Fig.3].
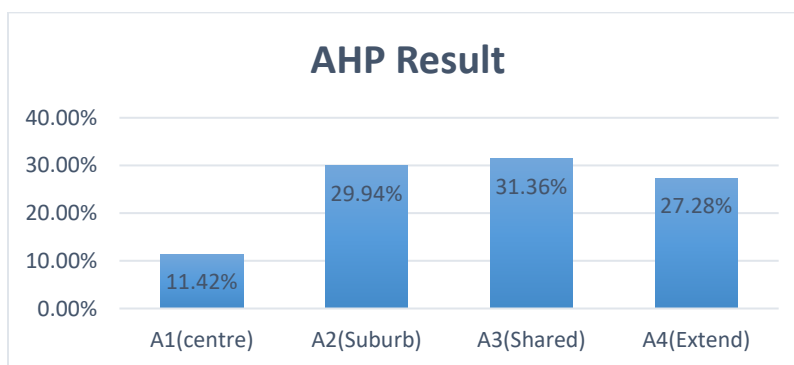

Fig.3 AHP result of each criterion

Methodology- TOPSIS:

The principle behind TOPSIS is that the distance between the optimal alternative and the positive ideal solution (PIS) should be minimum, the distance between the optimal alternative and negative ideal solution (NIS) should be maximum.

TOPSIS-Weights:

Based on the priority[Table. 1] the weights are assigned to each criterion. Table 4.1 represents the weights assigned to each criterion.

	C1(Public Transport)	C2(Parking)	C3(Warehouse space)	C4(Security)	C5(Cost)
Weights	0.1	0.2	0.25	0.15	0.3

Table 4.1 Weights assigned to each criterion.

Values of alternatives:

The conversion of the comparison scale and to a qualitative scale is by using the pairwise scale(Fig.2).

Scale	Value
Excellent	9
Good	7
Moderate	5
Poor	3

Table 4.2 Conversion Table

Table 4.3 depicts the outcome of the qualitative conversion for the TOPSIS analysis.

	C1(Public Transport)	C2(Parking)	C3(Warehouse space)	C4(Security)	C5(Cost)
Weights	0.1	0.2	0.25	0.15	0.3
A1(centre)	7	3	3	7	800,000
A2(Suburb)	3	7	9	9	600,000
A3(Shared)	5	9	7	7	300,000
A4(Extend)	9	5	7	5	250,000

Table 4.3 TOPSIS final table

•   The minimum value of cost is the positive ideal solution and vice versa for the negative ideal solution as the cost of extending or building should be minimum.

•   The maximum value of each criterion (except cost) is the positive ideal solution and vice versa for the negative ideal solution

TOPSIS Result:

Figure 4 depicts that the shared region has the highest score over the other alternatives followed by their current region, suburb and centre.
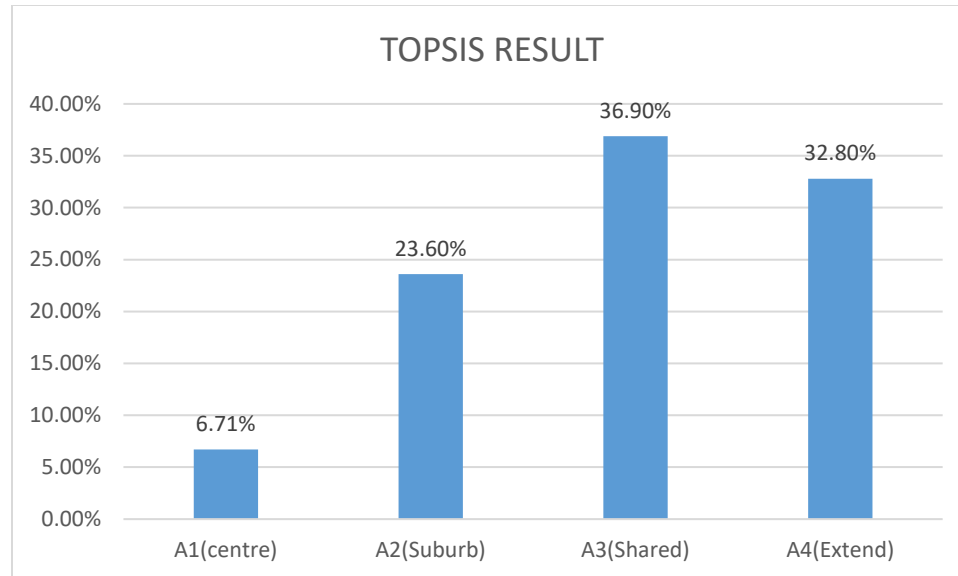
Fig 4. TOPSIS RESULT

CONCLUSION:

The highest priority is the cost of building or extending as our investment should be minimum with the maximum amount of profits. The warehouse space and parking have equal importance as the storage is more, goods will be more, delivery rate will be high so parking should be good. Security can be increased further depending on the requirement. The transfer of goods is by the trucks except for a few long-distance orders where railways are preferred.

RECOMMENDATION:

The results obtained from AHP and TOPSIS recommends the organization or the company to share the warehouse. The investment on shared is twice less than the investment of suburb. The shared warehouse has excellent parking facilities. They have good warehouse space, railway connectivity and security. The only limitation of this region is that they have poor bus links which may affect the mobility of workers. To overcome this limitation the company can provide railcard to the employees for their transportation.

If sharing is not possible, then a second alternative is recommended. The results of the second alternative of AHP (suburb) and TOPSIS (extend their current warehouse) are different. The second alternative recommended is to extend their warehouse as TOPSIS has a mathematically good structure over AHP, the number of alternatives and criteria are less.

Sharing the warehouse is recommended. If not the second-best alternative is to extend their current warehouse.