COST OPTIMIZATION OF RMC PLANT IN LUCKNOW REGION

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Abstract: Ready Mix Concrete is a modern construction material widely used by the construction industry all around the world. RMC is only productive and valuable when it is prepared on time and delivered on time to the consumer. Considering all the factors necessary for efficient work schedule, we have used the multi-criteria decision-making tool Analytic Hierarchy Process for determining the priority customer i.e. the most profitable customer, so that the working of RMC plant will be optimized by making schedule management which will result in higher productivity of plant in every situation of work. In this method, a pairwise comparison is made to find the best combination of sets which has a profitable impact on the RMC plant working process, in every case of factor comparison. Evaluations of factors with best comparisons will give the schedule of a profitable customer within a series of the priority list. By generating the outputs from the Analytic Hierarchy Process method it has been seen that the combinations above from a respected criteria value i.e. consistency ratio will tend the RMC plant in the least profit whereas combinations accepted below criteria value will be profitable, after comparing with all the factors vice versa with importance values from questionnaire survey report.

***Keywords* – Analytic hierarchy process, productivity, multi criteria decision making tool, priority customer etc.**

I. Introduction

Ready-mix concrete is a ready-made material in which cement, aggregate and other materials are weigh batched at a plant in a central mixer before delivery to the construction site, ready for placing by the customer. Being a constructive material it needs, no extra effort after manufacturing from batching plant till it is delivered as well as for quality purpose raw materials are of measured quality and quantity w.r.t norms and weigh respectively, from manufacturing till delivery process concrete is subjected to quality control. Ready-mix concrete is cost-effective because basic raw materials are not stored on site which reduces the need for storage space. Plant and machinery for mixing concrete are not required, and no wastage of basic material is done. Labour associated with the production of concrete and time required for the entire process is efficiently reduced. RMC provides the customer with a good service quality due to the availability of many concrete mixer trucks which enables delivery rebates to be kept under control, the supply of special services for difficult worksite like pumps, conveyor, etc. are done according to the demand of work. Production and delivery of RMC are of high significance in the daily operations of batch plants. Production scheduling and dispatching of transit mixers are generally developed by experts by utilizing their long-term experience. However, there are few effective methods and tools in support of these operations therefore, important factors are considered for the analysis of results.

II. Literature Reviews

As per the past few works related to RMC plant working and problems involved with-it were analyzed, which gave many adequate solutions to plant managers to do their work more efficiently than before. Studies analyzed all the necessary factors which show direct impact on the delivery process and hereby builds a model based on survival technique in a dying situation i.e. Genetic Algorithms, fmGA and (CYCLONE) simulation technique, transportation model, mixed-integer programming model, a multi-objective programming model , a minimax linear programming (LP) model for dispatching rule selection in the presence of multiple criteria for the dispatching operation of RMC trucks to obtain a near-optimal solution of a delivery problem. For process improvement methods used are SPC, vehicle tracking, focuses on energy consumption reduction while optimizing the mixing time, a regression model used for RMC productivity and this model was compared with Artificial Neural Network (ANN), similarly use of chi-square test in evaluating the hypothesis of factors considering time and delay was done. Therefore, from the above study of literature, the focus is given on the evaluation of the combined factors which will make a perfect decision chart of prioritization of customer selection.

III. Research Methodology

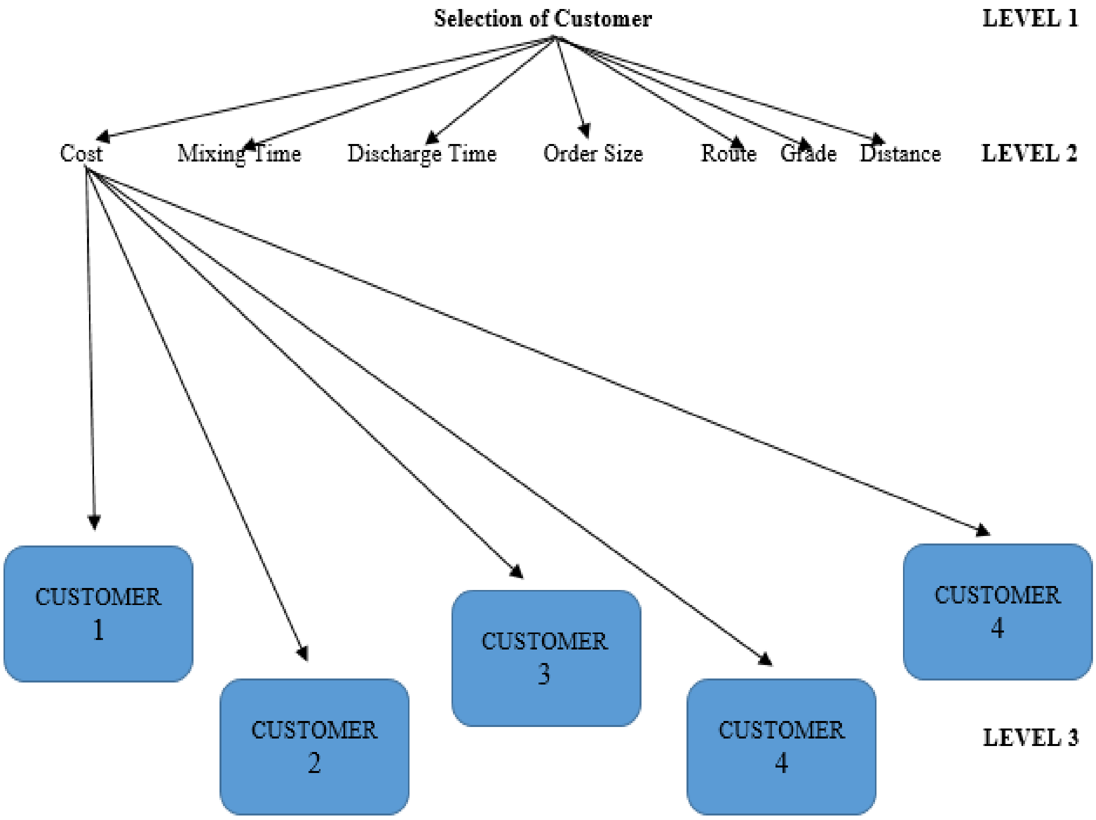
Analytic Hierarchy Process

The Analytic Hierarchy Process is an analyzing tool for dealing with complex problems of decision making and may instruct the decision maker to set priorities and make the best decision at any random situation of work. While reducing complex problems of decisions to a series of pairwise comparisons, and then evaluating the results helps to capture both objective and subjective aspects of a decision made. Similarly, AHP also incorporates a useful technique for checking the consistency of the decision maker's evaluations, thus minimizing the bias in the decision making the process.

A simple decision matrix with no. of criteria's i.e. Cost, Mixing Time, Discharge Time, Order Size, Route, Grade of Concrete and Distance with no. of Alternatives.

NO. OF FACTORS	1	2	3	4	5	6	7
→ CRITERIA	COST	MIXING TIME	DISCHARGE TIME	ORDER SIZE	ROUTE	GRADE	DISTANCE

Step 1) Developing a hierarchical structure with a goal at the top level, the criteria at the second level and the alternatives at the third level.



STEP 2) To create a pair wise comparison matrix for the determination of the relative importance of different criteria with respect to goal.

Pair Wise Comparison Matrix is created with the help of scale of relative importance.

1	= Equal Importance
3	= Moderate Importance
5	= Strong Importance
7	= Very Strong Importance
9	= Extreme Importance
2,4,6,8	= Intermediate Values
1/3, 1/5, 1/7, 1/9	= Values of Inverse Comparison

IV. Data Analysis

The length of pair wise matrix is equivalent to the no. of criteria's used in decision making process.

Here we have 7 x 7 matrix

CRITERIA	COST	MIXING TIME	DISCHARGE TIME	ORDER SIZE	ROUTE	GRADE	DISTANCE
COST							
MIXING TIME							
DISCHARGE TIME							
ORDER SIZE							
ROUTE							
GRADE							
DISTANCE							

Calculation of Consistency Index

λ_{max} = average value of all ratios

C.I = $(\lambda_{max} - n)/(n-1)$
n = number of compared elements

Consistency Ratio = Consistency Index (C.I)/ Random Index (R.I)

Random index is the consistency index of randomly generated pair wise matrix for small work up to 10 factors combination values. Table shown is for up to 10 criteria's.

n	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
RI	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

Consistency ratio CR is equal to 0.10 is a standard value.

If Consistency ratio CR greater than 0.10 = inconsistent
If Consistency ratio CR less than 0.10 = reasonably consistent.

Thereby, continuing with the process of decision making using AHP

Criteria	**Criteria Weighs**	**Weigh %**
Cost	A	A%
Mixing Time	B	B%
Discharge Time	C	C%
Order Size	D	D%
Route	E	E%
Grade of concrete	F	F%
Distance	G	G%
	SUM =A+B+C+D+E+F+G=100	=100%

Factors Taken for the evaluation of consistency are:

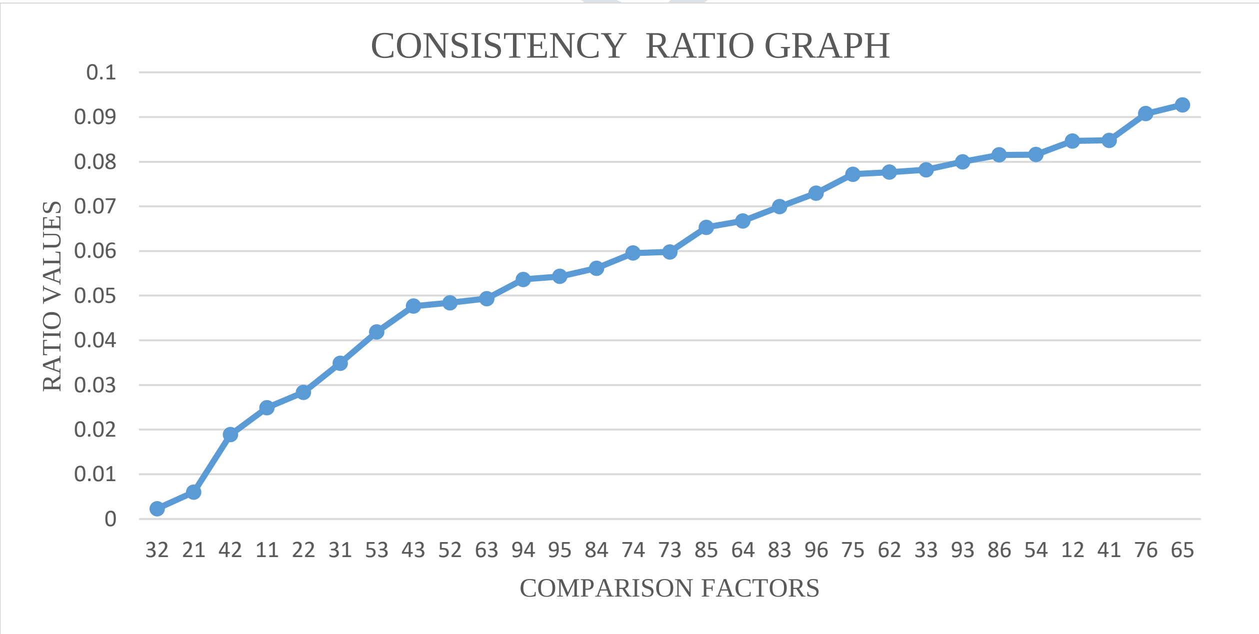
1. Cost
2. Mixing Time
3. Discharge Time
4. Order Size
5. Route
6. Grade Of Concrete
7. Distance

Values are taken in the range from 1 to 9 in a row and column w.r.t row and column to know the consistency value of each combination which will tell us those combinations which are best suited in the selection of customer and will help us in making a chart of priority customer to the least profitable customer. Comparison factors are coded in such a form that comparison will be done accordingly. For example, 32 means values of row i.e. (numerator) value will start from 3 to 9 and column i.e. (denominator) will remain 2 throughout the matrix evaluation.

From the above evaluations we have list of acceptable and rejected comparisons, which are as follows:

List of Acceptable Comparisons

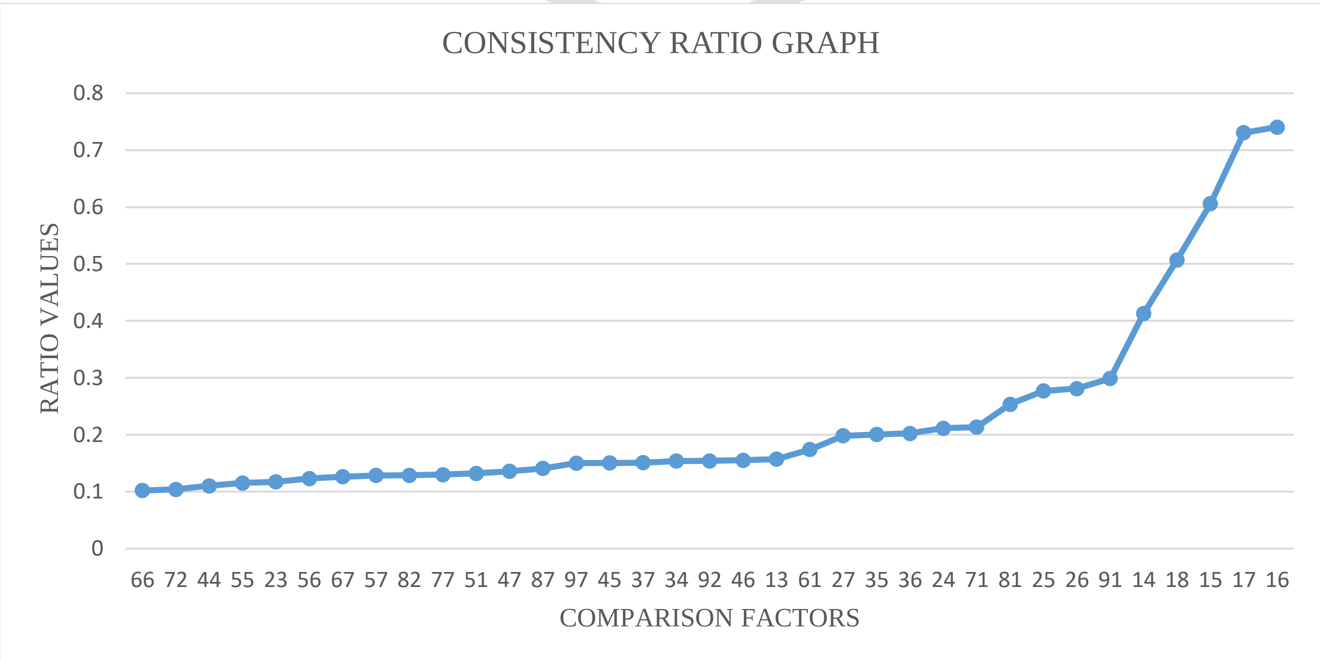
S No.	Comparison Factors	Consistency Index A	Random Index No. For (N=7) B	Consistency Index Ratio A/B
1	32	0.003	1.32	0.002272727
2	21	0.0079	1.32	0.005984848
9	42	0.0249	1.32	0.018863636
10	11	0.0329	1.32	0.024924242
16	22	0.0374	1.32	0.028333333
17	31	0.046	1.32	0.034848485
18	53	0.0553	1.32	0.041893939
23	43	0.0629	1.32	0.047651515
24	52	0.0639	1.32	0.048409091
25	63	0.0651	1.32	0.049318182
31	94	0.0708	1.32	0.053636364
32	95	0.0717	1.32	0.054318182
33	84	0.0741	1.32	0.056136364
38	74	0.0786	1.32	0.059545455
39	73	0.0789	1.32	0.059772727
40	85	0.0862	1.32	0.06530303
46	64	0.0881	1.32	0.066742424
47	83	0.0923	1.32	0.069924242
48	96	0.0963	1.32	0.072954545
49	75	0.1019	1.32	0.07719697
53	62	0.1025	1.32	0.077651515
54	33	0.1032	1.32	0.078181818
55	93	0.1056	1.32	0.08
56	86	0.1076	1.32	0.081515152
60	54	0.1077	1.32	0.081590909
61	12	0.1117	1.32	0.084621212
62	41	0.1119	1.32	0.084772727
41	76	0.1198	1.32	0.090757576
63	65	0.1224	1.32	0.092727273



Accepted Comparisons Graph

List of Rejected Comparisons

S No.	Comparison Factors	Consistency Index A	Random Index No. For (N=7) B	Consistency Index Ratio A/B
4	66	0.1346	1.32	0.101969697
5	72	0.1373	1.32	0.104015152
6	44	0.1456	1.32	0.11030303
7	55	0.1523	1.32	0.115378788
8	23	0.1547	1.32	0.11719697
11	56	0.1626	1.32	0.123181818
12	67	0.1665	1.32	0.126136364
13	57	0.1698	1.32	0.128636364
14	82	0.1699	1.32	0.128712121
15	77	0.1713	1.32	0.129772727
19	51	0.1744	1.32	0.132121212
20	47	0.1794	1.32	0.135909091
21	87	0.1858	1.32	0.140757576
22	97	0.1981	1.32	0.150075758
26	45	0.1986	1.32	0.150454545
27	37	0.1993	1.32	0.150984848
28	34	0.2031	1.32	0.153863636
29	92	0.2035	1.32	0.154166667
30	46	0.2048	1.32	0.155151515
34	13	0.2074	1.32	0.157121212
35	61	0.2299	1.32	0.174166667
36	27	0.2615	1.32	0.198106061
37	35	0.2646	1.32	0.200454545
41	36	0.2673	1.32	0.2025
42	24	0.2791	1.32	0.211439394
43	71	0.2817	1.32	0.213409091
44	81	0.3346	1.32	0.253484848
45	25	0.3657	1.32	0.277045455
50	26	0.3712	1.32	0.281212121
51	91	0.3944	1.32	0.298787879
52	14	0.5453	1.32	0.413106061
57	18	0.6691	1.32	0.506893939
58	15	0.7998	1.32	0.605909091
59	17	0.9644	1.32	0.730606061
64	16	0.9744	1.32	0.738209842



Rejected Comparisons Graph

V. Results

After evaluation of the factors by comparison with other factors we have 64 comparisons in which only 29 comparisons are reasonably consistent which have a sum of criteria weight of 100%, though they are acceptable comparisons rest 35 comparisons are reasonably inconsistent hence they are rejected. Results reveal that every factor has its importance in a limited frame of lowest to highest value i.e. from the table we have got most accepted surveyed data analysis of numeric importance given to the factors which are practically accepted.

Table – Criteria value range

Criteria	Lowest value	Highest value
Cost	3	9
Mixing time	1	3
Discharge time	2	3
Order size	4	7
Route	2	5
Grade of concrete	3	7
Distance	3	7

All the comparisons between above lowest to highest value of importance are made from the above table. The combinations of comparisons which have consistency ratio less than 0.10 i.e. the standard value are accepted. Sorting of the comparison's from lowest consistency ratio to higher one is made to know the most profitable customer to the least profitable one respectively. The valuable factors are:

1. Cost
2. Order size
3. Grade of concrete
4. Distance.

VI. Conclusion

The research work analyzed by considering all the factors necessary for the efficient working condition of RMC plant gives the related output that all the factors, when analyzed by the AHP method, give the output considering the best combination of value to give profitable output in every case of customer selection. From the results it has been concluded that the valuable factors should be kept in mind on priority before selecting your customer which are as follows:

- **Cost.**
- **Order size.**
- **Grade of concrete**
- **Distance**

Hence focus should be given on these factors first in selecting the customers' priority chart for giving them service to enhance the productivity of the plant. From the above-surveyed data, all the comparisons made by them having a value within consistency ratio standard value will be adopted for knowing the most profitable customer. In every situation, if we know our profitable customer w.r.t others we can generate maximum revenue per unit time w.r.t work done while serving our customers. In this way, the cost optimization of RMC plant can be achieved effectively and efficiently.

VII. Recommendations

Several other factors can also be included to form a big matrix for evaluation of best results. From the questionnaire survey from the experts of RMC plant, we let to know more factors which can be included for evaluation of more precise results. They are as follows:

- Cycle time
- Maintenance cost.
- Risk.
- Driver performance.

- Mixer pan used.
- Miscellaneous- truck efficiency, driver's performance etc.

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