Simulation Optimization for Model and Prototype using Non-parametric Method: a case study of Anambra/Imo River Basin Engineering Development Scheme

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Abstract: Non – Parametric experiments in this work is aimed at modeling an alternative method of testing null hypothesis for Anambra/Imo River Basin (prototype) and the contingency, reliability theory (model). The work assesses the relationship between the experimental and theoretically expected results and tests the null hypothesis, as follows: (a) If no maintenance is applied by the decision maker next year's productivity depends on this year's condition of the basin. (b) If maintenance is applied by the decision maker, next year's productivity depends on this year's condition of the basin. (c) If the cost function depends on the strategy (courses of action) of the decision maker in terms of loss during a-1- year period. (d) If the return function depends on the course of action of the decision maker in terms of gain during a 1-year period. (e) If simulation optimization depends on the minimization of expected cost .(f) If simulation optimization depends on the maximization of the expected revenue. The methodology involves contingency, reliability test and alterative interactive model of Pearson product moment correlation. Data were collected for the model and prototype from the Ministries, Parastatals and Anambra –Imo River Basin Development Authority Owerri. The problem of providing more information about a phenomenon or interactions in the analysis of variance was solved. The study shows that there is a significant difference between the actual experimentation of the Anambra – Imo River Basin schemes and expected theoretical result for both maintenance and without maintenance of the scheme, which led to the rejection of (H_0) . To further test the hypothesis The researcher analyzed the data with other powerful parametric tests such as Pearson's product moment correlation and scatter diagrams which coincided with r = 1.00 as height of perfection of performance of the basin when compared with the theory.

Keywords: Cost- minimization, optimization- performance, revenue- maximization.

1 INTRODUCTION

Contingency, reliability interaction was simulated based on the following background.
The chi-square test is a measure of relationship, association or independence, introduced by Pearson according to Eme (2012). The chi-square test is probably the best known and the most important of all non parametric method. It involves a measure of reliability by comparing observed frequency distribution failure mode with theoretical expected distribution failure mode when the hypothesis is false. In this case it is to say that it compares the performance between the Prototype and Model in their expected results. It is a non-parametric interactions which is fairly robust with respect to violations of assumption having more power efficiency (the power of an interaction relative to the sample size which permits one to compare the power of two different statistical tests. The power of a statistical test is the probability that the test will correctly reject a null hypothesis when that hypothesis is false). There were five basic conditions that necessitated the valid application of chi-square analysis in the Anambra – Imo River Basin and the theoretical expected results. These are: the sample observations are independent of each other, sample data are drawn at random from the population, sample data are expressed in original units, the

sample contains sixty-four observations with eight experiments in each cell and not more than 20% of the expected frequency is less than 5.

The problem starts from the violation of one or more parametric assumption in the River Basin development such as the dynamics of a true life situation, in adequate parameters, uncertainties etc and therefore Non-parametric test makes no assumption about the shape of the distribution or population data .The data represent an ordinal or nominal scale because the parametric assumption has been greatly violated and the nature of the distribution is unknown. There is problem of providing more information about a phenomenon or interactions in the analysis of variance Osuala (2007).

2 METHODS

Methodology involves methods and experiments in contingency, reliability model with sixty-four observations Eme (2012). Data were collected from the ministries, parastatals and Anambra – Imo River Basin Authority Owerri. Analysis of the data were done with more powerful parametric test such as the Pearson product moment correlation and scatter diagrams for a positive perfect fit of the data within the least of squares equation Akuezeilo (1993).

3 RESULTS AND DISCUSSION

Experiments (1), the model without maintenance shows that the chi- square (X^2)value of 10.512777 is interpreted from the probability value at 0.10 level of significance. The degree of freedom necessary to intercept X^2 values are determined from the frequency table by the number of rows minus one, times the number of columns minus one (r –I) (c- I) ie (8 – 1) (8 – 1) = 49. Since the obtained x^2 value of 10.512777 is less than the critical value of 63.1671, and falls in the acceptance region, therefore the null hypothesis is accepted. There is no significant difference between the experimental and theoretically expected result, which led to the acceptance of null hypothesis and proof of independent, characteristics of the two data. The Chi-square was not based on a fictitious data, in the case of the manager's problem when maintenance is not applied. In the test of how well the linear estimator, y = a + bx fits the raw data, the correlation coefficient, c = 0.8 results in a perfect fit for the raw data.

Experiments (2), the model with maintenance shows that the chi-square (X^2) value of 5.699 is interpreted from the probability value at 0.10 level of significance. The degree of freedom necessary to intercept X^2 values are determined from the frequency table by the number of rows minus one, times the number of columns minus one (r – 1) (C – 1) i.e. (8 – 1) (8 - 1) = 49. Since the obtained x^2 value of 5.699 is less than the critical value of 63.1671 and falls in the acceptance region therefore the null hypothesis is accepted. There is no significant difference between the experimental and theoretically expected result, which led to the acceptance of null hypothesis, therefore a proof of independent, characteristics of data. The chi-square was not based on a fictitious data, in the case of the manager's problem when maintenance is applied. In the test of how well the linear estimator, y = a + bx fits the raw data, the correlation coefficient, C = 0.63 results in a better fit for the raw data.

Experiments (3), the prototype without maintenance shows that the chi-square (X^2) value of 23.96 is interpreted from the probability value at 0.10 level of significance. The degree of freedom necessary to intercept X^2 values are always determined from the frequency table by the number of rows minus one, times the number of columns minus one (r – 1) (C – 1) ie (8 – 1) (8 - 1) = 49. The obtained value of X^2 = 23.96 is less than the critical value of 63.1671, and falls in the acceptance region. Thus null hypothesis (H_0) is accepted. The study shows that there is a slight significant difference between the actual (observed) experiment and theoretically expected results, which led to the acceptance of (H_0).Therefore, the result expected of the prototype is slightly the same with the model. This is due to 37% level of uncertainty in the performance of the Basin (prototype) when compared to the model. The fisher-test was further used to test the adequacy of each of the prototype and the model's data. Thus, by the use of regression equation and Pearson product moment correlation coefficient Pearson (r), the researcher determined whether the sample variances between (0) and (E) for the two sets of data are respectively significantly different .To further test the hypothesis, If the population correlation coefficient is in fact, 0.00, a critical value of r = 0.235 is found smaller than the obtained value of r = 1.00. Therefore, (H_0) is hereby rejected.

This confirms that the performance of the actual system (Basin) is really higher than the model (theory) with high component interaction The scatter chart/diagram of the regression equation shows a positive perfect fit of the data within the least of squares. In conclusion there is a relationship between the cost function and developments which depends on the action of the managing engineer when no maintenance is applied. Therefore simulation optimization is dependent on the minimization of expected cost.

In this case, next year's productivity depends on this year's state of the Basin , when the managing engineer did not apply maintenance.

Experiment (4), the prototype of with maintenance shows that the chi-square (X^2) value of 10.90 is interpreted from the probability value at 0.10 level of significance. The degree of freedom necessary to intercept X^2 values are always determined from the frequency table by the number of rows minus one, times the number of columns minus one (r – 1) (C – 1) ie (8 – 1) (8 - 1) = 49.The obtained value of x^2 = 10.90 is less than the critical value of 63.1671, and falls in the acceptance region. Thus null hypothesis (H_0) is accepted. The study shows that there is a slight significant difference between the actual (observed) experiment and expected theoretical results, which led to the acceptance of (H_0). Therefore, the result expected of the prototype is slightly the same with the model. This is due to 30% level of uncertainty in the performance of the Basin (prototype) when compared to the model. The fisher-test was further used to test the adequacy of the prototype and the model data. Thus, by the use of regression equation and Pearson product moment correlation coefficient (r), the researcher determined whether the sample variances between (0) and (E) for the two sets of data are respectively significantly different. Table 1, figures 1 and 2are the computer solutions. To further test the hypothesis, If the population correlation coefficient is in fact, 0.00, a critical value of r = 0.235 is found smaller than the obtained value of r =1.00. Therefore, (H_0) is hereby rejected. This confirms that the performance of the actual system (Basin) is really higher than the model (theory) with high component interaction.

The scatter chart/diagram of the regression equation shows a positive perfect fit of the data within the least of squares. In conclusion there is a relationship between the revenue function and developments which depends on the action of the managing engineer or decision maker when maintenance is applied. Therefore simulation optimization is dependent on the maximization of expected revenue. In this case, next year's productivity depends on this year's state of the Anambra/ Imo River Basin, when the decision maker applies maintenance.

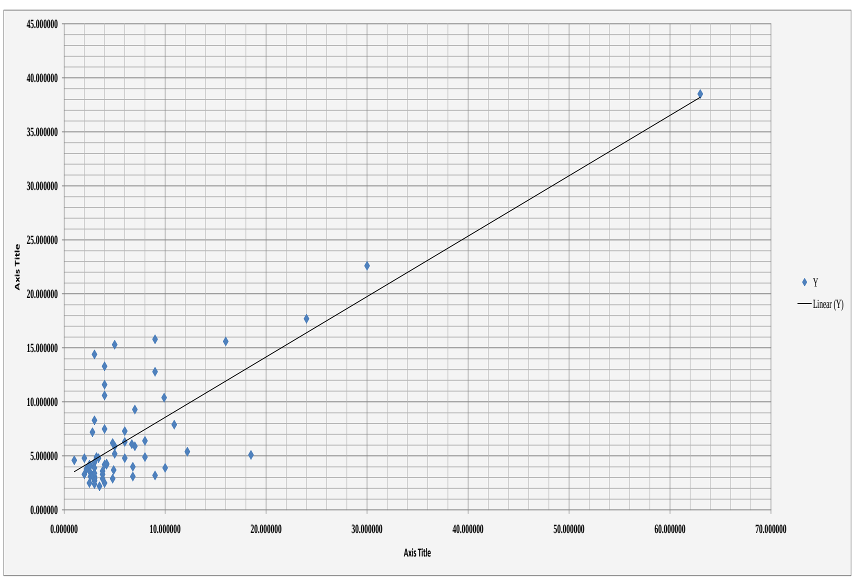
Table 1 Computer Solution (Pearson's Product Moment Correlation Coefficient, r)

0.170000	0.410000	-2.212969	-1.977656	4.376491	4.897231	3.911124
0.990000	0.680000	-1.392969	-1.707656	2.378712	1.940362	2.916090
1.580000	1.500000	-0.802969	-0.887656	0.712760	0.644759	0.787934
0.890000	0.650000	-1.492969	-1.737656	2.594266	2.228956	3.019449
0.850000	0.610000	-1.532969	-1.777656	2.725091	2.349993	3.160062
1.080000	1.280000	-1.302969	-1.107656	1.443241	1.697728	1.226902
1.000000	1.220000	-1.382969	-1.167656	1.614832	1.912603	1.363421
1.040000	1.250000	-1.342969	-1.137656	1.527837	1.803565	1.294262
1.320000	0.480000	-1.062969	-1.907656	2.027779	1.129903	3.639152
0.940000	0.800000	-1.442969	-1.587656	2.290938	2.082159	2.520652
1.620000	1.770000	-0.762969	-0.617656	0.471252	0.582121	0.381499

0.930000	0.760000	-1.452969	-1.627656	2.364934	2.111118	2.649265
0.870000	0.720000	-1.512969	-1.667656	2.523112	2.289074	2.781077
1.130000	1.500000	-1.252969	-0.887656	1.112206	1.569931	0.787934
1.050000	1.430000	-1.332969	-0.957656	1.276526	1.776806	0.917105
1.090000	1.480000	-1.292969	-0.907656	1.173571	1.671768	0.823840
0.600000	0.860000	-1.782969	-1.527656	2.723763	3.178978	2.333734
2.590000	1.420000	0.207031	-0.967656	-0.200335	0.042862	0.936359
3.230000	3.120000	0.847031	0.732344	0.620318	0.717462	0.536327
2.410000	1.350000	0.027031	-1.037656	-0.028049	0.000731	1.076730
2.300000	1.280000	-0.082969	-1.107656	0.091901	0.006884	1.226902
1.620000	2.660000	-0.762969	0.272344	-0.207790	0.582121	0.074171
1.500000	2.530000	-0.882969	0.142344	-0.125685	0.779634	0.020262
1.580000	2.610000	-0.802969	0.222344	-0.178535	0.644759	0.049437
0.960000	0.710000	-1.422969	-1.677656	2.387252	2.024840	2.814530
0.360000	1.180000	-2.022969	-1.207656	2.443051	4.092403	1.458434
2.500000	2.580000	0.117031	0.192344	0.022510	0.013696	0.036996
0.390000	1.110000	-1.992969	-1.277656	2.546329	3.971924	1.632405
0.410000	1.060000	-1.972969	-1.327656	2.619424	3.892606	1.762671
2.860000	2.200000	0.477031	-0.187656	-0.089518	0.227559	0.035215
2.790000	2.090000	0.407031	-0.297656	-0.121155	0.165674	0.088599
2.810000	2.160000	0.427031	-0.227656	-0.097216	0.182356	0.051827
0.920000	0.840000	-1.462969	-1.547656	2.264173	2.140278	2.395240
0.940000	1.400000	-1.442969	-0.987656	1.425157	2.082159	0.975465
3.230000	3.080000	0.847031	0.692344	0.586437	0.717462	0.479340
0.910000	1.320000	-1.472969	-1.067656	1.572624	2.169637	1.139890
0.830000	1.260000	-1.552969	-1.127656	1.751215	2.411712	1.271609
2.970000	2.620000	0.587031	0.232344	0.136393	0.344606	0.053984
2.860000	2.490000	0.477031	0.102344	0.048821	0.227559	0.010474
2.930000	2.570000	0.547031	0.182344	0.099748	0.299243	0.033249
0.640000	1.140000	-1.742969	-1.247656	2.174626	3.037940	1.556646
2.390000	1.890000	0.007031	-0.497656	-0.003499	0.000049	0.247662
3.950000	4.150000	1.567031	1.762344	2.761648	2.455587	3.105855
2.200000	1.790000	-0.182969	-0.597656	0.109352	0.033478	0.357193
2.040000	1.700000	-0.342969	-0.687656	0.235845	0.117628	0.472871
3.310000	3.530000	0.927031	1.142344	1.058988	0.859387	1.304949
3.210000	3.360000	0.827031	0.972344	0.804159	0.683981	0.945452
3.270000	3.470000	0.887031	1.082344	0.960073	0.786824	1.171468
0.820000	0.890000	-1.562969	-1.497656	2.340790	2.442871	2.242974
0.940000	1.480000	-1.442969	-0.907656	1.309720	2.082159	0.823840

3.240000	3.240000	0.857031	0.852344	0.730485	0.734503	0.726490
0.840000	1.400000	-1.542969	-0.987656	1.523923	2.380753	0.975465
0.800000	1.330000	-1.582969	-1.057656	1.674237	2.505790	1.118637
3.320000	2.760000	0.937031	0.372344	0.348898	0.878028	0.138640
3.200000	2.630000	0.817031	0.242344	0.198002	0.667540	0.058730
3.280000	2.710000	0.897031	0.322344	0.289152	0.804665	0.103905
0.520000	0.620000	-1.862969	-1.767656	3.293088	3.470653	3.124609
0.740000	1.040000	-1.642969	-1.347656	2.214157	2.699346	1.816177
2.360000	2.280000	-0.022969	-0.107656	0.002473	0.000528	0.011590
0.780000	0.980000	-1.602969	-1.407656	2.256429	2.569509	1.981496
0.780000	0.930000	-1.602969	-1.457656	2.336577	2.569509	2.124762
2.200000	1.940000	-0.182969	-0.447656	0.081907	0.033478	0.200396
2.000000	1.850000	-0.382969	-0.537656	0.205906	0.146665	0.289074
2.160000	1.900000	-0.222969	-0.487656	0.108732	0.049715	0.237809
110.040000	110.050000	107.657031	107.662344	11590.608306	11590.036378	11591.180262
1.719375	1.719531	-0.663594	-0.668125	0.443364	0.440357	0.446391
	R =	1.000000				

Fig 1 Scatter diagram contingency with maintenance



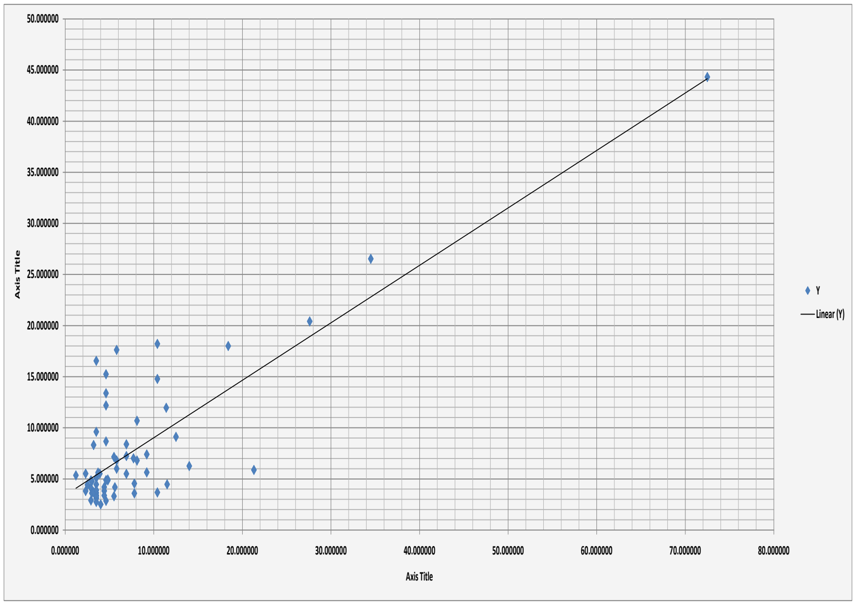


Fig 2 Scatter diagram contingency without maintenance

4 CONCLUSION

The study shows that there is a significant difference between the actual experiment of the Anambra – Imo River Basin schemes and expected theoretical results for both maintenance and without maintenance of the scheme, which led to the rejection of (H_0) . To further test the hypothesis, if the population correlation coefficient is in fact zero, the critical values were found smaller than the obtained values. Therefore (H_0) was again rejected. This confirms that the performance of the River Basins were really higher than the model with high component interaction. The scatter diagram and the regression equation show a positive perfect fit of the data within the least of squares.

There is a relationship between the cost function and developments which depends on the action of the managing engineer when no maintenance is applied. Therefore simulation optimization is dependent on the minimization of expected cost. In this case next year's productivity depends on this year's state of the system when the managing engineer did not apply maintenance.

Also there is a relationship between the benefit function and developments which depends on the action of the decision maker when maintenance is applied. Therefore simulation optimization is dependent on the maximization of expected revenue. In this case, next year's productivity depends on this year's state of the system, when the decision maker applies maintenance. The researcher analyzed the data with other parametric tests such as Pearson's product moment correlation with computer solutions which coincided with r = 1.00 as 100% (percent) level of performance of the basin when compared with the theory.

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at Anambra State University accorded him an International Award from Glen Daigger, President of the International Water Association London in the form of Books/Journals which he donated to the Library of Anambra State University. He received the honor for emerging first at a poster presentation held to mark the Association's 2012 World Water Congress and Exhibition, during the competition held from September 16 to 21, at Bussan, Korea, a total of 387 poster presenters participated. Out of this number, five were short listed for the finals where Dr. Eme's presentation was chosen as the best in the World. He had several other publications.