Candidate Recommendations for Voting System Using Modified AHP

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***Abstract*— Voting is an activity organized within a country on which the population is obliged to exercise the right to vote and to be elected. Voting is generally done in the traditional way, how the inhabitants go directly to the voting booths, but there are also some countries and local governments that have polled electronically using information technology or called e-voting. The voting has become an important part of the democratic system. Poll result data can show effectively in predicting election results. AHP is one of the techniques used to support decision making. In this paper we used AHP algorithm modification with Double-track - Most Significant Operation First (DT-MSOF) concept to help determine voter candidate recommendation during polling. AHP algorithm modification is performed in order to reduce the number of operations that need to be done, where based on the results of experiments the use of the concept of DT-MSOF on AHP can reduce the number of operations that need to be done to get the results (decisions) similar to that obtained by conventional AHP. In this paper we have applied AHP algorithm modification on candidate selection polls compared with AHP algorithm, where the result of poll recommendation for candidate selection shows the same result and has succeeded to reduce the number of operation.**

***Keywords*— voting, candidate recommendations, DT-MSOF, Modified Analytic Hierarchy Process, reduction operation**

I. INTRODUCTION

Voting is an activity organized within a country on which the population is obliged to exercise the right to vote and to be elected. Voting is generally done in the traditional way, how the inhabitants go directly to the voting booths, but there are also some countries and local governments that have polled electronically using information technology or called e-voting. The ballot has become an important part of the democratic system, both to determine policy choices, to choose a representative who will sit in a representative assembly, or to elect a leader.

Comprehensive research around the world finds that a polling system-based model that can predict election results of up to 90 percent. The study centered on direct elections by voters. In this study, researchers focused on systems that allowed voters to directly elect candidate leaders. The study concludes that polling is the most effective tool for predicting election results [1]. This study shows how effective the use of polled data is to predict election results. This applies not only to the US, but also to the whole country. This study was tested by a number of researchers by predicting the results of the elections in Latin America in 2013 and 2014, two weeks before the election took place. As a result, 10 of their 11 predictions are correct, which means 90.9 percent of the predictions are accurate. The second test was successfully performed in mid-2013. The test successfully predicted the results of various elections around the world that were shown directly with an accuracy of 80.5 percent. The model made based on this study is composed of a combined data set of more than 500 elections in 86 countries with data from 146 elections [1].

When voters do Polling, voters need candidate recommendations that match the criteria of candidates that the electorate wants. In order to determine the candidate's recommendation for voters in conducting Polling, the Analytical Hierarchy Process (AHP) method may be used. AHP compiled by Thomas when he can solve complex problems where aspects or criteria are taken quite a lot. Also this complexity is caused by unclear problem structures, uncertainty of decision-making perceptions and the uncertainty of the availability of accurate or even nonexistent

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statistical data. Sometimes the problems arising from the perceived and observed decision need to be taken immediately, but the variation is so complicated that the data can't be recorded numerically. The three main principles used in decision making use AHP: decomposition, comparative appraisal, and priority value synthesis [2].

In the study [3] it has been proposed a new approach to reduce the computational time of a decision-making process. The approach uses the intermediate-answer concept, the sequencing of execution by its Significant Level (Most Significant Operation-First), in which the operation is performed according to the level of its contribution to the final result. The execution of the operation will be carried out in sequence starting from the most significant. When MSOFs are combined with intermediate-answer concepts, some operations done at the end will have an impact of less end-to-end accuracy than other operations done at the beginning. To shorten computing time, these non-significant impact operations do not work. For limitations of execution using the concept of arithmetic interval (Double-Track Computation), whereas in addition to calculating the operating results of the original function on each phase, also carried out the calculation of the lower limit value and upper limit value (this is called Double-Track Computation). The lower limit and upper limit values are used to determine whether execution needs to be continued to the next operation or the execution result has been considered sufficient to meet the needs of its users. The simulations have shown that the DT-MSOF concept can reduce the number of operations that need to be executed to achieve a conclusive condition.

In this paper, AHP algorithm modification is used with the concept of Double-track - Most Significant Operation First (DT-MSOF) to help determining voter selection recommendations for voters during polling, so it is expected that the number of operations needed to get the correct decision will be reduced.

In the second part of this paper we explain about AHP Method. In the third part of this paper we explain how to do operational reduction of AHP algorithm. The fourth section contains the application of AHP algorithm modifications to the poll to determine the election of candidates in the ballot. The final section deals with the presentation of the simulation results, the study and the conclusions.

II. AHP Conventional Method

The steps in the AHP method for making decisions based on priority are [4]:

1. Define the problem and determine the desired solution.
2. Create a hierarchical structure that begins with a general purpose, followed by sub-goals, criteria and possible alternatives at the bottom of the criteria
3. Create a pair-wise comparison matrix that describes the relative contribution or influence of each element against each of the above objectives or criteria. Comparisons are based on the judgment of decision makers by assessing the importance of an element over other elements. Each element at a higher level is used to compare elements at the right level below it
4. The priority value obtained from the benchmarking process is used to give the priority weight at the appropriate level below it. This process is done for each element. And then for each element at the below level it is done a summation to get its global priority value. This weighting and summing process continues until the final priority value of all alternatives at the bottom level is reached.

III. Reduction Of AHP Algorithm Operation

Based on the AHP algorithm[4], modifications are made[5]:

a. The priority value of each criterion (and sub-criteria) of the objectives indicates the level of significance of each of the criteria (and sub-criteria), so that it is exploited with the concept of Most Significant Operation-First
b. The process of summing alternative priorities against criteria for each alternative that has the characteristics of IRIS (Increased Reward with Increased Service) can be exploited with the concept of Double-Track Computation

Based on the analysis of the AHP algorithm, the AHP algorithm modification is as follows[6]:

1. Building a hierarchy

2. Compare criteria with goals

3. Checking for consistency

4. Sort priority criteria descending (using MSOF)

5. For each criterion (starting from highest priority) do:

a. Compare alternatives to criteria

b. Calculate the lower limit and upper limit (using DT)

c. Check out the conclusive

d. If conclusive then make a decision

The following formula is used to calculate the lower limit and upper limit:

$$Lower\ bound(i) = \begin{cases} 0\%, i = 0 \\ \sum_{n=1}^{i} global\ priority\ of\ alternative(n), i > 0 \end{cases} \quad (3.1)$$

$$Upper\ bound(i) = \begin{cases} 100\%, i = 0 \\ 0\%, i = NC \\ Lower\ bound(i) + \max uncertain(i), i > 0 \end{cases} \quad (3.2)$$

$$\max uncertain(i) = \sum_{n=i+1}^{NC} global\ priority\ of\ criteria(n) \quad (3.3)$$
$$NC = number\ of\ criteria$$

If the exclusive conditions are met, then:

1. Priority values of spouses (criteria, alternatives) whose upper limit is already below the lower limit value of a supreme alternative (the winning candidate) need not be counted again
2. The exclusive condition is obtained when the lower limit value of an alternative is already above the upper limit of all other alternatives.

IV. Implementation Of AHP Algorithm And Modification Of AHP Algorithm

In the application of the modification of the AHP algorithm to the candidate poll for the voting interest, it is assumed that there are 3 (three) candidates, namely A, B and C. The voters are assumed to consider 4 (four) criteria as the basis of candidate comparisons, namely: 1. Honesty, 2. Leadership, 3. Final Education, 4. Activity in the community.

The objective of the Voters is to select candidates who meet the criteria. This goal is at the top of the problem hierarchy. At the next (second) hierarchy level is determined how the contribution of the four criteria in achieving the objectives. At the hierarchy level the problem is determined how each location alternative contributes to each criterion.

When [3] establishes a quantitative scale (1 to 9) to assess the importance of an element against other elements.

Table 1. Level of Interest for Criteria

Level of Interest (Reference)	**Numeric Value**
Equally preferred	1
Same until quite liked	2
Quite liked	3
Quite until well liked	4
Very liked	5
It is highly preferred until very much preferably	6
Very favored	7
Extremely favored to extraordinarily favorable	8
Amazingly preferred	9

Based on table 1 above, Voters assess the importance of a criterion against other criteria, and obtained the results of the weighting of Priority as in table 2.

Table 2. Results of Priority Weight Calculation

Criteria	**Honesty**	**Leadership**	**Education**	**Activity**	**Eigen Value**	**Priority Weight**
Honesty	1.0000	0.2000	5.0000	7.0000	1.6266	0.2458
Leadership	5.0000	1.0000	9.0000	7.0000	4.2129	0.6367
Education	0.2000	0.1111	1.0000	2.0000	0.4591	0.0694
Activity	0.1429	0.1429	0.5000	1.0000	0.3178	0.0480
Total	6.3429	1.4540	15.5000	17.0000	6.6164	1.0000

We get the table priority weight as in table 3.

Table 3. Priority Weight

Criteria	**Priority Weight**
Honesty	0.2458
Leadership	0.6367
Education	0.0694
Activity	0.0480

Then the matrix value is calculated between the criteria and the alternatives which have been assumed to be determined by the Voters with the results as in table 4.

Table 4. Matrix value calculation results

	Honesty	**Leadership**	**Education**	**Activity**	**Matrix Value**
A	0.7096	0.1599	0.1744	0.1515	0.2956
B	0.0959	0.0484	0.6941	0.6301	0.1328
C	0.1945	0.7917	0.1315	0.2184	0.5715

The ranking result is in table 5.

Table 5. Ranking Results

Candidates	**Weight**	**Ranking**
A	0.2956	2
B	0.1328	3
C	0.5715	1

So the poll results from voters using the conventional AHP algorithm are candidates C.

The results of the poll above is using conventional AHP algorithm, next we use AHP algorithm modification, where the process 1 to 3 is equal to the process in conventional AHP algorithm. And the next step of modifying the AHP algorithm is to sort out table 3 in descending order, like table 6.

Table 6. Sorting in descending of priority weights

Criteria	Priority Weight
Leadership	0.6367
Honesty	0.2458
Education	0.0694
Activity	0.0480

Then based on table 6, the comparison of alternatives with the criteria and calculate the lower limit and upper limit (using DT) for Leadership criteria first, the results obtained in table 7.

Table 7. Alternative comparison results with criteria and calculation of upper and lower limits for Leadership Criteria

Candidates	**Comparative Value**	**Lower Bound**	**Upper Bound**
A	0.1018	0.1018	0.4651
B	0.0308	0.0308	0.3941
C	0.5041	0.5041	0.8674

The next process determines the achievement of conclusive, which is based on table 7 obtained results:

1. The upper limit of candidate A below the lower limit value of candidate C, then candidate A will not be further processed
2. The upper limit of candidate B below the candidate's lower limit value, candidate B will not be further processed

Based on the above analysis, then achieved the exclusive and poll results from voters by using modification of Algorithm AHP is candidate C.

V. RESULT AND ANALYSIS

Based on simulation of Algorithm AHP conventional and also modification of Algorithm AHP at part 4, hence got result which same conclusion of poll, that is candidate C as result of poll from voter. Next performed a comparison of the number of operations performed on several processes performed on conventional AHP Algorithm and modification of Algorithm AHP as in table 8.

Table 8. Ranking Results

Operation	**AHP Algorithm**	**Modified AHP Algorithm**
Pair-wise comparison matrix	25	25
Calculated Alternative Weight	64	64
Criteria comparison matrix with alternative	12	0
Comparison of one criterion with alternative and calculate the lower bound and upper bound	0	6
Total Operations	101	**95**

Based on table 8 it is found that the modification of Algorithm AHP has been able to reduce the number of operations on AHP algorithm as much as 5.9%, which is obtained from the difference of the number of operations between conventional AHP Algorithm with AHP Algorithm modification of 6 operations.

VI. CONCLUSION

In this paper we have applied AHP algorithm modification on candidate selection polls compared with AHP algorithm, where the result of poll recommendation for candidate selection shows the same result and has succeeded to reduce the number of operation.

VII. FUTURE WORK

In this paper we have applied AHP algorithm modification on candidate selection polls compared with AHP algorithm, where the result of poll recommendation for candidate selection shows the same result and has succeeded to reduce the number of operation.

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