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An Improved Decision Support System for a Football Team Manager

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Abstract **- The success of any football match lies in player selection which a difficult decision is making task for football managers. Football managers may need to use a decision support system to aid their decision making process. In this paper, an improved system using a combination of fuzzy logic and neural network techniques has been developed to help managers overcome the difficulty in selection process. The neural network does the player rating while fuzzy logic does the player selection. The two models were combined to derive a hybrid model developed in the thesis for use in the system. The system was designed using object oriented analysis and design methodology (OOADM) to capture the players' parameters in object format. The system was implemented with Java programming language and data parameters stored in MySQL. Graphs were plotted to compare the present system and the improved system results. The result shows that the new system for a decision support has an improved accuracy in player selection decision marking**

Keywords: Players' selection, football manager, fuzzy logic, neural network and decision support system.

I. INTRODUCTION

Selectionof football players in a team is a decision made by the football managers based on the available information. The process of player selection in a football match is always difficult and the overall success is determined by the collection of individual players that form the team. Selection of players in a team is always a difficult decision making process. Coaches sometimes suffer indecision because they are required to consider a large number of qualitative and quantitative attributes in the player selection process. Very few models have been developed to support coaches in this effort. The performance of a team in a football match depends on the skills and abilities of the players that make up the team [9].

Some coaches may also use important weights to determine the impact of each attribute. Important weights are useful to coaches since they indicate how the impact of a particular attribute relates to the probability of a successful outcome. The player selection process in football match is important if a team has determined to win. A wrong selection can cost football team championship and even millions of dollars if the player turns out not living up to the team's expectations. Traditionally, professional football teams use a variety of sports psychology assessments for evaluating players. There is no doubt that these assessments are of great benefit and are extremely useful when trying to form a winning football team. However, this is just one part of the big puzzle when trying to assess a player's suitability for a team. The ability to select suitable player is indispensable for reaching the top for team sports (Boon, 2003).

II. LITERATURE REVIEW

An information system is regarded as a combination of information technology and human activities. It supports people in many fields such as operation, management and decision making. Usually information systems are categorized in three parts: Management Information System, Decision Support System and Executive Information System [8]. A team is defined as a small number of people with complementary skills who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable. The main goal of team building is teamwork, which is the vehicle for integrating information, technology, competence and resources based on human interactions [10]. Most of these studies have focused on the use of teams in business and industry. The business and industry's adoption of a teamwork methodology in the pursuit of cost effectiveness and greater innovation has spawned significant research [11][12][13].

The conceptual work of several scholars has highlighted five key elements for team-building: clear goals with measurable outcomes, clinical and administrative systems, division of labor, training, and communication [14][15][16]..

Askin and Sodhi (1994) have presented a novel method for organizing teams in concurrent engineering. They developed five different criteria for team formation and discussed team training, leadership, and computer support issues [19].

Zakarian and Kusiak (1999) proposed an analytical model for the selection of multi-functional teams. They used the analytic hierarchy process and the quality function deployment method to prioritize ''team membership'' based on customer requirements and product specifications.[17]

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Braha (2002) has proposed a team-building approach based on task partitioning by specifying task dependencies and partitioning the tasks among a number of teams [2]. Chen and Lin (2004) proposed a team member model for the formation of a multi-functional team in concurrent engineering [3]. They used the analytic hierarchy process and Myers– Briggs type indicators to model team member characteristics. In the software development field, (Gronau et al. 2006) developed an algorithm to propose a team composition for a specific task by analyzing the knowledge and skills of the employees[18].

III. MATERIAL AND METHOD

Success in designing a decision system depends on a clear understanding of the problem. Figure 3.1 shows the design of the proposed system that can help football coaches in selecting players for a football match. The system is designedusing neural network and fuzzy logic. Neural network is used in generating results which will be taken by fuzzy logic to make the final decision. The system requirement includes the input variable which comprises base statistics, mental statistics, physical statistics and skill statistics.

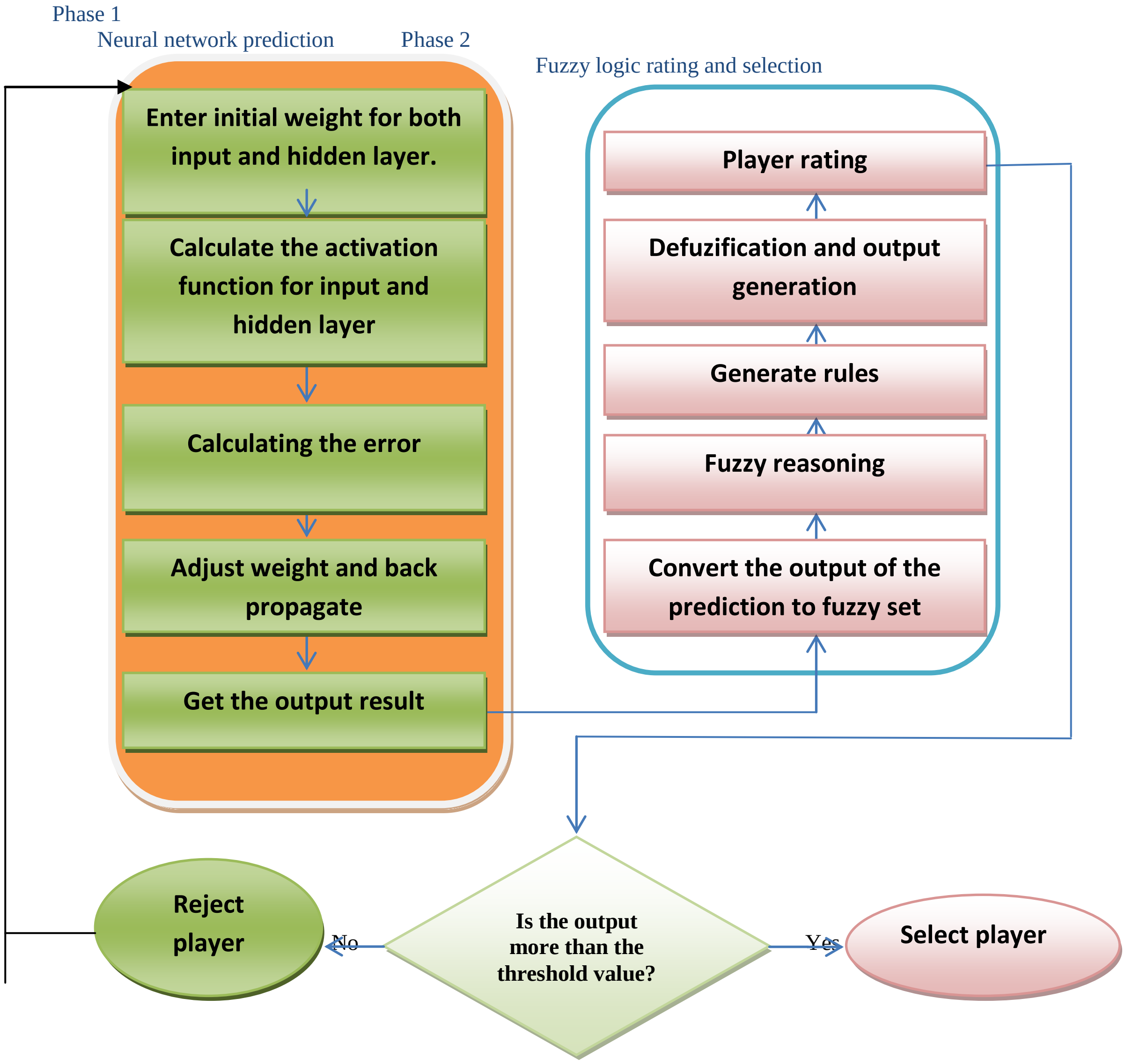

Figure.3.2. A diagrammatic representation of the proposed systems framework.

Phase 1: Neural network prediction

Enter initial weight for both input and hidden layer: Set all weights to random values ranging from -1.0 to 1.0. Forward propagation is a supervised learning algorithm that describes the "flow of information" through a neural network from its input layer to its output layer. The feed forward algorithm is used to calculate the optimal weights.
Calculate the activation function for input and hidden layer: Set an input pattern to the neurons of the net's input layer. Activate each neuron of the following layer by multiplying the weight values of the connections leading to this neuron with the output values of the preceding neurons, add up these values and pass the result to an activation function. The mathematical models for calculating activation function are as follows:

$$\boldsymbol{Input_j} = \boldsymbol{x_j} = \sum y_i w_{ij} \text{........................} 3.1$$

$y_i$is the generated output and w_{ij}represents weights

$$f(x) = \frac{1}{1+e^{-x_j}} \text{................................} 3.2$$

f (x) is a sigmoid that is used as the activation function

Calculating the error: Aftercomputing the output value of the neuron then the result will be compared with the desired target value.The mathematical model for error is as follows:

$$\boldsymbol{Error} = T_k - O_k \text{..} 3.3$$

T_k is the observed (True) output while Ok is the calculated (actual) output

Adjust weight and back propagate: Backpropagation is a supervised learning algorithm and is mainly used by Multi-Layer-Perceptron to change the weights connected to the net's hidden neuron layer(s). The Backpropagation algorithm uses a computer output error to change the weight values in backward direction. To get this net error, a forward propagation phase must have been done before back propagation algorithm is used to adjust the new weights to be trained in the network. The mathematical models for the back propagation algorithm are as follow:

The error in the output layer is calculated by using the formula in equation 3.4

$$\delta_k = o_k \boldsymbol{(1 - o_k)(T_k} - o_k) \text{......................} 3.4$$

O_k is the calculated (actual) output expressed in equation 3.5

$$O_k = \frac{1}{1+e^{-x_k}} \text{.....................................} 3.5$$

T_k is the observed (True) output

The back propagation error in the hidden layer is calculated by using the formula in equation 3.6

$$\delta_j = o_j \boldsymbol{(1 - o_j)} \sum_{\boldsymbol{k}} \delta_{\boldsymbol{k}} * w_{jk} \text{....................} 3.6$$

Where w_{jk} is the weight of the connection from unit j to unit k in the next layer and δ_k is the error of unit k.

The weight adjustment formula in equation (3.7) is used to adjust the weights to produce new weights which are fed back into the input layer.

$$\boldsymbol{W_{new} = W_{old} + \eta * \delta * input} \text{................} 3.7$$

Where η is a constant called the learning rate. The learning rate takes value between 0 and 1.

Phase 2: Fuzzy logic rating and selection
Convert the output of the prediction to fuzzy set: Fuzzy logic enables the formulation of prototypical linguistic rules of a fuzzy model that can easily be understood by experts where, at the same time, all kinds of mathematical details are hidden. To do so, knowledge is represented by fuzzy IF-THEN linguistic rules having the general form:
If X_1 is A_1 AND X_2 is A_2 … AND Xm is Am THEN y is B; where X_1. . .Xm are linguistic input variables with linguistic values A_1, . . ., Am, respectively and where *y* is the linguistic output variable with linguistic value *B*.

Fuzzy reasoning: Given fact *''x is A''* and rule *''IF x is A, THEN y is B''*, we conclude that *''y is B''*. Applying fuzzy reasoning, classical modus pones can be generalized to an 'approximates reasoning' scheme of type: Given fact *''x is A' ''* and rule *''IF x is A, THEN y is B''*, we conclude that *''y is B' ''*.
Here, the assumption made is that the closer *A'* to *A*, the closer will *B'* be to *B*. It turns out that especial combinations of operations on fuzzy sets like 'max–min' and 'max-product' composition can fulfill this requirement.
The complete fuzzy reasoning in a FS can be set up as follows:
1. the fuzzification module calculates the so-called 'firing rate' (or degree of fulfillment) of each rule by taking into account the similarity between the actual input defined by membership function and in case of a crisp input defined by the value and the inputof each rule defined by membership function.
2. Using the firing-rates calculation, the inference engine determines the fuzzy output for each rule, defined by membership function.
3. The inference engine combines all fuzzy outputs into one overall fuzzy output defined by membership function.
4. The defuzzification module calculates the crisp output using a defuzzification operation.

Generate rules:fuzzy logic works with the rules that are given to it. In this research two hundred and fifty six rules were given to the system to work with. The examples of the rules are listed below.
B = Below Average = 0 – 49
A = Average = 50 – 64
V = Very Good = 65 – 79
E = Exceptionally Good = 80 - 100
BS = Base Statistics
SS = Skill Statistics
MS = Mental Statistics
PS = Physical Statistics
PR = Player Rating
Rule 1: If (BS is B) and (SS is B) and (MS is B) and (PS is B) then (PR is B)
Rule 2: If (BS is B) and (SS is B) and (MS is B) and (PS is V) then (PR is B)
Rule 3: If (BS is B) and (SS is B) and (MS is V) and (PS is B) then (PR is B)
Rule 4: If (BS is B) and (SS is V) and (MS is B) and (PS is B) then (PR is B)

Rule 5: If (BS is V) and (SS is B) and (MS is B) and (PS is B) then (PR is B)
Rule 6: If (BS is B) and (SS is B) and (MS is B) and (PS is A) then (PR is B)
Rule 7: If (BS is B) and (SS is B) and (MS is A) and (PS is B) then (PR is B)
E) then (PR is B)
Rule 11: If (BS is B) and (SS is B) and (MS is E) and (PS is B) then (PR is B)
Rule 12: If (BS is B) and (SS is E) and (MS is B) and (PS is B) then (PR is B)
Rule 13: If (BS is E) and (SS is B) and (MS is B) and (PS is B) then (PR is B)
Rule 14: If (BS is B) and (SS is B) and (MS is V) and (PS is V) then (PR is A)
Rule 15: If (BS is B) and (SS is V) and (MS is V) and (PS is B) then (PR is A)
Rule 16: If (BS is V) and (SS is V) and (MS is B) and (PS is B) then (PR is A)
Rule 17: If (BS is V) and (SS is V) and (MS is V) and (PS is B) then (PR is V)
Rule 18: If (BS is B) and (SS is A) and (MS is A) and (PS is A) then (PR is A)
Rule 19: If (BS is E) and (SS is E) and (MS is A) and (PS is B) then (PR is V)
Rule 20: If (BS is A) and (SS is A) and (MS is B) and (PS is B) then (PR is B)
Rule 21: If (BS is A) and (SS is B) and (MS is B) and (PS is A) then (PR is B)
Rule 22: If (BS is B) and (SS is B) and (MS is B) and (PS is E) then (PR is B)
Rule 23: If (BS is B) and (SS is B) and (MS is A) and (PS is B) then (PR is B)
Rule 24: If (BS is E) and (SS is E) and (MS is B) and (PS is E) then (PR is E)

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Defuzification and output generation: Using the firing-rates calculation, the inference engine determines the fuzzy output for each rule, defined by membership function. The inference engine combines all fuzzy outputs into one overall fuzzy output defined by membership function. The defuzzification module calculates the crisp output using a defuzzification operation.

Rule 8: If (BS is B) and (SS is A) and (MS is B) and (PS is B) then (PR is B)
Rule 9: If (BS is A) and (SS is B) and (MS is B) and (PS is B) then (PR is B)
Rule 10: If (BS is B) and (SS is B) and (MS is B) and (PS is

IV EXPERIMENTS AND RESULT

The statistical data of some English Premiership players were used to test the system. From the experiment one can say that this system can decide for coaches with great accuracy. The process of player selection in a football team is a problem with conflicting objectives. Coaches are required to consider a large number of qualitativeand quantitative attributes in the player selection process. The players were rated based on their individual statistics in the firstphase and the second phase used fuzzy logic if-then-statement in selecting suitable player for the football team.

Table 4.6 Summary of the new systems' result

	Base Statistics	Physical Statistics	Mental Statistics	Skills Statistics
Rooney	77	79	82	69
Van Persie	82	73	77	75
Facao	84	85	80	84
Di Maria	74	86	84	90
Joan Mata	70	65	86	87

Table 4.7 Summary of the online statistical rating

	Base Statistics	Physical Statistics	Mental Statistics	Skills Statistics
Rooney	75	77	81	71
Van Persie	80	75	79	76
Facao	82	84	79	86
Di Maria	75	85	83	88
Joan Mata	72	66	85	86

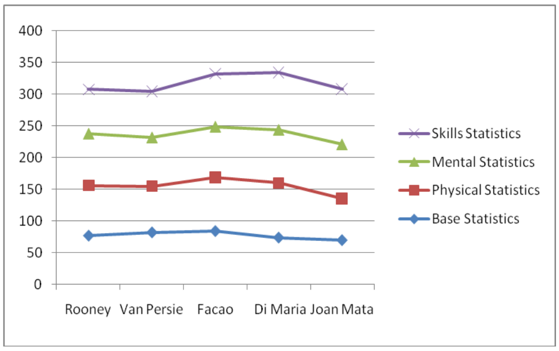

Figure 4.4 A Line graph representing result from the new system

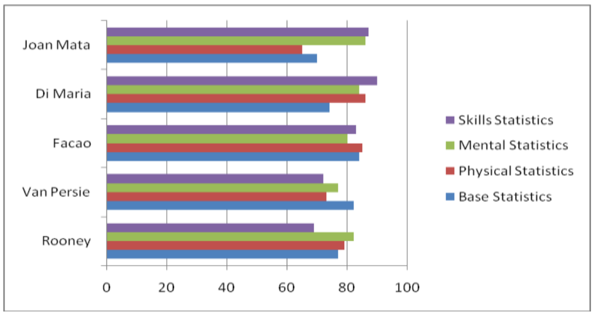

Figure 4.5 A Bar chart representing result from the new system

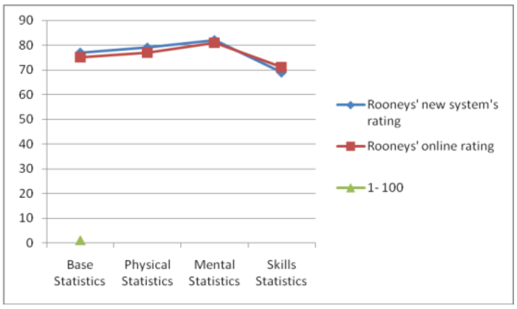

Figure 4.10 Comparison of the online rating with the developed system rating using statistics of Rooney

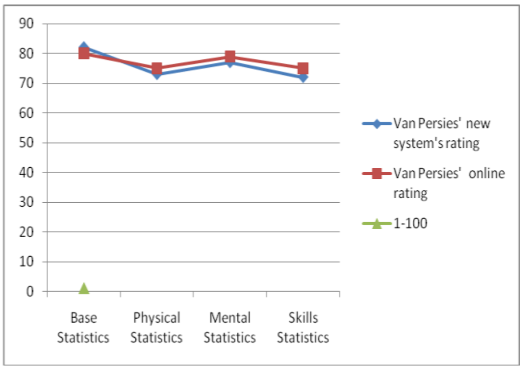

Figure 4.11 Comparison of the online rating with the developed system rating using statistics of Van Persie

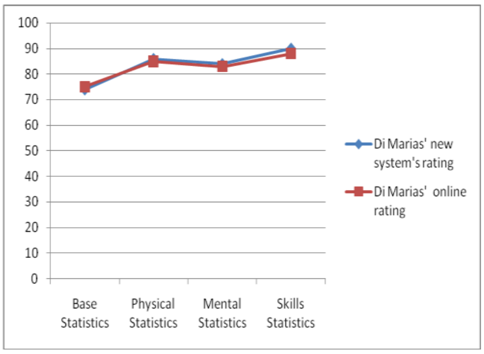

Figure 4.12 Comparison of the online rating with the developed system rating using statistics of Falcao

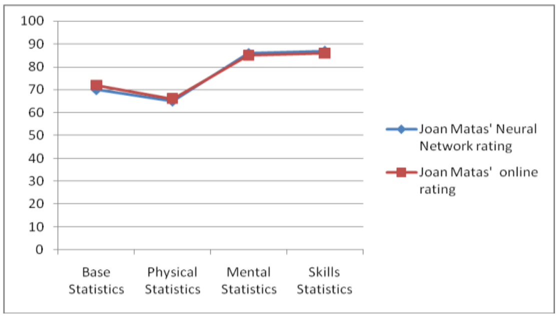

Figure 4.14 Comparison of the online rating with the developed system rating using statistics of Joan Mata.

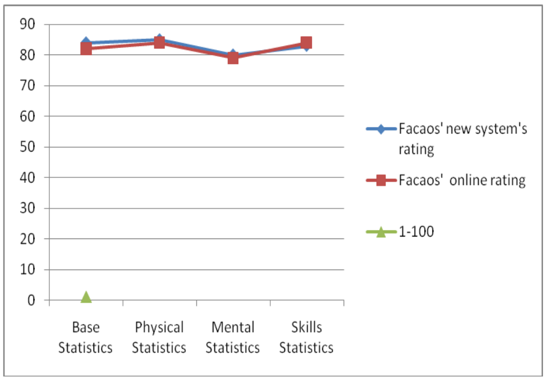

Figure 4.13 Comparison of the online rating with the developed system rating using statistics of Di Maria

V RESULT DISCUSSION

Table 4.6 shows the summary of the new systems rating for the players and table 4.7 shows the summary of the online statistical rating. Figure 4.4 shows the result comparism using line graph for the players that were used in the experiment. This graph gives a vivid picture of the players' individual rating. It can be seen from the table that these attributes are assigned some values based on the online rating. The neural network part uses this rating to generate its own result based on different statistics. Finally, fuzzy logic rates and selects the player based on the neural network outcome.

Figure 4.5 shows the result comparism using bar chart of different players. Figures 4.10, 4.11, 4.12, 4.13 and 4.14 show the relationship of the result of the developed system rating with the online statistical rating. It can be seen from the graph that the developed system result is very close with the online system.Rooneys' result for the base statistics, Physical statistics, mental statistics and skills statistics are 77, 79, 82 and 69 respectively. With this neural network result, fuzzy logic concludes that the player is very good and therefore suitable for selection. Van persies' result for the base statistics, Physical statistics, mental statistics and skills statistics are 82, 73, 77 and 75 respectively. With this neural network result, fuzzy logic concludes that the player is very good and therefore suitable for selection.Facao result for the base statistics, Physical statistics, mental statistics and skills statistics are 84, 85, 80 and 84 respectively. With this neural network result, fuzzy logic concludes that the player is very good and therefore suitable for selection. Di Marias' result for the base statistics, Physical statistics, mental statistics and skills statistics are 74, 86, 84 and 90 respectively. With this neural network result, fuzzy logic concludes that the player is very good and therefore suitable for selection. Joan Matas' result for the base statistics, Physical statistics, mental statistics and skills statistics are 70, 75, 86 and 87 respectively. With this neural network result, fuzzy logic concludes that the player is very good and therefore suitable for selection.

VI. CONCLUSION

A hybrid system of neural and fuzzy logic techniques has shown from this study to be a good tool for player selection. Decision support system for a football manager has to do with the clear understanding of the factors that affect player selection. In this research some fundamental factors such as pace, shooting , passing, dribbling, defending heading, aggression, attack positioning, interceptions, vision, acceleration agility, balance, jumping, reactions, sprint speed, strength, stamina, ball control, crossing, curve, dribbling, finishing, free kick accuracy, heading accuracy, long passing, long shots, marking, penalties, short passing, shot power, sliding tackle, standing tackle and volleys were shown to be factors that affect player selection.

According to the result, it can be seen that a combination of neural network and fuzzy logic is an effective tool for decision support system for a player selection in a football match. The advantage of Artificial Neural Network is its ability to be used as an arbitrary function approximation mechanism which 'learns' from observed data. Football team performance has imposed greater requirement on player selection strategies. The process of player selection in a football team is a problem with conflicting objectives. Coaches are required to consider a large number of qualitativeand quantitative attributes in the player selection process. The players were rated based on their individual statistics in the firstphase and the second phase used fuzzy logic if-then-statement in selecting suitable players for a football match. The developed system shows a high-level of 'accuracy' in player selection. While this system enables coaches to assimilate the precise data and imprecise or ambiguous judgments into a formal systematic approach, it should be used with care and in conjunction with the game objectives. The system helps coaches to think systematically about complex multi-criteria decision making problems and also improve on the quality of their decisions.

VII RECOMMENDATION

Firstly, ignoring most attributes used in player selection also has its own perils as these attributes definitely have an impact on the decision making process. Perhaps to compensate for the small amount of attribute used for these player selections, future researchers can instead use the major attributes that are required of a player to build a decision support system.

Secondly, there will be need for performance measures like mean square error and Regression values in the future research. These are popular and widely used criteria which gives a total picture of the training results. This might yield more useful and meaningful results.

Lastly, an interesting area for future research can be conducted in player selection and player utilization based on individual ability and capability using neural network and fuzzy logic model.

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