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Research Paper

A Study of Fuzzy Logic as a Decision Support System for Determining the Best Athletes

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Abstract

The selection of athletes with the best conditions is very required to follow various sports agenda that will be followed, to do the selection can be used decision support system by applying fuzzy logic as a tool of decision maker by doing the selection of variables used. Expected results with the use of this fuzzy logic obtained optimal selection with sufficient variables complete and the best athlete is a recommendation given and not made the final decision.

Keywords: *Decision Support System, Fuzzy Logic, Decision Maker*

1. Introduction

Physical ability is the most basic supporting factor of an athlete to perform[1]–[5]. No matter how high the technical skills and tactics they have, if the physical abilities are not good enough, then prestasis will not be achieved perfectly. In the sporting world the physical condition of an athlete will determine its success when he pursue a sport. To produce a competent athlete in his field a trainer or talent scout must perform some tests on prospective athletes or athletes to gauge their progress[6]–[8]. Manual calculation systems still have to look at references and are less accurate in drawing conclusions because human error can always happen[9]–[12], caused by the number of inputs and using different types of units, thus requiring a long calculation process to produce output[13], [14].

The parameters used as inputs in the System are the results of physical tests, each of which is included into a physical component, i.e. strength, speed, power, flexibility, agility, muscle endurance, and general endurance. The test results of each item or item in the form of units of time, distance, number of scores, number of rounds, and so on. The test items have less categories, enough, good, excellent, and perfect. These categories can be recommended by athletes. Determination of the category for each test item is still done manually and long enough in the process and sometimes mistakes because it uses memory in determining it, to solve this problem can be solved by using fuzzy logic[15], [16].

Fuzzy logic is a set theory that can help in resolving boundary uncertainty between one criterions with other criteria generated by the existence of human judgments on something cumulatively[16]–[20]. This theory can be used to help solve the physical athlete quality assessment problem. One solution that can be done to overcome the dependence on experts and boundary uncertainty between one criterion with other criteria, namely using fuzzy logic that is applied in the form of visual programs that can be used in determining the physical quality of the athlete.

2. Methodology

The decision support system is a set of model-based procedures for processing and assessment data to assist managers in making decisions and the system should be simple, fast, and easy to control, adaptive, complete with important issues, and easy to communicate[21]–[26] and not only decision support system need a fast response, almost any activity need a fast and quick information[27]–[30]. Based on the level of support, Decision Support System (DSS) based on the level of support can be divided into 6 stages[31]:

a. Retrieve Information Elements
   Retrieve Information Elements is the lowest support DSS can provide, i.e. selective access of information.
b. Analyze Entire File
   At this stage, managers are given access to view and analyze the file completely.
c. Prepare Reports from Multiple Files
   Such support is likely to be needed, given that managers are associated with many activities in a given moment.
d. Estimate Decision Consequences
   At this stage, managers may be able to see the impact of any decisions that may be taken.
e. Propose Decision
   Support at this stage is slightly more advanced. An alternative decision can be presented to the manager for consideration.
f. Make Decision
   This is the kind of support that is highly expected from DSS. This stage will provide a decision that is just waiting for the legitimacy of the manager to run.

Fuzzy logic developed from the fuzzy set theory. While the set is commonly used is a classic set that is also called the set of firm (crisp set).

The fuzzy set theory offers sufficient instruments for modeling and rules for the expert. By modeling linguistic variables in the form of fuzzy sets, it is possible to change the rules of experts into

mathematical terms. The most important application of the fuzzy system is in uncertain issues. Fuzzy logic matches and deals with this issue. The first step of designing fuzzy DSS is the determination of input and output variables. After that should design membership function of all variables.

System analysis in fuzzy is different from other systems in general. Starting from data input, data processing, data output and database. The model used in this research is fuzzy database Tahani model to present the system[32]–[34]. The fuzzy Tahani model database still uses the standard relation, it just uses the fuzzy set to get the information from the query. The fuzzy set is a group that represents a particular condition or state in a fuzzy variable. The variables used in this system are 7 test components and 18 sub components / test pieces:

a. Power Component, with measurement technique: hand dynamometer, leg dynamometer, back dynamometer, hand grip.
b. Speed Components, with measurement technique: 400 meter run.
c. Power Components, with measuring techniques: medicine ball put, vertical jumps.
d. Component Form / Flexibility, with measurement techniques: flexometer, flexed arm hangs, flexion of thrunk.
e. Agility, with measurement technique: shuttle run.
f. Muscle Resistance, with grain measuring techniques: pull ups, push-ups, sit ups, squat jumps, back lifts.
g. Durability, with measurement techniques: run 15 minutes (VO2max), bleep test.

3. Results and Discussion

Tests conducted with the criteria that have been mentioned earlier can be seen in table 1 below:

Table 1: Variable Fuzzy with Domain Value

Crisp Input	Gender	Less	Enough	Good	Very Good	Excellent
Leg Dynamometer	L	≤ 146	145 - 215	214 - 283	282 - 351	≥ 350
	P	≤ 65	64 - 124	123 -183	182 - 242	≥ 241
Back Dynamometer	L	≤ 80	79,5 - 101	100,5 - 122,5	122 - 143,5	≥143
	P	≤ 39,5	39 - 50	49,5 – 60,5	60 – 70,5	≥ 70
Hand Dynamometer	L	≤ 30	29 - 37	36 - 44	43 – 51	≥ 50
	P	≤ 18	17 - 27	26 - 36	35 – 45	≥ 44
Hand Grip	L	≤ 41,5	41 - 48	47,5 - 54,5	54 – 61	≥ 60,5
	P	≤ 30,5	30 - 34	33,5 – 38,5	38 – 40,5	≥ 40
Flexometer	L	≤ 6	5 - 12	11 - 18	17 – 24	≥ 23
	P	≤ 7	6 - 12	11 - 19	18 – 24	≥ 23
Medicine Ball Put	L	≤ 3,68	3,67 - 4,53	4,52 - 5,38	5,37 - 6,23	≥ 6,22
	P	≤ 2,38	2,37 – 2,95	2,94 – 3,52	3,51 – 4,04	≥ 4,03
Vertical Jump	L	≤ 46	45 - 53	52 - 62	61 – 70	≥ 69
	P	≤ 33	32 -38	37 - 44	43 – 48	≥ 47
Run 50 Meter	L	≥ 7,9	8 - 6,8	6,9 - 5,7	5,8 - 4,6	≤ 4,7
	P	≥ 9,1	9,2 - 8,3	8,4 - 7,5	7,6 – 6,8	≤ 6,9
Pull Ups	L	≤ 5	4 - 9	8 - 13	12 – 17	≥ 16
	P	≤ 7	6 - 14	13 - 21	20 – 28	≥ 27
Sit-Ups	L	≤ 30	29 - 50	49 - 70	69 – 90	≥ 89
	P	≤ 29	28 - 48	47 - 69	68 -88	≥ 87
Squat-Jumps	L	≤ 25	24 - 46	45 - 67	66 – 88	≥ 87
	P	≤ 23	22 - 34	33 - 45	44 – 56	≥ 55
Push-Ups	L	≤ 12	11 - 20	19 - 29	28 – 38	≥ 37
	P	≤ 5	4 - 10	9 - 16	15 – 21	≥ 20
Back Lifts	L	≤ 21	20 - 32	31 - 43	42 – 54	≥ 53
	P	≤ 17	16 - 30	29 - 43	42 – 56	≥ 55
Flexed Arm Hang	L	≤ 14	13 - 27	26 - 40	39 – 53	≥ 52
	P	≤ 8,2	8,1 – 21,7	21,6 – 35,3	35,2 – 48,8	≥ 48,7
Flexion Of Thrunk	L	≤ 6	5 - 12	11 - 18	17 – 24	≥ 23
	P	≤ 7	6 - 12	11 - 19	18 – 24	≥ 23
Shuttle Run	L	≥ 17,1	17,2 - 16,6	16,7 - 16,0	16,1 - 15,5	≤ 15,6
	P	≥ 18,9	19,0 - 18,2	18,3 - 17,4	17,5 - 16,7	≤ 16,8
Vo2max	L	≤ 50	49 - 55	54 - 61	60 - 65	≥ 64
	P	≤ 43	42 - 45	44 - 50	49 - 56	≥ 55
Bleep Test	L	≤ 37	36 - 48	47 - 58	57 - 75	≥ 74
	P	≤ 31	30 - 43	42 - 54	53 -69	≥ 68

Table 2: Physical Test

Variable	Test Value
Leg Dynamometer	213
Back Dynamometer	100
Hand Dynamometer	38
Hand Grip	55.5
Flexometer	7
Medicine Ball Put	4.52
Vertical Jump	45
Run 50 Meter	7
Pull Ups	9
Sit-Ups	35
Squat-Jumps	67
Push-Ups	25
Back Lifts	33
Flexed Arm Hang	28
Flexion Of Thrunk	7
Shuttle Run	16.6
Vo2max	54
Bleep Test	39

By referring to table 1, the fuzzy set variable, a membership function can be used for each test.

a. Membership Function Hand Dynamometer

Less Category(x_1) =	$\begin{cases} 1 & x1 \le 29 \\ (30 - x1)/(30 - 29) & 29 \le x1 \le 30 \\ 0 & x1 \ge 30 \end{cases}$
Enough Category(x_1) =	$\begin{cases} 0 & x1 \le 29 \text{ or } x1 \ge 37 \\ (x1 - 29)/(36 - 29) & 29 \le x1 \le 30 \\ (37 - x1)/(37 - 36) & 36 \le x1 \le 37 \end{cases}$
Good Category(x_1) =	$\begin{cases} 0 & x1 \le 36 \text{ or } x1 \ge 44 \\ (x1 - 36)/(43 - 36) & 36 \le x1 \le 43 \\ (44 - x1)/(44 - 43) & 43 \le x1 \le 44 \end{cases}$
Very Good Category(x_1) =	$\begin{cases} 0 & x1 \le 43 \text{ or } x1 \ge 51 \\ (x1 - 43)/(50 - 43) & 43 \le x1 \le 50 \\ (51 - x1)/(51 - 50) & 50 \le x1 \le 51 \end{cases}$
Excellent Category(x_1) =	$\begin{cases} 0 & x1 \le 50 \\ (x1 - 43)/(51 - 50) & 50 \le x1 \le 51 \\ 1 & x1 \ge 51 \end{cases}$

b. Leg Dynamometer Membership Function

Less Category(x_2) =	$\begin{cases} 1 & x2 \le 145 \\ (146 - x2)/(146 - 145) & 145 \le x2 \le 16 \\ 0 & x2 \ge 37 \end{cases}$
Enough Category(x_2) =	$\begin{cases} 0 & x2 \le 145 \text{ or } x2 \ge 215 \\ (x2 - 145)/(214 - 145) & 145 \le x2 \le 214 \\ (215 - x2)/(215 - 214) & 214 \le x2 \le 215 \end{cases}$
Good Category(x_2) =	$\begin{cases} 0 & x2 \le 214 \text{ or } x2 \ge 283 \\ (x2 - 214)/(282 - 214) & 214 \le x2 \le 282 \\ (283 - x2)/(283 - 282) & 282 \le x2 \le 283 \end{cases}$
Very Good Category(x_2) =	$\begin{cases} 0 & x2 \le 282 \text{ or } x2 \ge 51 \\ (x2 - 282)/(350 - 282) & 282 \le x2 \le 350 \\ (351 - x2)/(351 - 350) & 350 \le x2 \le 351 \end{cases}$

Excellent Category(x_2) =	$\begin{cases} 0 & x2 \le 350 \\ (x2-350)/(351-350) & 350 \le x2 \le 351 \\ 1 & x2 \ge 351 \end{cases}$

c. Back Dynamometer Membership Function

Less Category(x_3) =	$\begin{cases} 1 & x3 \le 79.5 \\ (80-x3)/(80-79.5) & 79.5 \le x3 \le 80 \\ 0 & x3 \ge 80 \end{cases}$
Enough Category(x_3) =	$\begin{cases} 0 & x3 \le 79.5 \; or \; x3 \ge 101 \\ (x3-79.5)/(100.5-79.5) & 79.5 \le x3 \le 100.5 \\ (101-x3)/(101-100.5) & 214 \le x3 \le 215 \end{cases}$
Good Category(x_3) =	$\begin{cases} 0 & x3 \le 100.5 \; or \; x3 \ge 122.5 \\ (x3-100.5)/(122-100.5) & 100.5 \le x3 \le 122 \\ (122.5-x3)/(122.5-122) & 122 \le x3 \le 122.5 \end{cases}$
Very Good Category(x_3) =	$\begin{cases} 0 & x3 \le 122 \; or \; x3 \ge 143.5 \\ (x3-122)/(143-122) & 122 \le x3 \le 143.5 \\ (143.5-x3)/(143.5-143) & 143 \le x3 \le 143.5 \end{cases}$
Excellent Category(x_3) =	$\begin{cases} 0 & x3 \le 143 \\ (x3-143)/(143.5-143) & 143 \le x3 \le 143.5 \\ 1 & x3 \ge 143.5 \end{cases}$

d. Hand Grip Membership Function

Less Category(x_4) =	$\begin{cases} 1 & x4 \le 41 \\ (41.5-x4)/(41.5-41) & 41 \le x4 \le 41.5 \\ 0 & x4 > 41.5 \end{cases}$
Enough Category(x_4) =	$\begin{cases} 0 & x4 \le 41 \; or \; x4 \ge 48 \\ (x4-41)/(47.5-41) & 41 \le x4 \le 47.5 \\ (48-x4)/(48-47.5) & 47.5 \le x4 \le 48 \end{cases}$
Good Category(x_4) =	$\begin{cases} 0 & x4 \le 47.5 \; or \; x4 \ge 54.5 \\ (x4-47.5)/(54-47.5) & 47.5 \le x4 \le 5 \\ (54.5-x4)/(54.5-54) & 54 \le x4 \le 54.5 \end{cases}$
Very Good Category(x_4) =	$\begin{cases} 0 & x4 \le 54 \; or \; x4 \ge 61 \\ (x4-54)/(60.5-54) & 54 \le x4 \le 60.5 \\ (61-x4)/(61-60/5) & 60/5 \le x4 \le 61 \end{cases}$
Excellent Category(x_4) =	$\begin{cases} 0 & x4 \le 60.5 \\ (x4-60.5)/(61-60.5) & 60.5 \le x4 \le 61 \\ 1 & x4 \ge 61 \end{cases}$

The completion of the above variable functions is performed for all variables and the following results are obtained:

Table 3: Degree of Athlete Membership

Crisp Input	Less	Enough	Good	Very Good	Excellent
Leg Dynamometer	0	0.99	0	0	0
Back Dynamometer	0	0.98	0	0	0
Hand Dynamometer	0	0	0.29	0	0
Hand Grip	0	0	0	0.23	0
Flexometer	0	0.33	0	0	0
Medicine Ball Put	0	1	0	0	0
Vertical Jump	1	0	0	0	0
Run 400 Meter	0	0.83	0	0	0
Pull Ups	0	0	0.25	0	0
Sit-Ups	0	0.3	0	0	0
Squat-Jumps	0	0	0	0.05	0
Push-Ups	0	0	0.67	0	0
Back Lifts	0	0	0.18	0	0
Flexed Arm Hang	0	0	0.15	0	0
Flexion Of Thrunk	0	0.33	0	0	0
Shuttle Run	0	0	0.14	0	0
Run 30 Mnt (Vo2max)	0	1	0	0	0
Bleep Test	0	0.27	0	0	0

The value of the table above is then used as the basis for decision-makers to get the best athletes.

4. Conclusion

This Decision Support System is a system designed to assist certain parties in making the best athlete selection decisions, and the results of these applied Fuzzy Logic calculations will result in the highest selection of the highest and best professional Candidate Selection criteria so that who is eligible to meet those criteria could be the best Athlete.

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