Prediction of DOTA 2 Match Result by Using Analytical Hierarchy Process Method

Gede Adi Aryanata [1], Putu Suta Adya Dharma Rahadi [2], and Yanu Suprapto Sudarmojo [3]

[1][2] Department of Electrical and Computer Engineering, Post Graduate Program, Udayana University
[3] Department of Electrical and Computer Engineering, Udayana University
E-Mail: gedeadiaryanata@gmail.com

Abstract—This research discuss about how to predict a match result by using data mining as the foundation to make a conclusion. In this research, Analytical Hierarchy Process (AHP) is used as a main data mining method for making a prediction. AHP works by using pre-existing data events as training data to obtain predictions of future data results. This research uses four parameters to predict the result of international Dota 2 match. Those parameters are experience per minutes (XPM) and gold per minutes (GPM), matchmaking ratio (MMR) point, 3 head to head matches result, and the last 10 results matches. In its implementation, the four parameters are given different rules and priority levels to support the performance of the AHP method. The result of this study has a satisfactory level of accuracy regarding the victory estimation of the match

Keywords—*AHP, Dota 2, Forecasting, Prediction, Data Mining.*

I. INTRODUCTION

E-Sport or Electronic Sport is a physical or non-physical agility competitiveness using electronic devices as a media match. E-Sport is often associated with video games that have become one of the electronic sports that has been recognized by the world. One of the development triggers of this activity is the rapid of technology development that gives the place of talent distribution and hobby of playing video games. Currently, in Indonesia, playing video games are still considered as a leisure time activities. However, in other developed countries such as South Korea, California, USA, Norway and Sweden have considered E-Sport to be a field of work. In addition, they do provide majors E -Sport in some universities in their countries. E-Sport is also planned to enliven the Asian Games by becoming one of the sports that will win a medal in 2022 in China [1].

E-Sport that has international competition with the biggest prize in the year 2016 is Dota 2. Dota 2 is a video game of Steam that has the largest total competition prize that amounted to Rp 271 billion. This annual competition is called *The International* (TI). Total prize from TI is obtained from the transaction of *Battle Pass The International* Dota 2 which are bought by Dota 2 players around the world. The transaction must be done at the official store of Dota 2 which the 25% of the transaction will be donated as the prize of the competition. Therefore, the more Dota 2 players buy Battle Pass The International, the greater the total prize of an annual competition. Recorded in 2017, the 30 richest E-Sport athletes come from Dota 2. In addition, Dota 2 has a very high level of international match intensity. On average, there are 60 international matches that can be attended by the players in a week. These facts are the foundation to do research about the estimation of Dota 2 match victory.

The similar research on the application of data mining in the process of predicting a match victory is discussed using several different methods. The application of artificial neural network and fuzzy methods to predict a football game match victory has a 62.5% percentage [2]. In research [2] 5 parameters are used as the basis of making decision. The application of the C.45 algorithm on a football match was implemented in the research [3]. The C.45 algorithm is applied by providing some parameters that can't be objectively assessed, e.g. the players courageous in a game. While the implementation of Bayesian Network algorithm in the winning simulation of Indonesian Government Election (PILKADA) stated that the implementation of 8 (eight) parameters are very depend on several main parameters obtained during PILKADA process such as quick count survey I and II [4]. The AHP algorithm is used in research [6] on determining a predictability of a football match. In the study [6], researchers used several parameters calculated with high levels of subjectivity such as team spirit, coach quality and player's quality. This research will apply the AHP algorithm with 4 (four) parameters measured as a consideration in predicting the victory of Dota 2 match

The purpose of this study is to provide academic literature that discusses data mining as the main topic by using AHP method as the main method to predict the victory of a match based on consideration of match data that has been done. The systematics of this literature are structured as follows: Section 2 describes the methodology used in this study. Section 3 presents the findings and discusses the results of the methodological outputs that have been applied in some previous studies. While in Section 4 concludes the discussion results in this

II. METHODOLOGY

A. Analytical Hierarchy Process

Analitycal Hierarchy Process (AHP) is a data mining method to solve an unstructured complex situation into several components in a hierarchical arrangement. It works by giving subjective values about the importance of each variable relatively and specifying which variable has the highest priority to influence the outcome in that situation. The basic principle of AHP is to compare all the parameters to be used for making

a decision. As previously stated, AHP will arrange these parameters into a hierarchy based on the importance of those parameters. Assessment of importance level between parameters is subjectively rated. The value is a number that states the importance scale between one parameter with other parameters

$$CR = \frac{CI}{RI}$$

$$CI = \frac{\lambda maks - n}{n - 1}$$

Fig. 1. *Consistent Index*

The scales range from 1 to 9 [5], where 1 is defined that between A parameter and B parameter have the same importance level with each other. While the value of 9 is defined that A parameter is very important compared to B parameter. After all parameters are compared one by one with other parameters, the matrix multiplication and normalized process are done to obtain a table that states the value of priority or commonly called the priority vector of the parameters arrangement. Priority vector represents the degree of importance between one parameter with other parameters in hierarchy. Before it can be used, the value testing of priority vector can be done by calculating Random Consistent Index (CR) in fig.1. CR value which less than 0.1 concludes that the priority vector can be used as a calculation value in determining a decision according to consistent parameters. Priority vector will be used in calculating the value of parameter between 2 (two) teams that have been set to be paired in the match of Dota 2.

B. Parameter Used

As described above, this research uses four parameters to assess and give decision consideration in predicting the victory of Dota 2 International Game. Those 4 parameters are including:

1) The result of the last 3 head-to-head matches between the competing teams. The difference in the number of wins in the three matches will be an amounted level of interest point in the Team A against team B. The amounted point in the level of interest on AHP is a subjective value. The author found a better final result by multiplying the winning margin of the match with the two that would later be used in calculations on the AHP method.

2) The last 10 matches between competing teams Just like the previous parameters, the difference in the number of wins in the last 10 games passed by both teams will be an amounted level of interest point in Team A against team B. As shown in fig.2, the authors find a better result by adding 1 point on the margin score of victory. The score of the winning difference is determined by adding 0.5 points to the team that earns a draw result, adding 1 point on the winning team and adding a 0 on the losing team. The score will be used in calculations on the AHP method.

3) The average value of experience per minutes (XPM) and gold per minutes (GPM). At each Dota 2 match, each player will earn XPM and GPM at the end of the game that stating the player's contribution level to the team in a match. The average value of XPM and GPM of Dota 2 game ranges from 250 to 700. In this study, this parameter used by the author in predicting the victory of an International Dota 2 match. In the calculations, the author found better results by comparing the average sum of values of XPM and GPM from 5 active players in the team. The difference of 50 points on average score of XPM and GPM by team A against team B will gain 1 point addition to the amounted interest level score of the average parameters of GPM and XPM.

4) The average value of matchmaking ratio (MMR) from 5 active players in the team. On each professional player of Dota 2 has an MMR score that shows the skill level of players during play Dota 2. MMR score is obtained by winning MMR Match every day. By winning MMR Match, Dota 2 player will get 25 points added for MMR score, while if defeated, players will get 25 points deduction for their MMR score. In general, every Dota 2 professional player has an MMR value from 2000 to 9000. MMR score. This MMR point becomes one of the parameters in determining the victory of International Dota 2 match. The author gets a better final score result by giving 1 point addition to the amounted level Interest score for each 500-points difference in MMR on a team against another team. The score will be used in calculations on the AHP method.

C. Used Dataset.

The dataset used in this study is based on the results of previous matches that are systematically summarized by Dotabuff [7] and Dota2 [8].

III. EXPERIMENTS

The proposed system has three stages of process on deciding the victory of the 2nd Dota match. The three processes have the same work process, but are conducted at different points of view. The first process is conducted by looking at the four parameters of decision-making considerations into a single unit. The second process is conducted by looking at the four parameters of decision-making considerations that mutually one with the other. The third process is conducted by uniting the four parameters in the second process by doing the matrix multiplication with the result of the first process and comparing the results of victory predictions of Team A with Team B . The scheme of this study is illustrated in Fig.2

TABLE I. PRIORITY VECTOR

Parameter	Priority Vector
Head to Head	0.46
Last 10 Match	0.28
Avg XPM and GPM	0.11
Avg MMR	0.15

The first process aims to determine the priority vector of 4 predefined parameters. Priority vector shows the priority level between one parameter with other parameters in the form of

hierarchy. The priority vector value is obtained by determining the amount value of interest level from each parameter. The
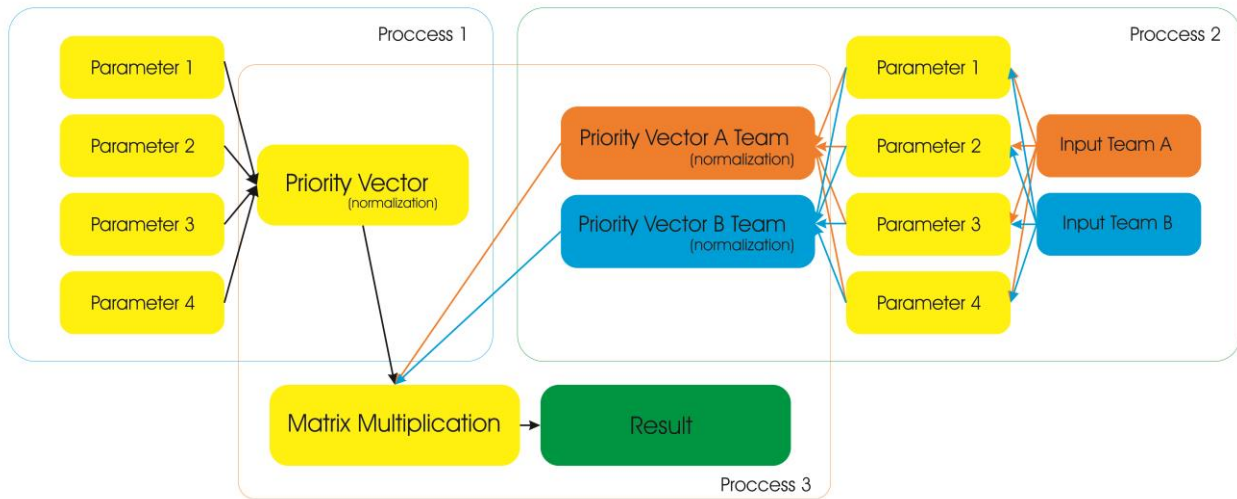

Fig. 2 Method Scheme

value of priority vector is shown in the table I. The calculation result of the interest level from four parameters shows the result of 3 head to head matches between the two competing teams is the most influential parameter. It is shown with the value of 3 head to head matches vector of 0.46, while the smallest influencing parameter are Average XPM and GPM with priority vector value of 0.11.

The first process aims to determine the priority vector of 4 predefined parameters. *Priority vector* shows the priority level between one parameter with other parameters in the form of hierarchy. The *priority vector* value is obtained by determining the amount value of interest level from each parameter. The value of *priority vector* is shown in the table I. The calculation result of the interest level from four parameters shows the result of 3 head to head matches between the two competing teams is the most influential parameter. It is shown with the value of priority vector Head to Head of 0.46, while the smallest influencing parameter are Average XPM and GPM with priority vector value of 0.11.

TABLE II. PAIR VECTOR NAVI VS VIRTUS PRO

Last 10	NAVI	Virtus Pro
Navi	1	0.25
Vuctus Pro	4	1

Head To Head	NAVI	Virtus Pro
Navi	1	0.17
Vuctus Pro	6	1

Avg XPM & GPM	NAVI	Virtus Pro
Navi	1	1.00
Vuctus Pro	1	1

AVG MMR	NAVI	Virtus Pro
Navi	1	1.00
Vuctus Pro	1	1

The second process is aimed to determine the vectors value of both Dota 2 teams who will compete. Each team is rated in accordance with 4 predefined parameters, including 3 Head to Head matches, recapitulation of the last 10 games, the average XPM and GPM values of all team members, as well as the average MMR score of all team members.

The obtained result of *pair vector* is the result of the correlation result of the four parameters between one team and the other team. One of the matches used as a test in this study was a match between NaVi and Virtus Pro on March 13, 2017. Calculations on the second process were initiated by calculating 4 decision-making parameters. In the first parameter, 3 last Head to Head match, Virtus Pro wins all the last match against the Navi. Therefore, it gives the 6 value of interest on the Virtus Pro side, while 1/6 on the Navi side.

The second parameter, last 10 match, the difference score of the match was won by Virtus Pro by 4 more wins than the Navi. It gives a weighting score of 4 on Virtuspro while ¼ on the Navi. In the third parameter, average XPM and GPM, Virtus Pro wins the average difference of XPM and GPM by 12.7 points. Since the difference between of XPM and GPM points is less than 50 points, both teams get the amount of interest score 1 in the third parameter. The last parameter is the

difference of average MMR. The average difference of MMR of both teams are 261.25 points. The difference is less than 500 which makes the amount of interest score of both teams is worth 1. The calculation of the calculated parameter scores can be seen in table II.

TABLE III. NORMALIZATION VECTOR AND MATRIX MULTIPLICATION

Parameter	P. Vector	Navi	Virtus Pro
Head To Head	0.46	0.14	0.86
Last 10 Match	0.28	0.20	0.80
Avg XPM GPM	0.11	0.50	0.50
Avg MMR	0.15	0.50	0.50
Win Persentage		**25%**	**75%**

TABLE IV. EXPERIMENT RESULT

Experiment				
Match			**Result**	**Prediction**
Navi	VS	Virtus Pro	Virtus Pro	Virtus Pro (75%)
Navi	**VS**	**Spirit**	**Spirit**	**Navi (55%)**
Navi	VS	Empire	Navi	Navi (56%)
Navi	VS	Comanche	Navi	Navi(56%)
Virtus Pro	VS	Spirit	Victus Pro	Virtus Pro (77%)
Virtus Pro	VS	Empire	Victus Pro	Virtus Pro (68%)
Virtus Pro	VS	Comache	Victus Pro	Virtus Pro (74%)
Spirit	**VS**	**Empire**	**Empire**	**Spirit (66%)**
Spirit	**VS**	**Comanche**	**Comanche**	**Spirit (53%)**
Empire	VS	Comanche	Empire	Empire (75%)
Friends	VS	Virtus Pro	Virtus Pro	Virtus Pro (78%)
Friends	**VS**	**Spirit**	**Friends**	**Spirit (56%)**
Friends	**VS**	**Empire**	**Friends**	**Empire (66%)**
Friends	VS	Comanche	Comanche	Comanche (55%)
Friends	VS	Navi	Navi	Navi (56%)

After obtaining all parameter scores, the next process is to perform normalization on each parameter score and to form a matrix multiplication between the two vectors with the priority vector that has been generated in the first process. This process is described more succinctly in table III. The result of matrix multiplication between team A's vector and *priority vector* will result a prediction of winning percentage of team A, as well as on team B. This estimation percentage score is the end result of this process. In this case, the method predicts Virtus Pro will win the game against the Navi on March 13, 2017 with a 75% victory percentage.

In the testing phase of the method, the author compares the predicted results with the actual results. In the match of Navi

against Victus Pro on 13 March 2017, the final result of the match was won by Victus Pro. The match is one of the testing schemes undertaken in this study. Testing will be done by taking 6 professional team of Dota 2 that competed in international matches. The 6 teams are Navi, Virtus Pro, Spirit, Empire, Comanche and Spirit. From 6 teams used as subjects test, 15 matches between the teams were obtained to be test matches on this method. The table IV shows the team meet each other in turn and show the calculation results using AHP method with 4 parameters that have been shown before. Table IV shows that 10 out of 15 matches get the correct predictive score.

IV. CONCLUSION

In this research, the application of AHP method on victory prediction of Dota 2 match is considered very good in predicting a victory based on information obtained before the match. The percentage of implementation of this method is at 75%. The output of the system using the AHP method is strongly influenced by the selection of subjective values. In this research, the subjectivity factor that is still encountered is on the determination of rule on each parameter specified. The rule on each parameter specified by the author is determined by looking at the scale of the parameters and the average parameter scores owned by Dota 2 professional players in general. However, the value of subjectivity in this literature is better than the literature on *state of the art*. For future research, the implementation of AHP is expected to review and take into account the use of parameters and rules in parameters that do not have a high degree of subjectivity.

REFERENCES

[1] GamesCricketRugbyEnduranceCFL, R. FB, R. BB, O. Sports, S. Olympics and X. Games, "Esports to join Asian Games as medal sport in 2022", ESPN.com, 2017. [Online]. Available: http://www.espn.com/esports/story/_/id/19185921/esports-join-asian-games-medal-sport-2022. [Accessed: 20- May- 2017].

[2] A. Aribowo, S. Lukas and Y. William, "PREDIKSI HASIL PERTANDINGAN SEPAK BOLA MENGGUNAKAN JARINGAN SARAF TIRUAN DAN LOGIKA FUZZY", Konferensi Nasional Sistem dan Informatika, 2008.

[3] G. Styawan, "ALGORITMA C4.5 UNTUK SIMULASI PREDIKSI KEMENANGAN DALAM PERTANDINGAN SEPAKBOLA", Academia.edu. [Online]. Available: http://www.academia.edu/25357419/ALGORITMA_C4.5_UNTUK_SI MULASI_PREDIKSI_KEMENANGAN_DALAM_PERTANDINGAN _SEPAKBOLA. [Accessed: 14- May- 2017].

[4] M. Nur and A. Lukman, "Algoritma Bayesian Network Untuk Simulasi Prediksi Pemenang PILKADA Menggunakan MSBNx", Academia.edu. [Online]. Available: http://www.academia.edu/6209584/Algoritma_Bayesian_Network_Untu k_Simulasi_Prediksi_Pemenang_PILKADA_Menggunakan_MSBNx. [Accessed: 13- May- 2017].

[5] Saaty, T.L., 1980. "The Analytic Hierarchy Process." McGra w-Hill, New York.

[6] D. Walangare and R. Delima, "Sistem Prediksi Pertandingan Sepak Bola Dengan Metode Analytical Hierarchy Process (AHP)", INFORMATIKA, vol. 8, no. 2, pp. 181-188, 2012.

[7] "Popular Teams", Dotabuff.com. [Online]. Available: https://www.dotabuff.com/esports/teams/. [Accessed: 10- Apr- 2017].

[8] "Dota 2 - Leaderboards", Dota2.com. [Online]. Available: http://www.dota2.com/leaderboards. [Accessed: 10- Apr- 2017