

## GDSS Development of Bali Tourism Destinations With AHP and Borda Algorithms Based on Tri Hita Karana

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### Abstrak

Pengembangan destinasi wisata Bali menggunakan konsep kearifan lokal Tri Hita Karana (THK). THK merupakan sebuah konsep yang mengandung filosofi kehidupan masyarakat di Bali yang berarti tiga penyebab kesejahteraan. Konsep ini diperlukan untuk mewujudkan pariwisata, budaya dan alam. Dalam menentukan keputusan untuk mengembangkan suatu objek di suatu destinasi wisata dengan menggunakan konsep THK, diperlukan pengetahuan dari beberapa pemangku kepentingan. Untuk menggabungkan keputusan dari beberapa pemangku kepentingan diperlukan. GDSS merupakan sistem berbasis komputer yang dapat mendukung Dinas Pariwisata Pemerintah Provinsi Bali dan beberapa komponen yang terlibat dalam THK untuk mengambil keputusan dalam mengembangkan suatu objek di suatu destinasi wisata. Untuk menentukan keputusan setiap individu digunakan model AHP. Model AHP merupakan model yang dapat memecahkan masalah multi kriteria yang kompleks menjadi suatu hierarki. Model AHP ini akan menghasilkan alternatif keputusan individu dari hasil pengolahan bobot parameter untuk setiap individu. Berdasarkan hasil akhir GDSS, pengembangan destinasi pariwisata Bali berbasis THK berupa ranking enam parameter yang digunakan (Promosi destinasi, Peningkatan fasilitas, Sumber Daya Manusia, Sinergi, Pelestarian Lingkungan, Penataan tempat suci tempat). Alternatif yang memiliki nilai tertinggi digunakan sebagai acuan dalam mengembangkan destinasi wisata berbasis THK.

**Kata kunci**—GDSS, AHP, Borda, THK

### Abstract

Development of Bali tourist destinations using the concept of local wisdom Tri Hita Karana (THK). THK is a concept that contains the philosophy of community life in Bali which means three causes of welfare. This concept is needed to realize tourism, culture and nature. In determining a decision to develop an object in a tourist destination using the THK concept, knowledge from several stakeholders is needed. To combine decisions from several stakeholders is needed. GDSS is a computer-based system that can support the Bali Provincial Government Tourism Office and several components involved in THK to take a decision in developing an object in a tourist destination. To determine the decision of each individual used the AHP model. The AHP model is a model that can solve complex multi-criteria problems into a hierarchy. This AHP model will produce alternative individual decisions from the results of parameter weight processing for each individual. Based on the final result of the GDSS, the development of Bali tourism destinations based on THK is in the form of the rank of the six parameters used (Promotion of tourist destinations, Improvement of facilities, Human Resources, Synergy, Environmental preservation, Setting of holy places). The alternative that has the highest value is used as a reference in developing a THK-based tourist destination.

**Keywords**— GDSS, AHP, Borda, THK

## 1. INTRODUCTION

Bali Province is one of the provinces that is famous for its culture and natural tourism so it has become an icon of Indonesian tourism in the eyes of the world. The socio-cultural life of the Balinese people is so unique and religious that it is based on beliefs and religion that are combined harmoniously with the concept of local wisdom Tri Hita Karana, making Bali very attractive to local and international tourists to visit. Tri Hita Karana is a cultural heritage of the past that contains the basic philosophy of Balinese life. Tri Hita Karana is the basis for obtaining happiness in life if you can have a harmonious relationship based on yadnya (rituals, sacrifices) to Ida Sang Hyang Widhi in the form of devotion (sincere), to fellow humans in the form of devotion, and to the natural environment in the form of nature conservation [1][2].

The concept of THK in the implementation of Bali tourism is a concept that can direct the development of Bali tourism for the future to be better and more advanced without losing the culture and norms that form the basis of Balinese life [3]. This has also been regulated in the Regional Regulations of the Province of Bali, precisely in Regional Regulation 5 of 2020 concerning the Standards of Organizing Balinese Cultural Tourism with the Grace of God Almighty. In the regional regulation, precisely in Article 3, it is stated that the standard setting for the implementation of Balinese cultural tourism is aimed at preserving the natural environment and Balinese culture, which is imbued with the Tri Hita Karana philosophy based on the values of Sad Kerthi local wisdom and improving the quality of the implementation of Bali tourism. Thus, it is hoped that this will later realize a dynamic reciprocal relationship between tourism and culture that makes them develop synergistically, harmoniously, and sustainably to provide welfare to the community and cultural and environmental sustainability [4].

The Bali Provincial Government Tourism Office carries out the management and development of Bali tourist destinations. The number of components that need to be further developed in Bali tourist destinations based on the concept of local wisdom Tri Hita Karana makes the Bali Provincial Tourism Office unable to immediately develop a tourist destination based on the wishes and interests of the agency itself. There need to be discussions with the community, holy people (mangku/pinandita), and stakeholders so that the development that will be carried out can be in line with the Tri Hita Karana concept so that the development of Bali tourism can develop synergistically with the lives of all Balinese people. Based on data obtained from the three sources at the Tourism Office of the Bali Provincial Government, the three sources have the same view on the development of Bali tourism destinations based on the Tri Hita Karana concept that must be developed in stages because it requires relatively large funds, especially after the Covid-19 pandemic with the current situation. Bali's economy has not yet recovered, and to find out to what extent these developments can have an effect on the attractiveness of tourist destinations.

Bali for the sustainability of the sustainable development of Bali tourism which is good for the future. Based on this, the Bali Provincial Government Tourism Office needs to make a group decision by considering several aspects of the criteria that are closely related to the concept of local wisdom Tri Hita Karana, namely Parahyangan, Pawongan, and Palemahan to be able to prioritize the components that will be developed in tourist destinations. In determining a decision, many factors influence the decision making of a decision maker, so it is deemed necessary to identify various important factors and consider the level of influence of one factor with other factors before making a final decision [5]. GDSS is a computer-based system that supports a group of people who are involved in a common task (goal) [6]. GDSS combines communication, computation, and decision support technology to formulate solutions to problems that are not structured in several people [7].

One of the DSS models that can manage the factors of perception, preference, experience, and intuition from decision makers into a decision is the Analytic Hierarchy Process (AHP) model [8]. This model was chosen to make an effective decision-making framework for a complex problem by simplifying the decision-making process, solving the problem into

criteria, and then arranging these criteria in a hierarchical arrangement. The AHP method in developing tourist destinations is used to weight the parameters for each decision maker (DM) involved in the process of developing Bali tourist destinations so that the results of the analysis can synthesize various considerations to determine which variables have the highest priority and act to influence the results in that situation [6][8].

This AHP model will produce a rank of values from the results of parameter weighting in each DM, so we need a method to combine the results of the ranks in each DM to obtain an accurate and more objective decision. The Borda method is one method that is suitable for combining the rank results for each DM in the previous AHP method because the Borda method is a method that can accommodate the process of evaluating the analysis of the rank results to determine the development of tourist destinations based on the Tri Hita Karana concept based on the assessment each voter [9][10].

Based on the description above, the authors are interested in conducting research under the title "GDSS Analysis of Bali Tourism Destination Development with the AHP and Borda Algorithm Based on the Tri Hita Karana Concept" so that later this research is expected to help the Bali Provincial Government Tourism Office in analyzing the results of decisions to develop Bali tourist destinations. by involving every element contained in the concept of local wisdom Tri Hita Karana which is considered to have good potential for Bali tourism in the future.

## 2. METHODS

The research method to solve the problem of developing Bali Tourism Destinations with the AHP and Borda Algorithm Based on the Tri Hita Karana Concept.

### 2.1 Concept of Tri Hita Karana

Tri Hita Karana developed, expanded, and became popular in the community. Lexically, Tri Hita Karana means three causes of welfare. (Tri = three, Hita = prosperity, Karana = cause). In essence, Tri Hita Karana contains the understanding that the three causes of welfare are rooted in the harmonious relationship between humans and their gods, humans and their natural environment. Humans with each other [4][3].

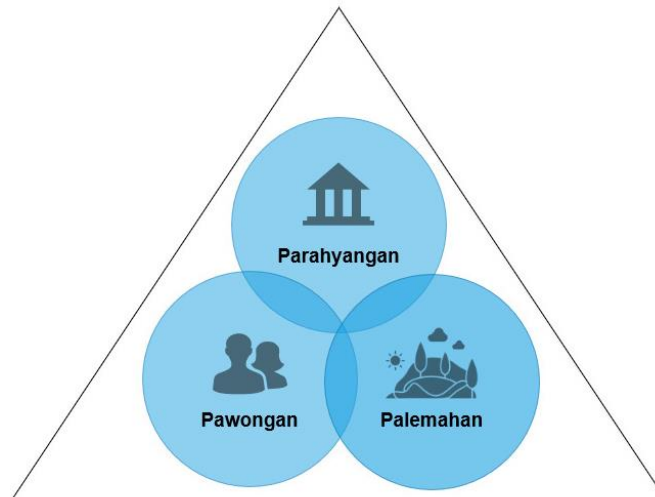


Figure 1 Schematic of Tri Hita Karana

Bali Tourism Based on Tri Hita Karana, To preserve Balinese culture and nature from the influence of tourism globalization, it is necessary to measure the application of the Tri Hita Karana Values, namely, the relationship between humans (pawongan), the relationship between humans and the environment (palemahan) and the relationship between humans and God. (parahyangan) is a source of dynamics of change and development in Bali tourism. Due to the

rapid development of the times in this current era, the life of the Balinese people has undergone many changes from the influx of unfiltered foreign cultures. Through the application of the Tri Hita concept, the development of tourism in Bali can lead to the development of sustainable tourism. Tourism development towards sustainable tourism needs to generate income, create jobs and conserve ecosystems by positively impacting the environment and local culture [3][11][12].

## 2. 2 Alternative, Decision Maker (DM) and Criteria

As for alternatives, the decision maker (DM) and the criteria used in the development of Bali tourist destinations with the AHP and Borda algorithms based on the Tri Hita Karana concept are explained in the following sub-chapters.

### 2. 2. 1 Alternatives

Alternatives are different objects with the same opportunity to be selected in a decision support system. In this study, some alternatives have the chance to be chosen to be developed in Bali tourist destinations based on the concept of local wisdom Tri Hita Karana. These alternatives are described in Table 1

Table 1 Alternatives to the Development of Bali Tourism Destinations Based on the THK Concept

Code	Description	Description
A1	Promotion of tourist destinations	<i>Pawongan</i>
A2	Facility repair	<i>Palemahan</i>
A3	Human Resources (HR)	<i>Pawongan</i>
A4	Synergy	<i>Palemahan &amp; Pawongan</i>
A5	Environmental Conservation	<i>Palemahan</i>
A6	Sanctuary setting	<i>Parahyangan</i>

### 2. 2. 2 Decision Maker (DM)

*Decision maker* Is someone who has the right to determine or make a decision. In this study, DM to determine decisions in the development of Bali tourist destinations based on the concept of local wisdom Tri Hita Karana is divided into three DMs. DM 1 is the Head of the Tourist Attraction Development Section, which represents the Parahyangan section, DM 2 is the Head of Human Resources Development and Institutional Division, who represents the Pawongan section; and finally, DM 3 is the Head of the Tourism Destinations Section who represents the Palemahan section. The details of each of the three DMs are described in Table 2.

Table 2 DM Development of Bali Tourism Destinations based on the THK concept

Code	Description	Clasificaiton
DM1	Head of Bali Tourism Attraction Development Section	<i>Parahyangan</i>
DM2	Head of Institutional and HR Development Bidang	<i>Pawongan</i>
DM3	Head of Tourism Destinations	<i>Palemahan</i>

### 2. 2. 3 Criteria

Criteria are parameters that are used as a reference in making a decision. In this study, each DM has its own criteria to be able to determine the available alternative options. In Table 3, the criteria for each DM will be described. A decision support system is an information system at the management level of an organization that produces various alternative decisions by combining data and sophisticated analytical models or data analysis tools to support semi-structured and unstructured decisions,

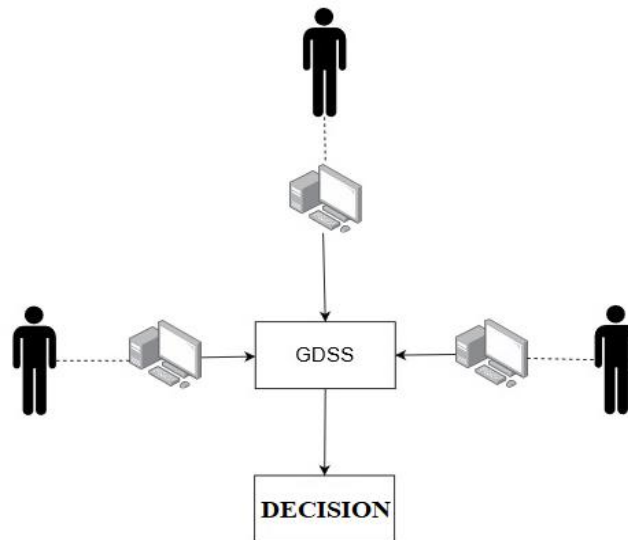


Figure 2 GDSS General Model

In determining a decision to develop a Bali tourist destination based on the concept of local wisdom THK, the Bali Provincial Government Tourism Office requires a group decision by considering several aspects of the criteria that are closely related to the concept of local wisdom Tri Hita Karana, namely parayangan, pawongan, and palemahan. to be able to prioritize the components that will be developed in Bali tourist destinations. GDSS is a computer-based system that supports groups of people who are involved in a common task (goal).

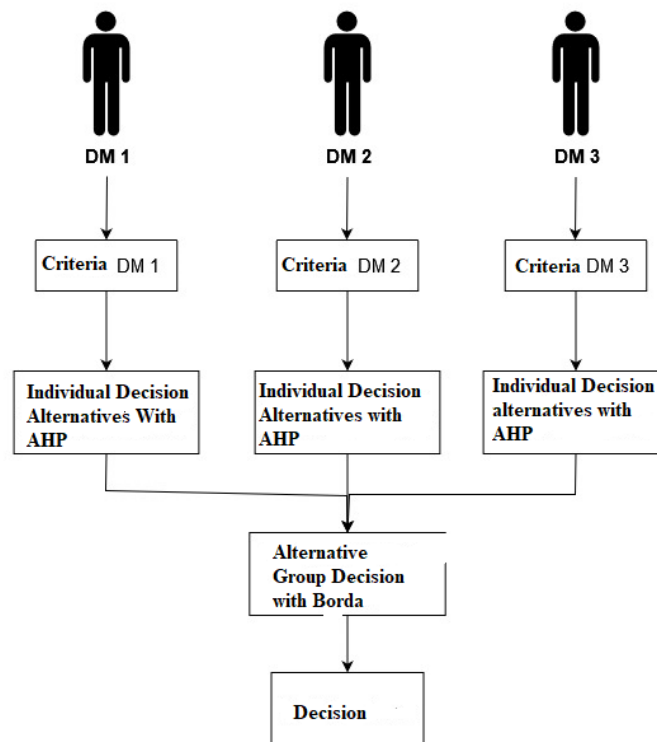


Figure 3 Decision Making Model for Bali Tourism Destination Development

GDSS systems have been widely applied in organizations or companies, the capabilities inherent in group decision support systems can help organizations or companies that use them

and allow the creation of coordination of both internal and external activity processes in a more accurate way [7][10].

#### 2. 4 Analytical Hierarchy Process (AHP)

The AHP method is one of the decision-making methods proposed by Thomas L. Saaty. The workings of this method are almost similar to the way the brain works, namely by breaking down complex problems into more structured and systematic problems [13, 14]. The problem solving is done by using the principle of hierarchy. According to Saaty, the hierarchy is organized into a structure consisting of several levels. The order of the levels/levels is the objectives, criteria, sub-criteria and so on until the alternative level [15]. The steps used in solving a problem with AHP are as follows [16, 17]:

- 1) Defining a problem and determining the solution to the problem as desired, then compiling a hierarchy of the problems encountered.s
- 2) Determine the priority of an element. The step in determining priority is to create a pairwise comparison matrix. The comparison matrix is a square matrix  $A = (a_{ij})_{n \times n}$  yang meliputi:  $a_{ij} > 0$ ,  $a_{ij} = 1/a_{ji}$  dan  $a_{ii} = a_{jj} = 1$ , which is often called the reciprocal matrix.
- 3) Sintesis.

Considerations for pairwise comparisons are synthesized to obtain priority values. The way this is done is.

- a. Adding the values of each column in the matrix

$$\sum_{i=1}^n a_{ij}, \quad i, j = 1, 2, \dots, n. \quad (1)$$

- b. Divide each value in the column by the total column to get the normalized value of the matrix matrix

$$a'_{ij} = \frac{a_{ij}}{\sum_{i=1}^n a_{ij}}, \quad i, j = 1, 2, \dots, n. \quad (2)$$

- c. The sum of each value in the row and then dividing by the number of elements to get the average value.

$$W_i^T = \frac{\sum_{j=1}^n a'_{ij}}{n}, \quad i, j = 1, 2, \dots, n. \quad (3)$$

- 4) Measure the value of consistency.

- a. Consistent value is determined to find out how well it is used in a decision. In measuring the consistent value the steps taken are:
- b. Multiply each value in the first column by the relative priority of the first element, the value in the second column by the relative priority of the second element, and so on.
- c. Sum each row.
- d. The results obtained from adding up each row are then divided by the respective relative priority elements.
- e. Adding the above quotient by the number of elements present, and the final result is called  $\lambda$  maks.

$$\lambda \max = \sum_{i=1}^n \sum_{j=1}^n a_{ij} W_j \quad (4)$$

### 3. RESULTS AND DISCUSSION

#### 3.1 Individual Rank

The calculation process for determining alternative developments for Bali tourist destinations based on the THK concept, begins with comparing the criteria for each DM. This comparison of criteria aims to find the weight of each criterion. The following is a comparison of criteria for DM 1 which is described in Table 6. The next process is to find the Consistency Ratio (CR) value from the process of determining the weight value for each DM. The value of CR can be obtained by dividing the value of CI by the value of IR or random index.

Table 6 Comparison of Criteria for Development of Bali Tourism Destinations DM 1

	K <sub>1</sub>	K <sub>2</sub>	K <sub>3</sub>	K <sub>4</sub>	K <sub>5</sub>	K <sub>6</sub>
K <sub>1</sub>	1	1	5	1	5	3
K <sub>2</sub>	1	1	4	1	3	3
K <sub>3</sub>	0,2	0,25	1	1	3	3
K <sub>4</sub>	1	1	1	1	5	3
K <sub>5</sub>	0,2	0,333	0,333	0,2	1	2
K <sub>6</sub>	0,333	0,333	0,333	0,333	0,5	1
SUM	3,733	3,917	11,667	4,533	17,5	15

The IR value can be obtained based on the number of elements that exist, then convert it based on the IR table from the AHP model that has been provided. If the CR value obtained is less than or equal to 0.1 then the calculations performed can be declared consistent, but if the calculations performed get results greater than 0.1 then the calculations can be declared inconsistent and the criteria comparison process must be repeated again, until with a CR value of less than 0.1. Table 6 and Table 7 above show the results of each calculation step in the AHP model for comparison of DM 1 criteria. The same is done for comparison of DM 2 and DM 3 criteria.

Table 7 DM Alternative Weight 1

	Multiply	Roots	Normalized	Cn	Wi
K <sub>1</sub>	75	2,053573307	0,2852	3,733333	1,064824927
K <sub>2</sub>	36	1,817120593	0,2524	3,916667	0,988488435
K <sub>3</sub>	0,45	0,875391017	0,1216	11,667	1,418469839
K <sub>4</sub>	15	1,570417802	0,2181	4,533333	0,988790065
K <sub>5</sub>	0,008889	0,455136061	0,0632	17,5	1,106242974
K <sub>6</sub>	0,006173	0,428299431	0,0595	15	0,892298139
	SUM	7,199938211	1	Lamda :	6,45911438
RI	1,24				
CI	0,0918				
CR	0,0741				
consistent	consistent				

The individual rank process is obtained from the results of the DM assessment of each alternative. After calculating the alternative weight values of each of the criteria contained in each DM, the alternative rank of each DM is determined. Where this process will produce a final score, the highest value will get the first rank, and the lowest value will get the last rank. Table 8 shows the results of the individual rank of DM 1, namely the Head of the Bali Tourism Attraction Development Section.

Table 8 DM Individual Rank 1

Kode	K1	K2	K3	K4	K5	K6	Rank
Bobot	0,2852	0,2524	0,1216	0,2181	0,0632	0,0595	
A1	0,4185	0,0794	0,3556	0,1554	0,1171	0,2883	2
A2	0,0922	0,0689	0,2490	0,2083	0,1363	0,3315	4
A3	0,1570	0,1270	0,0817	0,0805	0,3706	0,0943	5
A4	0,1472	0,2172	0,0817	0,1679	0,1673	0,0943	3
A5	0,1261	0,4385	0,1397	0,3402	0,1043	0,0900	1
A6	0,0589	0,0689	0,0921	0,0476	0,1043	0,1014	6

Table 9 shows the results of the rank of individuals in DM 2, namely the Head of Institutional Development and Human Resources. The rank shown in DM 2 has a difference from that shown in Table 8, namely the results of the rank of individuals in DM 1.

Table 9 DM Individual Rank 2

Kode	K1	K2	K3	K4	K5	K6	Rank
Bobot	0,2259	0,2259	0,2176	0,1939	0,0922	0,0446	
A1	0,1716	0,2142	0,2612	0,1829	0,1900	0,0597	1
A2	0,1313	0,0952	0,0973	0,1567	0,1543	0,3014	5
A3	0,1059	0,0663	0,1127	0,0869	0,1304	0,0911	6
A4	0,1105	0,0714	0,2793	0,1077	0,1513	0,0773	4
A5	0,0642	0,0952	0,1007	0,2607	0,1424	0,2227	3
A6	0,4165	0,4579	0,1488	0,2051	0,2316	0,2477	2

Table 10 shows the results of the rank of individuals in DM 3, namely the Head of the Tourism Destinations Division. The ranks shown in DM 3 have differences from those shown in Table 8 and Table 9, namely the results of individual ranks in DM 1 and DM 2. Where the differences in individual rank results produced by each DM will then be analyzed using the Borda model.

Table 10 DM Individual Rank 3

Kode	K1	K2	K3	K4	K5	K6	K7	Rank
Bobot	0,2209	0,1812	0,3307	0,0664	0,0553	0,0428	0,1027	
A1	0,0901	0,0813	0,2612	0,4275	0,1180	0,0521	0,2167	3
A2	0,0580	0,0415	0,0973	0,0935	0,0966	0,3187	0,1138	6
A3	0,3567	0,1772	0,1127	0,1081	0,3232	0,0951	0,3636	1
A4	0,2295	0,1167	0,2793	0,0935	0,1090	0,0785	0,0946	2
A5	0,0668	0,3269	0,1007	0,0744	0,1260	0,2515	0,1438	5
A6	0,1670	0,2564	0,1488	0,2342	0,2271	0,2040	0,0675	4

### 3. 2 Alternative Decisions with Borda

The next calculation is to combine the rank results obtained in each DM using the Borda model by determining the rank and value of  $n$  for each alternative in each DM. Then the value of  $n$  for each alternative is adjusted to the rank points obtained, where the first rank will get the largest value and vice versa. The values obtained by each alternative are added together to obtain the total value that will be converted into the rank results. The following describes the assessment of points in Table 11 for rank using the Borda model.



Table 11 Rating with Borda

DM	Preferred Candidate/Alternative						Rank	Point
	A1	A2	A3	A4	A5	A6		
DM1	2	4	5	3	1	6	1	6
DM2	1	5	6	3	4	2	2	5
DM3	3	6	1	2	5	4	3	4
							4	3
							5	2
							6	1

In Table 11, the rank of the results of the alternative assessment of each DM is described. In the table there is a column of rank and points which is an elaboration of the value or points obtained when rank with the Borda model. Furthermore, these values are added up so as to produce a final ranking. Table 12 describes the results of the calculation of the values in Table 11. Table 12 shows that alternative A1, namely Tourism Destination Promotion, is ranked first, while alternative A2, namely Facility repair, is ranked sixth or last.

Table 12 Alternative Final Decision Results

Alternative	DM1	DM2	DM3	Total	Rank
Promotion of tourist destinations	5	3	4	15	1
Facility repair	3	2	1	6	6
Human Resources (HR)	2	1	6	9	4
Synergy	4	4	5	13	2
Environmental Conservation	6	3	2	11	3
Sanctuary setting	1	5	3	9	5

Based on these results, it can be concluded that in the development of tourist destinations based on the Tri Hita Karana concept at the Monkey Forest Ubud tourist destination, an alternative that needs to be developed in these tourist destinations is an alternative Tourism Destination Promotion.

#### 4. CONCLUSION

Based on the results of the research and discussion that has been carried out, it is concluded that the GDSS modeling made by applying the AHP and Borda algorithms can determine the alternatives needed to develop a tourist destination based on THK local wisdom by using an assessment from each DM based on the following sections: Part of THK is Parahyangan, Pawongan, and Palemahan. The results obtained in this GDSS can be a recommendation for the Bali Provincial Government Tourism Office to develop a tourist destination based on the THK concept. GDSS in developing Bali tourism destinations based on THK is dynamic because the parameters used can be changed according to developments and the required needs.

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