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Optimization Model of Multi Criteria Decision Analysis for Smart and Sustainable Sport Tourism Planning Development Problem

Husain[1*], Bambang Krismono Triwijoyo[2], Muhammad Taufik[3], Herman Mawengkang[4]

[1] Department of Engineering, Universitas Bumigora, Mataram 83127, Indonesia
[2] Department of Computer Science, Universitas Bumigora, Mataram 83127, Indonesia
[3] Department of Humaniora, Law, and Tourism, Universitas Bumigora, Mataram 83127, Indonesia
[4] Department of Mathematics, Universitas Sumatera Utara, Medan 20155, Indonesia

Corresponding Author Email: husain@universitasbumigora.ac.id

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ABSTRACT

The development of sustainable tourism planning is comprised of various interrelated components. As a result, the system is complex, with each factor involved having its own unique goals and management strategies. This phenomenon triggers unexpected conflicts among stakeholders. Given the dynamic and complex challenges in sustainable tourism development, the ability to identify them is required. Therefore, the study aims to delve deeper into factors that influence the implementation of sustainable smart sports tourism planning. It also explores strategies required to analyze the dynamic causal relationships of these factors using a system approach method with the causal loop diagram (CLD) model and produce a new multi criteria decision analysis (MCDA) dynamic computational model which represents conditions in terms of tourist visit rates and economic and environmental improvements that describe the interrelationships of interacting factors. This model is implemented by maximizing service quality, maximizing marketing, maximizing regional income, minimizing implementation costs, maximizing the use of smart/ICT, minimizing environmental damage, minimizing tourist destination promotion, and maximizing investment. maximizing art and cultural activities. Smart and sustainable sports tourism planning and development use the model as a consideration and decision-making tool.

1. INTRODUCTION

Sustainable tourism development can be regarded as a part of the economic development of a country, such as Indonesia, and in particular of a region. For instance, this activity enable creates jobs for the wider community which in turn allows for an increase in the overall income of the community, which automatically improves the prosperity of the community [1, 2]. One of the determining factors for the success of tourism development is the application of ICT (Information Communication and Technology) which is now rapidly developed [3]. Developing a sustainable tourism plan is often complex and dynamic, and there are many factors involved that are interdependent with each other. Normally, each factor has different goals and interests, which will lead to unexpected conflicts among stakeholders. Therefore, the ability to identify the dynamic influence of these multi-faceted problems is necessary [4, 5].

In the development of sustainable tourism, there are several supporting factors involved, including: tourists, central and local governments, business actors, investment, surrounding communities, infrastructure, budget, taxes, transportation, environment [6, 7]. The researchers conducted this research to gain a deeper understanding of the planning problem and identify the factors that impact the execution of the sustainable tourism development plan. To analyze the dynamic causal relationships of these factors, we use a systems approach method with the causal loop diagram (CLD) model that will create a new multi criteria decision analysis (MCDA) dynamic computational model. This model represents both economic and environmental conditions in terms of the level of tourist visits. The model addresses several priorities, including maximizing service quality, maximizing marketing, maximizing regional revenue, minimizing operator costs, maximizing smart and ICT utilization, and minimizing environmental damage. The model is used for consideration and decision-making for sustainable tourism development planning. The contribution to sustainable tourism development planning, creating a dynamic model in the form of a clear causal loop diagram (CLD) and a new mathematical function MCDA can contribute to science, academics, information and computer technology and can be used as reflection material by future researchers about knowledge that can add insight into the field of decision-making theory, the development of model design methodology, and practical problem management especially in terms of smart and sustainable sports tourism development planning decision making.

Practical implications of this study are for strategic planning for government and other stakeholders. Local governments can utilize this model as a guide to formulate policies that balance economic, social, and environmental aspects for the development of sports tourism destinations. This model also assists stakeholders in establishing optimal priorities that align with identified criteria, including service quality, investment, and environmental impacts, among others. Efficiency and optimization of this model enable sports tourism destination management to optimize operational efficiency, thereby reducing maintenance and promotion costs. Additionally, the integration of smart technology into the model enables data-driven management, including the prediction of tourist visits and the analysis of the environmental impact of tourism activities. By implementing effective marketing strategies and utilizing smart technology, sports tourism destinations can enhance their international appeal while ensuring sustainability. Interestingly, this model offers guidance on how to create a unique sports tourism experience by integrating local arts and culture while minimizing negative environmental impacts. By prioritizing policies that minimize ecosystem damage, this model can help reduce environmental impacts. These implications are crucial for ensuring the long-term sustainability of sports tourism destinations, particularly in areas that are susceptible to exploitation.

Related works of this paper has been widely used in decision making for the tourism and sports sectors, such as previous studies have used MCDA to evaluate the attractiveness of sports tourism destinations based on criteria such as infrastructure, sustainability, and accessibility. However, this approach is often static and does not take into account dynamic factors such as changes in global tourism trends [8].

In decision making research, MCDA is used to balance the interests of various stakeholders, such as government, local communities, and tourists. However, the integration of often conflicting preferences requires a more efficient optimization method [9, 10].

Studies related to the use of technology for intelligent planning artificial intelligence (AI) and machine learning and big data have begun to be integrated into tourism planning to identify tourist visit patterns, preferences, and environmental impacts and can help develop predictive models for long-term planning. However, the integration of this data within the MCDA framework is still rarely adopted in the development of sport tourism is still in its early stages [11-13].

2. DEFINITIONS

2.1 Tourism

Tourism is an activity that is closely related to recreational activities or trips [14]. In universal terms, the interpretation of tourism is a vacation trip to be carried out for some time from one tourist location to another, together with a plan to seek or simply to enjoy holiday activities to fulfill various kinds of desires [15]. Tourism is an activity that involves sightseeing expeditions [16]. Etymologically, the word tourism can be interpreted or considered with the word travel, where in English pronunciation, what is meant as an expedition or a traveler is to repeatedly visit a tourist destination from one location to another [15].

Sports tourism is a form of tourism in which sporting activities are the main attraction for tourists [17, 18]. In this context, tourists travel to a place with the intention of participating in sporting activities, watching sporting events, or even just enjoying the sporting facilities available at that location [19].

Sports tourism encompasses a wide range of activities, such as [20, 21]:

1. Active participation: Tourists directly participate in sports, such as cycling, hiking, skiing, golf, diving, or running a marathon.
2. Watching sporting events: Tourists travel to watch major sporting events, such as the Olympics, the World Cup, or international tennis matches.
3. Experience sporting facilities: Tourists visit places that are famous for certain sporting facilities, such as ski resorts, historic stadiums, or sports complexes.

Sports tourism plays an important role in local economies because it can attract large numbers of visitors, increase local revenues, and promote the location as a tourist destination [22].

2.2 Sustainable tourism

The term "sustainable tourism" refers to travel that meets the demands of tourists, the travel industry, the environment, and local communities while taking into account all potential economic, social, and environmental effects [23, 24]. Sustainable tourism is a long-term tourism development strategy that encompasses several aspects. These include environmental aspects, such as the development of hotel and restaurant accommodations, which prioritize integrated coverage, and socio-cultural aspects, which involve adapting to the local culture of a tourist destination to preserve local culture and wisdom, thereby enabling tourists to gain a deeper understanding of the local community [25, 26].

Cultural heritage that is owned by the local population, then the economic aspect with the hope that the local community will get an impact on the economic improvement of the existence of sustainable tourism so as to open up job opportunities and opportunities to educate businesses that support the tourism industry and the creative economy [27, 28]. One example of sustainable tourism development is agrotourism, ecotourism, sport tourism etc. [29].

2.3 Model

A model is a representation of an object, thing, or idea in the simplified form of a condition or phenomenon. The model aims to study the actual system phenomenon by incorporating information about it [30, 31]. A model can be an imitation of an actual object, system, or event that only contains information that is considered important to be studied [32]. The purpose of modeling studies is to determine the information that is considered important to be collected, so that there is no unique model [33]. One system can have various models, depending on the model builder's point of view and interests. System modeling is a collection of activities in modeling where the model is a representation or abstraction of an object or actual situation, a simplification of a complex reality [34].

2.4 Causal loop diagram

Causal loop diagram (CLD) is an appropriate method for illustrating feedback and causative links in a given problem scenario. In order to show how the dependent variable changes when the independent variable changes, the variables are connected by causal connections that are represented by arrows [35]. Each causal link has a link polarity that can be either positive (+) or negative (-). Loop identifiers, which specify whether a loop provides positive (reinforcing) or negative (balanced) feedback, also highlight significant loops [36, 37].

A causal diagram as shown in Figure 1 illustrates the causal relationship between variables by connecting them with arrows. A causal link explains how one factor affects another. When the two components of the causal link are as follows: (1). A positive relationship is when element A positively influences element B, meaning that when the value of A rises, the value of B also rises. (2). Negative relationship: A situation in which element A has a detrimental effect on element B, meaning that a rise in A's value results in a fall in B's value. One example of the causal loop diagram (CLD) is as follows [38-40]:

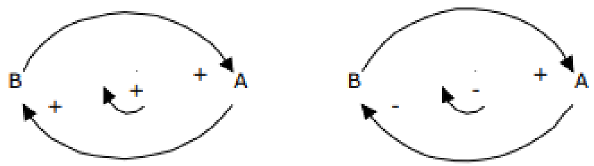

Figure 1. Causal loop diagram illustration

3. METHOD

The following is a flow diagram in creating a dynamic MCDA model for planning smart and sustainable sports tourism development.

1. Literature study

Literature research attempted to obtain theories about the case that has been formulated. These theories act as a guide to obtain solutions in dismantling the problems faced. The researchers gather information from books or scientific papers associated with this study.

The collection of information carried out in this research uses primary information and secondary information that is qualitative.

2. Primary data

Primary data is information obtained from the object being studied directly, all information obtained for the purposes of dissertation research.

3. Secondary data

Secondary data is in the form of existing information obtained from previous research results. The data is divided into internal and external secondary information. Internal secondary information is interpreted for example as information that influences organizational policy. On the other hand, external secondary information to be used in the form of library research, namely data.

4. Formulating supporting factors

Formulating supporting factors, stakeholders who are directly or indirectly involved in the implementation and development plan for smart and sustainable sports tourism, these factors will later become a variable.

5. Making causal loop diagram

After the supporting factors are determined, they are then analyzed using a causal loop diagram to obtain a cause and effect that shows the interrelated relationship between each factor/variable in a smart and sustainable sports tourism development plan.

6. Model simulation

The model that has been produced is then simulated using the Vensim application. By using this simulation, the model that has been described in the form of CLD can be simulated by looking at the influence of each factor/variable both when optimizing and minimizing.

7. Model creation

To build a new model, first try the existing problem definition, so that the next step is based on the problem definition, a conceptual model is formulated that displays the relationship between aspects/variables that determine the model's attitude. This model includes a verbal model that only describes the problem, system, and research objectives.

4. RESULT AND DISCUSSION

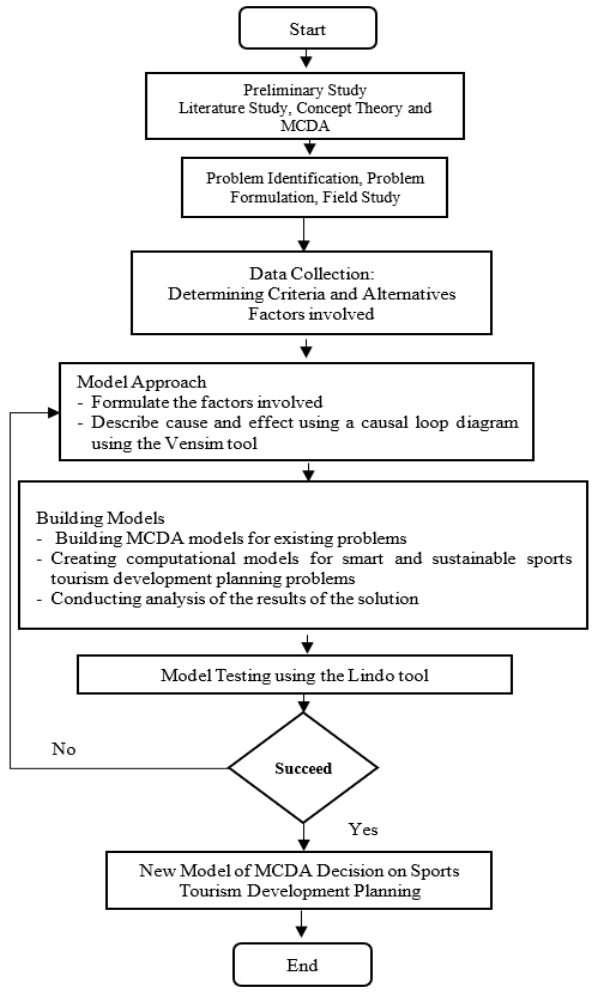

Figure 2. Research process flowchart

Figure 2 describes and discusses the factors that influence each other in the development of sustainable Islamic tourism.

This paper presents a feature selection technique modeled as a combinatorial optimization problem for sentiment analysis. We propose a metaheuristic approach to solve the problem. The approach's basic idea is to explore the resulting continuous solution space containing feasible integer solution points for the combinatorial optimization problem. Figure 3 shows the causal relationship, the relationship between one variable and another that influences each other in the development of smart and sustainable sports tourism. In general, there are nine priority factors in the decision-making analysis, including maximizing service quality, marketing, regional income, implementation costs, utilization of smart/ICT, environmental damage, promotion of tourist destinations, maximizing arts and cultural activities. From all these priority factors, there is a causal relationship between one and another that can affect the development of smart and sustainable sports tourism.

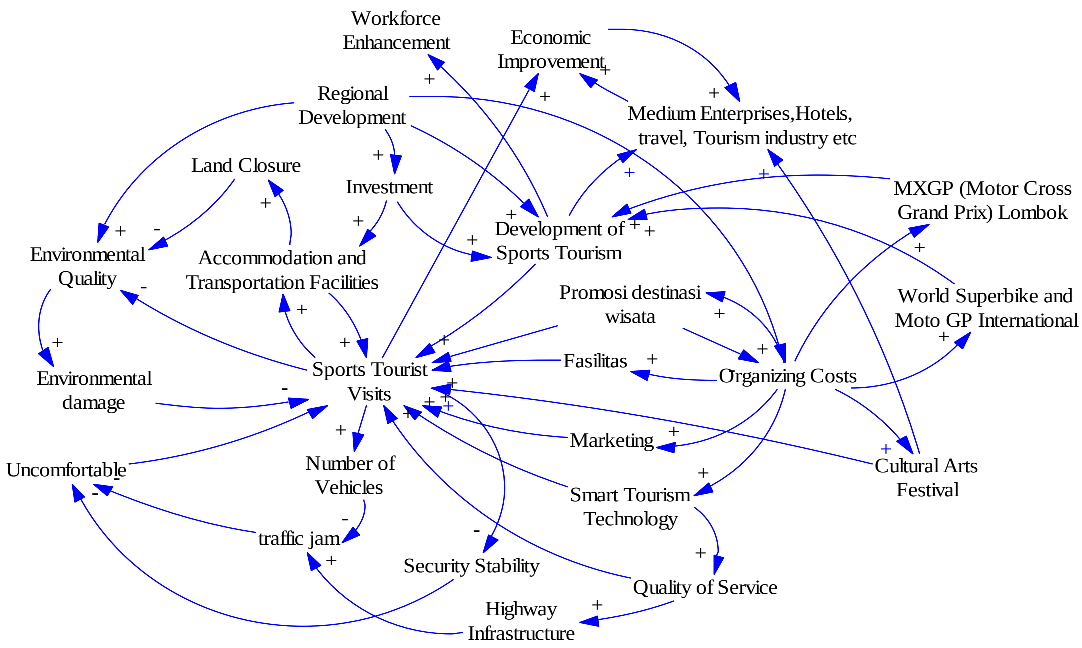

Figure 3. Causal loop diagram development of sustainable sport tourism

The following are the reasons for selecting the criteria in the MCDA model research for optimizing smart and sustainable sports tourism planning:

1. Maximizing service quality

Service quality is an important element in creating a satisfying tourism experience. In the context of sports tourism, quality services include the comfort of sports facilities, visitor safety, and professionalism of the workforce. This criterion was chosen because high service quality will increase tourist loyalty and destination attractiveness [41].

2. Maximizing marketing

Effective marketing, including through digital media, influences the attractiveness of sports tourism destinations globally [42]. This criterion aims to ensure that the destination is widely known by the target market, by utilizing modern marketing strategies such as social media, digital campaigns, and technology-based promotions.

3. Maximizing regional income

Sports tourism contributes significantly to regional income through taxes, levies, and tourist spending [43]. This criterion is important because increasing regional income supports infrastructure development and the welfare of local communities.

4. Minimizing maintenance costs

Sports facilities require significant maintenance costs to keep them functioning optimally [44]. This criterion was chosen to ensure operational cost efficiency, so that resources can be allocated to other destination developments.

5. Maximizing the use of smart technology/ICT

Smart technologies such as IoT, big data, and AI help create efficient and user-friendly destinations [44]. In sport tourism, these technologies are used to enhance the tourist experience, visitor data management, and operational efficiency. This criterion was chosen because smart technology is part of the concept of "smart tourism."

6. Minimizing environmental damage

Environmental sustainability is a key component of sustainable tourism [45]. This criterion aims to reduce negative impacts, such as carbon footprint, ecosystem damage, and waste from sport tourism activities, so that tourism can run without sacrificing long-term sustainability.

7. Minimizing destination promotion costs

Although marketing is important, promotion costs must be optimized to prevent waste of resources [46]. With digital and community-based marketing strategies, promotion costs can be reduced without reducing their effectiveness.

8. Maximizing investment

Investment in sport tourism, both from the public and private sectors, is needed for the development of infrastructure, facilities, and other supporting activities [47]. This criterion was chosen to encourage investment that supports the growth of sport tourism destinations in a sustainable manner.

9. Maximizing arts and culture activities

Local arts and culture are unique attractions that can enhance the tourist experience while preserving cultural heritage [48]. This criterion was chosen because the integration of arts and culture activities in sport tourism helps promote local values and creates a positive impact on the local community.

Main reasons for criteria selection:

1. Criteria reflect the various interests of tourists, governments, local communities, and investors or multi-stakeholder complexity.
2. Alignment with the Sustainability Pillars, these criteria cover economic, social, and environmental dimensions, in line with the principles of sustainable development.
3. Relevance to the smart tourism concept, the integration of technology and operational efficiency are the focus to face the challenges of the digital era.
4. Support for long-term development, the reason for

selecting the criteria in ensuring a sustainable positive impact on sport tourism destinations.

5. The combination of these criteria provides a holistic approach to optimizing planning and decision-making in sport tourism.

4.1 Modeling the MCDA

The classical multiple-criteria decision-making (MCDM) model describes how to evaluate, prioritize, and choose the most advantageous option from a set of options, each of which is characterized by multiple, often conflicting levels of performance across a variety of characteristics [49, 50]. The ultimate choice is made by taking into account intra-attribute and inter-attribute comparisons, frequently requiring trade-off procedures. Mathematically, the following matrix can be used to describe a typical MCDM problem with m choices and n criteria.

With the use of technology, the optimization model tourism system planning for intelligent and sustainable sport has nine goals, including:

Maximize its quality of service.
Maximize its marketing efforts.
Maximize its regional income.
Minimize maintenance costs.
Maximize its use of smart/ICT technologies.
Minimize environmental damage.
Minimize promotion of tourist destinations.
Maximize its investment potential.
Maximize arts and cultural activities.

It is seen that all objective happens in a way simultaneously, however there is conflict between each other. Thus, the appropriate optimization model with a condition problem is a multi-objective program model outlined in programming models multi-objective optimization or multi criteria decision analysis programming (MCDAP).

The general MCDAP model can be stated in expression mathematics as following:

Maximize,

$$[f_h(x), h \in K] \tag{1}$$

with constraint,

$$x \in X = \{x : Ax \leq b,\ x \in [0, r)\} \tag{2}$$

where, $h = \{1,2,\dots,K\}$ is the number of functions, and A is the coefficient matrix of the constraints and b is the right-hand side vector, whereas known data is $b \in R^m$. Then $f_h(x)$ is a linear function of the decision variable *x,* and *r* is the *n* upper limit given to *x*.

4.1.1 Classic MCDM model

Multiple-criteria decision-making (MCDM) models outline how to evaluate, prioritize, and select the most advantageous alternatives from a set characterized by multiple, often conflicting, levels of achievement across various attributes [51, 52]. The final decision is made by considering both inter-attribute and intra-attribute comparisons, potentially involving trade-off mechanisms. Mathematically, a typical MCDM problem with *m* alternatives and *n* criteria is represented by the following matrix:

$$\begin{array}{c c} & \begin{array}{cccc} c_1 & c_2 & \cdots & c_n \end{array} \\ \begin{array}{c} a_1 \\ a_2 \\ \vdots \\ a_m \end{array} & \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \end{array} = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_m \end{bmatrix} \tag{3}$$

where, $x_{ij} \in [0,1]$ represents the alternative level of achievement a_i, $i = 1,\dots,m$ with respect to the criterion $c_j, j = 1,\dots,n$ with 0 interpreted as “no satisfaction” and 1 corresponding to “complete satisfaction.” It is also common to introduce a weight vector $w \in [0,1]^n, \sum_{j=1}^{n} w_j = 1$ whose generic components $w_j, j = 1,\dots,n$ is the weight associated with a criterion c_j that represents its relative importance.

Evaluation of alternatives is carried out using an aggregation function $f: [0,1]^n \rightarrow [0,1]$, which maps a vector of criteria values x_i, $i = 1,\dots,m$ to the interval [0,1] and fulfill, for all $\boldsymbol{x}, \boldsymbol{y} \in [0,1]^n$,

$$\begin{cases} f\underbrace{(0,0,\dots,0)}_{n\ times} = 0 \\ f\underbrace{(1,1,\dots,1)}_{n\ times} = 1 \end{cases} \text{(Boundary Guarding)} \tag{4}$$

$$\boldsymbol{x} \leq \boldsymbol{y} \Rightarrow f(\boldsymbol{x}) \leq f(\boldsymbol{y}) \text{ (Monotonicity)} \tag{5}$$

The resulting value is considered a score indicating how preferred the corresponding alternative is, with the common understanding that 0 corresponds to “no preference” and 1 to “strongest preference”. Given this score, alternatives can then be ordered, resulting in a ranking, and the best possible one is selected.

It is evident that the choice of aggregation function, used to combine criterion values into a single score, plays a critical role in these models. Consequently, their mathematical properties must be thoroughly categorized and understood. To address this, the following sections present some of the most commonly used aggregation functions, highlighting notable properties and offering references to relevant literature for interested readers.

4.1.2 Goal programming (GP)

Goal programming (GP) is an important part of field of MCDAP optimization. This is because through this GP model, MCDAP issues can be easier to resolve. The idea of goal programming (GP) is to form level achievement from every objective or criteria, so first of all must be submitted is the goal of each desired objective obtained, then desired solution the defined as minimum deviation value for every goal.

Suppose objective f_i has a negative deviation, or not achieving the goal (target) d_i^- and then has a positive deviation, that is, exceeding the goal d_i^+, then the mathematical formulation of goal programming (GP) can be written:

Minimums,

$$\sum_{i=1}^{h} P_i(d_i^-, d_i^+) \tag{6}$$

with constraints:

$$f_i(x) + d_i^- - d_i^+ = b_i, i = 1,\dots,h \tag{7}$$

$$x \in X \tag{8}$$

$$d_i^-, d_i^+ \geq 0, i = 1, \ldots, h \tag{9}$$

This goal programming (GP) model changed become what is called with GP models with priority. This model written down with replace form function objective become:

Minimum,

$$\sum_{i=1}^{h} P_i(d_i^-, d_i^+) \tag{10}$$

where, P_i states the priority order of each target.

Objective of goal programming (GP) is for measure big minimum form against no deviation desired from the target. From the corner look method function the objectives and priorities determined by the GP are divided in two variants.

Approach the first called weighted GP. On approach This weight (or priority) is given against the measuring target interest relative and then determine an attempted solution for minimize weighted total amount from deviation all targets.

Approach the second is called preemptive goal programming (or lexicographic), do target measurements according to order its interests.

In the paper This approach used for completing the goal programming model is approach second that is lexicographic goal programming (GP). Rational reasons from usage approach This because seen need for make order priorities and targets (goals). Priority intended in study is:

Priority First
Maximize it quality service (P1)
Priority Second
Maximize it marketing (P2)
Priority Third
Maximize it regional income (P3)
Priority to Four
Minimize cost maintenance (P4)
Priority to Five
Maximize it smart/ICT utilization (P5)
Priority to Six
Minimize happen damage environment (P6)
Priority to Seven
Minimize promotion destination tourism (P7)
Priority to Eight
Maximize it investment (P8)
Priority to Nine
Maximize arts/cultural activities (P9)

Completion process started from solution priority highest (P_1) with obstacles involved in it, then priority next (P_2) incl obstacles, and so on. By mathematics lexicographic goal programming (GP) can stated in form general as following:

Deviation variables

d_i^+: Positive deviation from target of tourists *i*.
d_i^-: Negative deviation from target tourist *i*.

Minimum

$$Q = \sum_{i=1}^{11} P_i(d_i^+, d_i^-) \tag{11}$$

With constraint,

$$\textstyle\sum_{j=1}^{n} a_{ij}x_i - d_i^+ + d_i^- = b_i, \text{ for } i = 1 \ldots 11 \tag{12}$$

System constraints,

$$\textstyle\sum_{j=1}^{n} a_{ij}x_i = b_i, \text{ for } i = m+1, \ldots, m+k \tag{13}$$

$$d_i^+, d_i^-, x_i \geq 0 \text{ for } i = 1, \ldots., 11 \tag{14}$$

Foreign tourists consist of 10 plus domestic tourists so that there are 11 types of tourists. According to the Ministry of Tourism and Creative Economy, the types of sport tourism are divided into four, namely marine or water (e.g., Power Boat), event sport tourism (e.g., soccer, MotorGP), terrain or tourism and sports in the landscape contour (highlands) (e.g., cycling), and city sport tourism that occurs in urban sports facilities. In this modeling, the symbol *i* states the four types of sport as follows:

i=1, marine sports type
i=2, type of sporting event
i=3, landscape sport type
i=4, city sport type

4.1.3 Model formulation

1. <u>Customer goals: Quality service</u>

Satisfaction for quality goals service to customers (tourists) can served with the following model.

Minimize

$$d_1^+ \tag{15}$$

Constraint

$$q_i x_i + d_1^- - \mathrm{d}_1^+ = Q \tag{16}$$

with x_{ij}=amount traveler type *i, j*=1, 2, …, 12, *i*=1, 2, 3, 4 sport types, so that overall traveler *i*=16. q_i=cost service for traveler type *i*, d_1^+ , d_1^- =advantages and disadvantages goal achievement.

Here, no achieving quality goals service allowed because That Negative deviation does not cover in function objective. Completion Later will consists from all *x*'s that satisfy $q_i x_i \geq 0, \forall_i$ provides set solution so possible. If the model doesn't can minimize d_i^+ to zero, then solution consists from all *x* that minimize $q_i x_i$ to mark certain.

2. <u>Marketing</u>

Market requirements against amount tourists (i.e., number of all booking in period planning) is fulfilled. In terms of This is quite an achievement desired, so negative and positive goal deviation must be included in function objective. This goal can be served as following:

Minimize

$$d_2^+ \tag{17}$$

Constraint

$$x_1 + d_2^- - d_2^+ = V_1 \tag{18}$$

$$x_2 + d_2^- - d_2^+ = V_2 \tag{19}$$

$$x_3 + d_2^- - d_2^+ = V_3 \tag{20}$$

$$x_4 + d_2^- - d_2^+ = V_4 \tag{21}$$

where,

d_2^+=Exceeds goal achievement of amount traveler type 1
d_2^-=Less achieving the goal of amount traveler type 1
d_2^+=Exceeds goal achievement of amount traveler type 2

d_2^-=Less goal achievement of amount traveler type 2
d_2^+=Exceeds goal achievement of amount traveler type 3
d_2^-=Less goal achievement of amount traveler type 3
d_2^+=Exceeds goal achievement of amount traveler type 4
d_2^-=Less goal achievement of amount traveler type 4
V_1=target market for tourists type 1 (goals)
V_2=target market for tourists type 2 (goals)
V_3=target market for tourists type 3 (goals)
V_4=target market for tourists type 4 (goals)

Here, minimization from $d(.)^{-}+d(.)^{+}$ will minimize absolute value of $x(.)$. $V(.)$. In other words, minimization negative and positive deviation from amount traveler will tend determine $x_j,\ j = 1, 2, 3, 4$ in a way appropriate.

$$Min\ P_2(d_2^-) \tag{22}$$

Constraint

$$\sum_{i=1}^{N} x_i + d_2^+ - d_2^- = V \tag{23}$$

3. Regional income goals

From the planning of regional income criteria modeling, it can be targeted that the sales target for the smart/IT-based Sports tourist pattern for next year is S million Rupiah. The achievement of this income goal will be set at S, which is a function of the total gross margin against the number of tourists of all types. This goal can be presented as follows:

Minimize

$$d_3^- \tag{24}$$

Constraint

$$s_i x_i + d_3^- - d_3^+ = S \tag{25}$$

where,
d_3^-=achievement of acquisition goal income area
d_3^+=exceeds the acquisition goal income area
S=target income area from SMART-based sport tourism.

Here, the advantage of goal acquisition clear can be accepted, so deviation positive of the goal is removed in function objective. Set solution will is all x like that until $s_i x_i = S, i = 1, 2, 3, 4$ with minimize d_3^- to zero, provided solution so possible in models. Otherwise, set solution will consists from all x which minimizes $S - s_i x_i,\ \forall_i$ until a possible value.

4. Cost maintenance sports tourism

Goals from organizer is minimize cost expenditure procurement sport tourism towards arrival traveler all type. This goal can be served as:

Minimize

$$d_4^+ \tag{26}$$

Constraint

$$c_i x_i + d_4^- - d_4^+ = 0 \tag{27}$$

where,
d_4^-=no achieving cost goals expenditure
d_4^+=exceeds cost goal expenditure

This is the solution will identify all x which fulfills $c_i x_i \geq 0,\ \forall_i$, provided solution so possible. If the model does not can minimize d_4^+ to zero, completion will consist from all x which minimizes $c_i x_i$ to possible values.

5. Utilization goal technology information and communication (ICT)

Management organizer sport tourism is sure that the use of ICT is factor essential to its success business tour. Therefore that, management think that more ICT requirements succeed rather than utilization conventional. So that deviation positive from the goal can be removed from the function objective. Organizer's goal with minimize lack utilization ICT can served in expression mathematics as following.

Minimize

$$d_5^- \tag{28}$$

Constraint

$$a_i x_i + d_5^- - d_5^+ = A \tag{29}$$

where,
A=capacity available from ICT (target)
d_5^+=ICT utilization exceeds capacity
d_5^-=idle capacity from ICT

This is the solution will identify all x are such until $a_i x_i \leq A,\ \forall_i$ with minimize negative deviation to zero, if solution so possible in models.

6. Quality goals environment

Management organizers tour is certain that if level quality environment good, it will become powerful for visiting sport tourists. Here determination quality environment linked with cost incurred organizer. The organizers can give comfort to travelers in healthy environment. So that organizer targeting amount of funds B for cost maintenance quality environment.

Therefore, that's the deviation variable negative d_6^+ is eliminated from function objective. The mathematical expression for the goal of minimizing cost above the target of maintenance quality environment can be stated as following:

Minimize

$$d_6^+ \tag{30}$$

Constraint

$$b_i x_i + d_6^- - d_6^+ = B \tag{31}$$

where,
B=target designed cost fund organizer
d_6^-=expenditure cost below target
d_6^+=expenditure cost exceed target

In this part of the model, positive deviations will be minimized to zero, this is done if the solution is possible in the model.

7. Promotion of sports tourism destinations

This promotional strategy is to determine the target market regarding sports tourism. This determination helps managers know to whom they need to market their tourist attractions. The target market is very influential in the sustainability of a tourist attraction. Determining the right target market greatly influences the number of tourists who visit. The manager hopes to collaborate with various stakeholders to identify the ideal target market for the tourist attraction. In addition, managers can identify the types of sports tourism that are currently popular with the target audience. This can also make it easier for managers to determine the target market. Organizers have the ability to allocate a specific amount of PO funds towards destination promotion costs. Therefore, we eliminate the negative deviation variable d_7^+ from the objective function in this context. We can mathematically express the goal of minimizing costs above the organizer's determined target as follows:

Minimize

$$d_7^+ \tag{32}$$

Constraint

$$b_i x_i + d_7^- - d_7^+ = PO \tag{33}$$

where,

PO=target cost funds designed for determining sports tourism

d_7^-=cost expenditure below target

d_7^+=cost expenditure exceeds target

Here the positive deviation to zero will be minimized if such a solution is possible in the model.

8. Investment

Investment, as a global trend, is currently regarded as a complex industry, encompassing a wide range of industries beyond sports. Indonesia offers a diverse range of investment opportunities. The goal of the state's opening investment fields to investors is to foster economic and social growth, adhering to the state's overall policy and national plan boundaries. Organizers now need to better understand attendee preferences, motivations, and other factors that influence sports tourists' decisions to attend or participate in their events. Sports tourism has become an important resource for a country, so in this case the organizers dare to target investment funds of the size of SI (sports investment). This leads to the elimination of the negative deviation variable d_8^+ from the objective function. Therefore, we can mathematically express the organizer's goal of cost minimization above the target as follows:

Minimize

$$d_8^+ \tag{34}$$

Constraint

$$b_i x_i + d_8^- - d_8^+ = SI \tag{35}$$

where,

PO=target cost funds designed for determining sports tourism.

d_8^-=expenditure of investment funds below target

d_8^+=investment fund expenditure exceeds target

Here the positive deviation to zero will be minimized if such a solution is possible in the model.

9. Arts/cultural activities

Theoretical integration has been necessary in sports tourism research to capture the synergy of existing contributions. In response, this article proposes a conceptual framework for supplementary tourism activities, driven by secondary and/or tertiary tourist attractions, which aim to supplement or enhance the benefits and opportunities offered by the primary tourist attraction. The integration of sports and non-sport interactions into the sports tourist attraction system achieves this. The conceptual framework presents three additional types of tourism activities that influence each other not only within the four categories of sports tourism attractions (spectator-based events, participation-based events, active sports, and cultural heritage sports), but also across all non-sports tourist attractions. We discuss the theoretical and practical implications in the specific Indonesian context and identify future research directions. A clear appreciation of additional tourism activities will help regional and national tourism organizations and businesses to understand and maximize the benefits and opportunities of sports-related tourism.

The BF (budget of festive activities) represents the target funds required to organize arts/cultural festival activities. Therefore, we eliminate the negative deviation variable d_9^+ from the objective function. Mathematically, we can express the goal of minimizing costs above the organizer-determined target as follows:

Minimize

$$d_9^+ \tag{36}$$

Constraint

$$b_i x_i + d_9^- - d_9^+ = BF \tag{37}$$

where,

PO=target cost funds designed for determining sports tourism

d_9^-=expenditure of investment funds below target

d_9^+=investment fund expenditure exceeds target

i=the number of countries is 11, from foreign 10 domestic 1.

Here the positive deviation to zero will be minimized if such a solution is possible in the model.

Goal programming model for simulation using LINDO software is shown in the Figure 4.

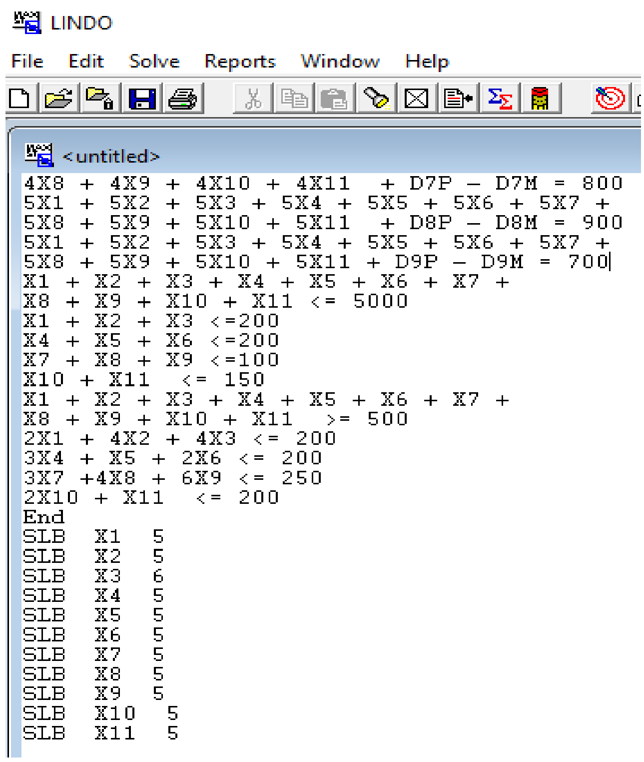

Figure 4. Simulation model using LINDO software

The analysis using the LINDO application with a goal programming model demonstrates an optimal solution that integrates nine key priorities: maximizing service quality, maximizing marketing efforts, maximizing regional income, minimizing operational costs, maximizing the use of Smart/ICT technology, minimizing environmental damage, minimizing destination promotion costs, maximizing investment, and maximizing arts and cultural activities. These priorities aim to balance operational efficiency, tourism appeal, and environmental and social sustainability.

In this model, the interpretation of deviation variables (d) provides essential insights into the achievement levels for each priority. Priority 1 (d_1=0) indicates that service quality targets have been fully met, reflecting the success of strategies designed to enhance the tourist experience. Priority 2 (d_2=0) shows that marketing efforts can still be further strengthened to attract more visitors, although current achievements are adequate. However, Priority 3 (d_3=8580) reveals that regional income from the tourism sector remains below target, highlighting untapped potential.

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LP OPTIMUM FOUND AT STEP 18

OBJECTIVE FUNCTION VALUE

1) 10088.00

VARIABLE	VALUE	REDUCED COST
D1P	0.000000	1.000000
D2M	0.000000	1.000000
D3M	8580.000000	0.000000
D4P	0.000000	1.000000
D5M	500.000000	0.000000
D6P	0.000000	1.000000
D7M	1008.000000	0.000000
D8P	0.000000	1.000000
D9P	0.000000	1.000000
X1	78.000000	0.000000
X2	5.000000	18.000000
X3	6.000000	18.000000
X4	5.000000	36.000000
X5	175.000000	0.000000
X6	5.000000	18.000000
X7	64.000000	0.000000
X8	7.000000	0.000000
X9	5.000000	14.000000
X10	50.000000	0.000000
X11	100.000000	0.000000
D1M	4200.000000	0.000000
D2P	300.000000	0.000000
D3P	0.000000	1.000000
D4M	6700.000000	0.000000
D5P	0.000000	1.000000
D6M	908.000000	0.000000
D7P	0.000000	1.000000
D8M	1600.000000	0.000000
D9M	1800.000000	0.000000

Figure 5. Simulation results using LINDO software (1)

LINDO

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ROW	SLACK OR SURPLUS	DUAL PRICES
2)	0.000000	0.000000
3)	0.000000	0.000000
4)	0.000000	1.000000
5)	0.000000	0.000000
6)	0.000000	1.000000
7)	0.000000	0.000000
8)	0.000000	1.000000
9)	0.000000	0.000000
10)	0.000000	0.000000
11)	4500.000000	0.000000
12)	111.000000	0.000000
13)	15.000000	0.000000
14)	24.000000	0.000000
15)	0.000000	8.000000
16)	0.000000	-44.000000
17)	0.000000	9.000000
18)	0.000000	18.000000
19)	0.000000	7.000000
20)	0.000000	10.000000

Figure 6. Simulation results using LINDO software (2)

LINDO

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NO. ITERATIONS= 18

RANGES IN WHICH THE BASIS IS UNCHANGED:

VARIABLE	CURRENT COEF	OBJ COEFFICIENT RANGES ALLOWABLE INCREASE	ALLOWABLE DECREASE
D1P	1.000000	INFINITY	1.000000
D2M	1.000000	INFINITY	1.000000
D3M	1.000000	INFINITY	0.400000
D4P	1.000000	INFINITY	1.000000
D5M	1.000000	INFINITY	1.000000
D6P	1.000000	INFINITY	1.000000
D7M	1.000000	0.666667	1.000000
D8P	1.000000	INFINITY	1.000000
D9P	1.000000	INFINITY	1.000000
X1	0.000000	9.000000	INFINITY
X2	0.000000	INFINITY	18.000000
X3	0.000000	INFINITY	18.000000
X4	0.000000	INFINITY	36.000000
X5	0.000000	9.000000	INFINITY
X6	0.000000	INFINITY	18.000000
X7	0.000000	INFINITY	2.000000
X8	0.000000	2.666667	INFINITY
X9	0.000000	INFINITY	14.000000
X10	0.000000	10.000000	8.000000
X11	0.000000	4.000000	10.000000
D1M	0.000000	INFINITY	1.000000
D2P	0.000000	44.000000	1.000000
D3P	0.000000	INFINITY	1.000000
D4M	0.000000	INFINITY	1.000000
D5P	0.000000	INFINITY	1.000000
D6M	0.000000	0.666667	1.000000
D7P	0.000000	INFINITY	1.000000
D8M	0.000000	INFINITY	1.000000
D9M	0.000000	INFINITY	1.000000

Figure 7. Simulation results using LINDO software (3)

LINDO

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ROW	CURRENT RHS	RIGHTHAND SIDE RANGES ALLOWABLE INCREASE	ALLOWABLE DECREASE
2	800.000000	4200.000000	INFINITY
3	800.000000	INFINITY	300.000000
4	800.000000	8580.000000	INFINITY
5	800.000000	6700.000000	INFINITY
6	500.000000	500.000000	INFINITY
7	900.000000	908.000000	INFINITY
8	800.000000	1008.000000	INFINITY
9	900.000000	1600.000000	INFINITY
10	700.000000	1800.000000	INFINITY
11	5000.000000	INFINITY	4500.000000
12	200.000000	INFINITY	111.000000
13	200.000000	INFINITY	15.000000
14	100.000000	INFINITY	24.000000
15	150.000000	14.750000	0.666667
16	500.000000	0.666667	14.750000
17	200.000000	29.500000	1.333333
18	200.000000	14.750000	0.666667
19	250.000000	59.000000	2.000000
20	200.000000	95.000000	45.000000

Figure 8. Simulation results using LINDO software (4)

Meanwhile, Priority 4 (d_4=0) confirms that operational costs align with the number of tourists served, ensuring no budget overuse. For Priority 5 (d_5=500), there is an indication that the utilization of Smart/ICT technology in managing and promoting tourism could still be improved for higher efficiency. Priority 6 (d_6=0) reflects that environmental protection costs are at appropriate levels, demonstrating a strong focus on sustainability. However, Priority 7 (d_7=1008) reveals that promotion costs can still be increased to boost the number of visitors, particularly for destinations with significant potential but low recognition.

Priority 8 (d_8=0) indicates that investments from the tourism sector are sufficient to support strategic activities. Lastly, Priority 9 (d_9=0) shows that arts and cultural activities have been adequately supported, allowing for the preservation and promotion of local identities as tourism attractions.

The optimal solution was achieved in the 18th iteration, with an objective function value of 10,088 that shows at Figure 5. Several decision variables significantly contributed to the solution, such as X1=78, X7=64, and X11=100. These variables represent optimal allocations to meet the defined priorities. Conversely, some variables, such as D1P, D4P, and D6P, have a value of zero, indicating that they do not contribute to the optimal solution and can be excluded from consideration.

In terms of constraints, the analysis shows that some constraints are binding (active), with zero slack, such as row 3, indicating that these constraints directly limit the solution. On the other hand, constraints with large slack values, such as row 11 with a surplus of 4,500 shows at Figure 6, indicate unused capacity that could potentially be reallocated to other priorities in the future. Further sensitivity analysis reveals that the model is relatively stable, where small changes in objective function coefficients or constraint values would not impact the optimal solution displayed in Figure 7. For instance, the coefficient for X1 can increase up to 9 without affecting the solution basis, while row 7 can be relaxed up to 908 before altering the outcome showed in Figure 8.

In summary, the results demonstrate that the optimal solution successfully maximizes the objective function according to the planned priorities. However, there are significant opportunities to enhance regional income, Smart/ICT utilization, and promotion budget allocation to support broader growth in the tourism sector. This analysis provides a robust foundation for strategic decision-making in tourism development while showcasing the model's flexibility to adjust parameters for improved efficiency and effectiveness in the future.

5. CONCLUSIONS

This study presents an optimization model using multi-criteria decision analysis (MCDA) for the planning and development of smart and sustainable sport tourism. By leveraging the Vensim software, we effectively integrated various criteria, including environmental, economic, IT and social factors, to address the complexities involved in sport tourism development. The model provides a robust framework for decision-makers to evaluate and prioritize strategies that balance sustainability with tourism growth. Vensim's application in this context demonstrates its ability to simulate and optimize scenarios, providing valuable insights for planning in dynamic and multi-dimensional environment. Practical implications of this study are for strategic planning for government and other stakeholders local governments can use this model as a guide to design policies for developing sports tourism destinations that are balanced between economic, social, and environmental aspects. This model also helps stakeholders in setting optimal priorities based on identified criteria, such as service quality, investment, and environmental impacts, etc. Future research could focus on refining the model with real-world data and exploring its applicability in different regional contexts to further enhance the decision-making process in sport tourism development.

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