Analysis of Immersive Virtual Reality Tourism Resources Combined with Fuzzy Comprehensive Evaluation Algorithm

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Nowadays, transforming tourism resources into attractive tourism landscapes is a critical core task. We must first conduct a scientific and reasonable analysis and evaluation of tourism resources. In addition to providing a direct theoretical foundation for the planning and growth of tourist resources, a thorough assessment of these assets is necessary for their effective preservation, good governance, and planning. A few examples of current approaches to overall assessment include the analytic hierarchy procedure, PCA, data report evaluation, fuzzy overall assessment, artificial neural networks, and assessment systems that combine several approaches. Recently, the use of comprehensive fuzzy evaluation methods and neural networks has become widespread. This paper introduces parallel algorithms and proposes a fuzzy overall evaluation model based on a parallel genetic neural network.

Povzetek: Raziskava preučuje vpliv virtualne resničnosti na oceno turističnih virov z uporabo metode mehke komprehensivne evalvacije. Pristop izboljšuje strateško načrtovanje turizma.

1 Introduction

Fuzzy analysis and analytic hierarchy process have been widely used in the evaluation of tourism resources. However, it is worth noting that when using fuzzy analysis method or analytic hierarchy process, the value of tourism resources is evaluated after only the top-level results are given. In other words, it only compares the most apparent attributes or characteristics of resources. This inevitably leads to the inaccurate judgment of factor influence in resource research, and this directly affects the rationality of the evaluation results of the merits of resource value, especially the guiding significance for the further development and value enhancement of resources.

VR is revolutionizing the way people visit different places. The next phase of tourism is virtual, and it will transform the way consumers enjoy travel without breaking the bank. Telepresence occurs when the human senses become psychologically immersed in a virtual world due to its interaction and vividness. The perfect blend of realism, interactivity, and immersion creates a breathtaking virtual tour. Experiences in the actual world, such as vacations, may be imagined in virtual reality. Interactivity engulfs tourists' attention for a unique tourism experience, while technological stimulation in AR/VR changes the real-world aspects to engage their images (affective/cognitive). A virtual reality (VR) tour of a tourist attraction may be a great way for people to get a feel for the place before they ever arrive. Different from conventional photography is virtual reality. Users are able to fully engage with the experience. Thus, visitors may get a feel for a city's culture long before they arrive. Immersion, interaction, and multi-sensibility are the three main features of virtual reality technology.

- A VR system that involves complete immersion. The most cutting-edge and perfect VR setup is an immersive one. It provides users with a completely immersive experience through various detection and tracking devices. The advantage of this system is its high degree of immersion, but its disadvantage is the high cost of system equipment and the difficulty of promotion.
- VR setup for desktop computers. Desktop VR, often called window VR, is a system that runs on a computer. It is a basic VR system that allows users to interact with a virtual environment using various devices, such as personal computers. The disadvantage of this system is that there is no feeling of being completely immersed in it, and the user will be disturbed by the external environment. Its advantages are simple structure, low price, economical and practical, and easy to promote.
- A VR system with various augmentations. Virtual items may be seen overlaid on top of the actual environment by users. Not only can the system function on actual items that really reach the world of reality and imagination, but it can also minimize the amount of computation needed to generate complicated genuine environments.
- VR system that operates on a distributed network. It accomplishes its goal of collaborative work by connecting people in various locations over distant networks so that

they may see and control the same virtual environment and share the experience inside it.

1.1 Application of virtual reality technology in tourism

- A virtual tour that allows you to travel the actual environment in all directions in three dimensions. Panoramic virtual reality is an alternative to conventional 3D animation that uses real-world panoramic images as its foundation. Using computer technology, a panoramic picture may be created by combining many sets of photographs shot using a 360-degree camera ring. This allows for an interactive, full-scale view of the area. This technology makes up for the shortcomings of 3D animation, and it is used in the travel industry. It allows the audience to independently select the tour content and independently create an interactive tour route, which gives users complete freedom, more interaction, and more expression.

- The resuscitation of once-popular tourist locations that are now or soon to be extinct. It is frequently difficult for visitors to old architectural sites to envision the structures in their original, pre-modern configuration. Technological solutions to this issue have emerged with the advent of digital virtual reality technologies. Tech experts refer to this as "reality reproduction" devices.

- Offers new chances to save cultural artifacts. It is of great practical importance to preserve China's old cultural legacy, which is rich and dazzling, and this may be achieved via the digital exhibition of sophisticated multimedia as well as virtual reality technology. In order to preserve the cultural heritage for a longer time, the researchers completed the creation of China's first virtual reality.

- Travel plan. The building of tourist attractions may be planned more logically with the use of virtual reality technology. It is not necessary to plan in order to carry out the strategy. Using a man-machine interface, the user may first model the desired scenic area in VR, then build a VR system to match, and then access the scene. Evaluate potential strategies by seeing and experiencing the plot firsthand; next, after weighing the benefits and drawbacks of each strategy, test how it might work in practice; and lastly, develop and execute the strategy. The use of VR in tourist planning allows for a more accurate visualization of tourist shapes, layouts, and outlines. This not only reduces design defects, but also improves planning quality and schedule, and speeds up the development cycle. At present, the company has independently developed the "tourism planning virtual reality design system" and realized the tourism planning program, which has been applied to the field of tourism planning and digital tourism construction, and has achieved good results.

1.2 Objectives

According to theoretical considerations, studying virtual reality (VR) experiences in conjunction with real-world tourist locations can yield two main results: first, a clearer picture of what it means to be physically present in VR environments where one can engage in activities that mimic real consumption (like sightseeing), and second, a model of how VR can influence one's perspective on actual consumption (like visiting). Knowing how tourists react to different virtual reality stimuli (i.e., the attitude-altering effects of "having been" to a place) is practically important from a management perspective, since destinations must make strategic decisions regarding the investment in various VR platforms and modalities. So, this study's overarching goal is to find out how users' perceptions of space during virtual tours of tourist destinations affect their overall impressions of such places.

By studying the effects of spatial presence in virtual reality settings on attitudes toward tourist locations, this study hopes to have a better grasp on how VR experiences may affect vacation planning. Two levels of spatial presence were discovered based on research that included 202 participants and virtual tours of tourist destinations: being someplace other than the real area and self-location in a virtual reality (VR) setting. The results showed that users' focus on virtual reality settings was a major factor in the feeling of spatial presence. Another finding that supports the persuasiveness of VR is the favorable effect of spatial presence on post-VR attitude change for tourist locations.

Users' past interactions with tourist spots (i.e., previous visits) impact their virtual reality (VR) impressions of such spots. The degree to which a person feels physically present in a virtual reality (VR) encounter is affected by their ability to draw on memories of their own experiences in the real world, often known as previous knowledge of the area. Users who have been to the location before compared to those who have not are likely to have different experiences in terms of feeling present and, ultimately, how their attitudes regarding the place alter following a virtual reality encounter. The methods of factor analysis and analysis of variance (ANOVA) were used to evaluate the data in order to test the hypotheses.

2 Related work

Researchers in India looked into virtual reality (VR) in the tourism sector and how both tourists and tour operators saw it used for advertising purposes in [16]. Additionally, that research delves into the ways its uses might boost consumer happiness while offering strategic e-value to India's tourist sector. The method relied on a quantitative approach and analyzed data from two sample groups: travel operators and visitors. The area of virtual and augmented reality was systematically reviewed. Using structural equation modeling and cross-tabs, the main data were evaluated. The suggested stakeholder participation would help the Indian tourist business flourish, and it was pointed out that the virtual reality movement in the country is still young.

Read more about the effects of VR on tourist intentions in Indonesia's post-COVID-19 economic recovery era in [17]. Tourist attractions continue to draw large crowds every year, despite worries about accessibility and the state of the economy. That study proposes a novel approach to advertising tourist spots using virtual reality technology. That technique makes use of virtual reality technology to let viewers see representations of popular tourist locations from any perspective. The research found that there is a favorable correlation between the intention of consumers to embrace VR and their behavior in the tourist industry. It is worth mentioning that the "Social Influence" component, which is most impacted through friends and family, is the one that users' intents for applying VR for tourism are most affected by. By enhancing user experiences and accessibility, that study shows that virtual reality technology has the potential to revolutionize Indonesia's tourist business.

During the endemic stage of the COVID-19 pandemic, the purpose of [18] is to study the impact of VR technologies' hedonic and utilitarian aspects on customers' travel intentions. As potential creatures for that paradigm, the research also included emotional involvement and two types of trust. They used the method of partial least square structural equation modeling to examine data obtained from 263 respondents by snowball sampling. The results showed that all hedonic and utilitarian criteria, with the exception of perceived amusement, significantly correlate positively with emotional involvement. Trust in the vendor and product is also enhanced by emotional investment. Trust in the vendor is the only variable that significantly correlates with desire to travel, according to the research.

The Zaltman Metaphor Elicitation Technique is used in an empirical investigation of how VR-themed tourists convey their inner values and meanings in [19]. They categorized their findings according to three main categories after inviting 26 participants to take part in a virtual reality tourist experience. To start, they summed up some of the features of VR-themed tourism, including terms like "anxiety of virtual reality," "escapism of virtual reality," and "freedom of virtual reality." The second stage was to build an impartial consensus map using the 'conservative,' 'average,' and 'optimistic' calculating procedures. Third, the authors determined the relevance of the integrated linking structures. Aside from "illusion" and "illusionary circumstance," the terms "imagination" and "fantasy dream" were found to be the most relevant.

In order to increase the number of tourists visiting Taman Safari Bogor, the researchers will use corporate architecture to incorporate virtual reality into the tour business in [20]. The researchers at that study utilized the Essential Enterprise Architecture structure simulation because it helps to clarify the Business Architectural Design, and Information Systems Architecture, as well as Information Technology Architectural layout that will be required during the Virtual Reality implementation stage. The virtual reality tour at Taman Safari Indonesia might be the solution to the COVID-19 pandemic's poor visitor numbers and a means of attracting visitors from all around the world, including other nations.

In particular, the objective of [21] is to look at how companies in the hospitality and tourism industry are effectively using VR to boost the value they offer to customers. The study distilled that phenomenon down to its essentials by using qualitative research methods and a phenomenological perspective. A total of eight participants' VR experiences were recorded by the researchers by combining the ideas of noema, noesis, and intentionality. Thorough interviews were conducted with participants to gather data, which was then analyzed using a general qualitative data analysis approach. From the standpoint of service providers, the research shows that VR technology benefits consumers in the hotel and tourist sectors in two ways: first, by solving practical problems and second, by creating enjoyable experiences.

Potentially emerging in the future, virtual tourism is discussed in [22] as a separate kind of tourism. To assess people's openness to virtual tourism, researchers used a survey with 243 respondents and a focus group interview. Travel preferences and thoughts on virtual tourism were among the topics covered in the survey. Analysis of the data showed that there were worries about the technical parts of virtual tourism. More than 20% of those who took the survey had never heard of VR, and only 17% had used it. Nearly 40% were unaware that VR may be useful in the travel sector, while only 11.20% had actually used VR. At the same time, respondents acknowledged virtual tourism's benefits over conventional travel, but many were skeptical of the technology's potential.

Table 1: Comparison analysis of existing methods

Author(s)	Year of publication	Methodology used	Key findings	Limitations identified
Charista, E., Christopher, N., Gui, A., & Wijaya, R.	2023	The area of virtual and augmented reality was systematically reviewed. Using structural equation modeling and cross-tabs, the main data were evaluated.	The method relied on a quantitative approach and analyzed data from two sample groups: travel operators and visitors.	Lack of Indian tourist business flourish, and it was pointed out that the virtual reality movement is not focused
Tan, K., Hii, I.S., Zhu, W., Leong, C., & Lin, E.	2022	VR on tourist intentions in Indonesia's post-COVID-19	The research found that there is a favorable correlation between the intention of consumers to embrace VR and their behavior in the tourist industry.	Lack of uncertainty modeling
Lin, L., & Yeh, H.	2022	Analyzing data collected from 263 respondents using the partial least square the modeling of structural equations approach	The results showed that all hedonic and utilitarian criteria, with the exception of perceived amusement, significantly correlate positively with emotional involvement.	Lack of accuracy in research
Suroso, J.S., Wang, G., Suroso, M.F., Astaman, F.P., Budhaye, L.M., & Bustoni, W.	2022	Zaltman Metaphor Elicitation Technique	Findings according to three main categories after inviting 26 participants to take part in a virtual reality tourist experience.	Lack of optimistic calculation
Muwandeniya, W.A., & Eranda, B.A.	2022	VR into the Taman Safari Bogor Tour Business	Virtual Reality implementation	Lack of precision, recall and high standard deviation

Polishchuk, E., Bujdosó, Z., El Archi, Y., Benbba, B., Zhu, K., & Dávid, L.D.	2023	Hotel and tourism sector are making good use of virtual reality technology	Total of eight participants' VR experiences are used	Low accuracy and mean values of factors
Jamgade, S., & Jayaprakash, A.	2023	Virtual tourism is discussed with 243 respondents and a focus group interview	More than 20% of those who took the survey had never heard of VR, and only 17% had used it. Nearly 40% were unaware that VR may be useful in the travel sector.	Not suitable for large number of respondents

3 Traditional virtual tourism resources

3.1 Analytic hierarchy process (AHP)

In the 1970s, academics in the United States introduced the method of analytical hierarchy as an additional tool for decision-making. It breaks down decision-making issues into its component parts—goals, standards, and plans—and then uses these parts to do quantitative and qualitative analysis. It is a method of evaluating and analyzing non-quantitative events in system design.

One thorough approach to review is the analytic hierarchy process, which includes the following steps: One step is to create a model with a hierarchical structure that breaks down into several levels: goal, quasi-measurement, object, and program. Second, compare each tectonic layer level using a paired comparison matrix, which is built using the pairwise comparison approach and a 1-9 comparison scale structure; Third, a consistency test and weight vector calculation should be performed, with the consistency index, random consistency index, and consistency ratio being the major tools for this assessment.Fourth, in accordance with the formula, conduct a combination consistency test after calculating the combination weight vector; this mostly involves determining the combination weight vector from the bottom layer to the goal.

U.S. operations researcher T.L. developed the analytical hierarchy method as an all-encompassing assessment approach in the 1970s. Analyzing the plan's multi-index system is made easier with this hierarchical and organized decision-making approach. It takes a complicated system's decision-making mental process and models and quantifies it.

One supplementary approach to decision-making that the study highlighted is the analytic hierarchy process. Common objectives, sub-goals across all levels, analytical criteria, and individualized investment plans are the hierarchical frameworks into which a decision-making issue is divided. Next, it calculates the relative importance of each layer's elements using the eigenvector solution technique in the decision matrix. After that, it utilizes the weighted sum approach iteratively to determine how each choice contributes to the ultimate aim. The ideal option is the one that yields the highest total mass.

3.2 Principal component analysis method

As a broad approach to studying issues with many dimensions, principal component analysis (PCA) is the go-to tool for mathematical analysis and has many real-world applications. In 1901, scholars first suggested using principal components to examine non-random quantities [3].

Principal component analysis is based on an ordered analysis approach that integrates qualitative and quantitative data; it begins by calculating all potential indices, then uses the relative distance among samples to choose which ones to use.

There are many real-world uses for principal component analysis, the primary technique of mathematical analysis. Principal component analysis has the following benefits. To start, it can do away with the relative weight of different assessment metrics. Secondly, it has the potential to make indication selection easier. Third, certain indicators may be utilized to examine the data, although many of the original indicators are kept when there are several rating indications. The fourth benefit of the comprehensive assessment feature is that it avoids the drawbacks of assigning weights for certain evaluation techniques by using the contribution rate as the weight for each primary component. Fifthly, this method's computation is computer-friendly and follows a fairly regular pattern.

The mathematical model of the analytic hierarchy process: Suppose a certain random variable $X = (X_1, X_2, X_p)$ contains p indicators, and the variables are sampled from n points. In this way, the original data matrix

$$(X_1, X_2, X_p) = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \cdots & \cdots & \cdots & \cdots \\ x_{n1} & x_{21} & \cdots & x_{np} \end{bmatrix}$$

can be obtained, where xij represents the value of the j-th index in the i-th element.This P index's M (M<P) index composite (principal component) is to be thoroughly examined by principal component analysis. It uses principal components as much as possible to represent as much original information as possible, so that it can prepare for stage clustering or comprehensive evaluation.

Principal component analysis is a general method used to analyze multi-dimensional problems. Principal component analysis has a great effect in analyzing multi-dimensional problems. First, it can reduce the dimension of the examined index space. Second, it uses factor loading for clarifying some relationships between variables. Third, it is a cyclic representation method for multi-dimensional data. Fourth, it is a structural regression model. In this model, the A principal component can be utilized as a new independent variable instead of the original variable x. Fifth, it can screen regression variables through principal component analysis. Finally, the effect of variable subsets can be obtained by selecting the sum with the least amount of calculation.

3.3 Neural network method

Neural network is an important branch of artificial intelligence. It imitates the structure and intelligent characteristics of the human brain, stores information in a distributed manner and performs similar processing. It has good self-organization, self-adaptation and self-learning capabilities, and it has characteristics such as nonlinearity and non-locality; it can also analyze and extract practical statistical laws from a large amount of statistical data. Neural network is a dynamic nonlinear system. It does not need to presuppose the relationship between input variables and output variables. On the contrary, it establishes a non-linear input-to-output relationship mapping through sample training, thus surpassing the complexity of the traditional evaluation process [4]. Modeling and analysis are made much easier by this. At the moment, the BP algorithm—which stands for error feedback propagation—is the method that neural networks utilize to train. The network performs two calculations for each training sample: first, it transfers the amount of calculation to each layer, and then it generates the output after processing. The expected result is obtained by taking the vector of the deviation among the actual and expected outputs and using it in the back propagation calculation. The network then uses the error vector to modify the weights layer by layer.

3.4 Fuzzy Comprehensive evaluation

With the proliferation of virtual reality (VR) platforms and consumer devices, there is a lot of room for growth in the market for VR tourist content. Managers and marketers of tourist destinations have a dilemma when deciding how to strategically invest in virtual reality technology to influence customers' vacation choices. Research on the impact of virtual reality on consumer perceptions of tourist places is complicated by this new trend. Using individual devices (smartphones and VR viewers) to virtually tour real tourist spots, this research seeks to address these issues by exploring spatial presence in the VR experience. Researchers discovered that the distribution of focus considerably affected one's perception of physical position (i.e., spatial presence).

When evaluating items or phenomena that are impacted by several variables, a comprehensive assessment takes all of these elements into account. It ranks or chooses the best objects based on the values assigned to them by an evaluation index that takes into account the specified criteria. Managing science and engineering place a premium on thorough assessment as both a theory and a methodology. It has a lot of potential uses and is quite practical.

There are five main components to a thorough assessment: the evaluator, the evaluation object, the evaluation index, the weight coefficient, and the complete evaluation model. An all-encompassing assessment system is organically formed by combining the fundamental components. According to [9], these are the main stages of a thorough review.

1. Determine the system to be evaluated. The essence is to establish a system description model that can reasonably reflect the concerned features of the target system. The characteristics of the evaluation target system directly determine the content, method and method of evaluation.
2. Establish an evaluation index system. It is usually based on the hierarchical method of human understanding and solving complex problems, from coarse to fine, from global to local. In addition to helping with index selection and subordination, it may provide light on the assessment index system.
3. Determine the personnel participating in the comprehensive evaluation, select evaluation principles and corresponding evaluation models.
4. Conduct a comprehensive evaluation, which mainly includes:

(1) Quantification of attribute values of different evaluation indicators;

(2) Evaluation experts assign values to different target (indicator) subset weight coefficients;

(3) Comprehensive calculation based on the evaluation model.

5. Output the evaluation result and explain its meaning.

Real life is full of vague concepts. For example: delicious food, beautiful carpet, comfortable feeling, convenient operation, satisfied users, etc. Because if something belongs to such a concept, you cannot simply choose between "yes" and "no". There is really a "transition" and a "shield" here. The scope of these concepts has framework uncertainties, and these are largely vague. This uncertainty is caused by the lack of a clear definition and deterministic evaluation criteria for the concept, and it is not that people have not given a clear definition. The nature of the matter makes it impossible to give clear definitions and evaluation criteria. This kind of uncertainty is different from the "randomness" studied in probability theory and mathematical statistics. People call it "fuzziness".

Fuzziness is related to clarity. Many phenomena in real life are clear, but due to the existence of human factors, more phenomena are still unclear. For example, if a student scores 59 points in the exam, then "this student failed" is clear, but "this student has a bad grade" is not very clear. A score of 59 does not mean a completely bad score, but only reflects part of the situation; if it is 61, the "student passed" is clear, but can we say "the student has a good grade"? This is not necessarily true. The two conditions of “very good” and “very bad” is not clear, but they are ambiguous to a certain extent, and this uncertain relationship is ambiguous. Fuzzy mathematics is now a hot topic. Fuzzy mathematics has seen a surge in interest due to the emergence of AI. Also of paramount importance is the application of fuzzy mathematics to AI.

Fuzzy set is a method of expressing fuzzy concepts, and it is a generalization of ordinary set theory. In an ordinary set, the membership of an element to set A has only two values, 0 and 1.Fuzzy set expands the membership degree of element u to set A from 0 or 1 to [0,1].If there are elements that do not absolutely belong to a certain set in the universe U, or there are elements that belong to or do not belong to the set in different degrees, such a set is called a fuzzy set.Then the representation of the fuzzy set is shown in formula (1):

$$A=\{(a_1,\mu_A(a_1)),(a_2,\mu_A(a_2)),\cdots,(a_n,\mu_A(a_n))\} \quad (1)$$

Sets are the foundation of modern mathematics. While proposing fuzzy sets, the concept of "fuzzy" has also been incorporated into many branches of mathematics. The development speed of fuzzy mathematics is also very fast. Looking at the published papers, its growth is almost exponential. The research of fuzzy mathematics can be divided into three aspects, namely, investigating the theory of fuzzy mathematics and its relationship with precise mathematics and statistical mathematics; the second is the research of fuzzy language and fuzzy logic; Research into fuzzy mathematics is the third application. Fuzzy topology, group theory, convex theory, probability, and ring theory are all subfields of fuzzy mathematics.

Key technology of fuzzy comprehensive evaluation method

1. Establishment of evaluation index system. How to establish an analysis index system is a major issue in the effective use of systematic comprehensive analysis methods. The selection of indicators is generally divided into two steps: one is the preliminary setting of indicators. In order to finish the first indication setup, the analysis relies on factor analysis and uses the indicator selection concept. The second is the selection of indicators, that is, the selection of preliminary indicators [10].
2. The determination of the weight of the evaluation index. Weight is also called weight or weighting factor. It reflects the relative importance of different indicators, including two meanings: First, weight is the degree of preference for different indicators, and weight is generally understood as the basis for measuring the importance of indicators; Second, the weight is the performance of identifying the advantages and disadvantages of different evaluation objects in a specific mathematical model.

The construction of the weight vector is influenced by human subjectivity or calculation methods. At present, there are generally several methods for constructing the weight vector of the evaluation factors of the fuzzy comprehensive evaluation algorithm:

1. Expert estimation method: This method is to estimate the weight of factors directly by authoritative experts in the industry. However, when there is only one expert to evaluate, there will inevitably be errors in the results. Therefore, the number of experts in general will be greater than 1, and the estimated results of all experts are weighted and averaged to obtain the final weight vector.
2. Expert survey method: This method also requires the help of authorities in the field. Different from the estimation method, the survey method does not directly provide the specific weight value by the expert, but calculates the specific weight through the expert's opinion. First, the expert fills in all the evaluation factors in the questionnaire, that is, the importance of the indicators, which are usually represented by numbers. Secondly, assign weight coefficients according to the professional level f of experts in the field, so as to obtain the required vector by using the weights and average weights of all experts;
3. Statistical frequency distribution method: This method does not involve experts, it is a quantitative statistical analysis method that requires sampling, and the result depends on the sample. The ambiguity question of the sample is made into a questionnaire, and the weight of specific indicators in the ambiguity question is obtained by statistical analysis of the sample results.
4. Matrix comparison method: that is, weight is obtained by comparing factors in pairs.

3.5 Principle of BP neural network

The concept of multi-level networked learning is brought to life via the BP network. Following the setting of the input network mode, data is sent from the input layer block to the hidden layer block, which applies several layers of processing before sending the data to the output layer block. Figure 1 shows how the output layer component updates the state layer through layer via forward propagation, which results in an output mode. The error is sent layer by layer together the connection path and weight of each layer is adjusted if there is an error that does not meet the specifications between the expected output mode and the output response. This process is called back propagation of the error. Repetition of the forward and backward propagation of errors occurs when the network is taught in a training mode continually for an identified number of training modes. The BP network is said to have learnt exceptionally well when every training mode satisfies the criteria. [11].

Backpropagation of the error occurs when there is an unqualified error among the intended output mode and the actual response. Starting at the output layer, the backpropagation algorithm uses the hidden layer to reroute mistakes. The weights are adjusted using the gradient approach. Let w be the adjustable weight vector in a given network, and T is the set of training examples, then the performance function is defined as

$$P=-\frac{1}{|T|}\sum_{<x,y>}(F(w,x)-y)^2 \quad (2)$$

Multi-level networked learning uses the theory of knowledge space and network technology to propose an online multi-level learning model. The principle is based on the same learning content, which adapts to different learning objects, learning levels and learning purposes. Students' learning efficiency and teachers' ability to provide individualised feedback are both improved by the multi-level networked learning paradigm.

Learning and training a neural network involves adjusting the weight of every layer. Here are the steps to calculate the index weight:Here are the steps to calculate the index weight: the first step is to set the initial parameters ω and θ of the BP neural network (ω is the initial weight, θ is the critical value); the second step is to add the known samples to the BP neural network, then use $y_i=[1+e^{-}(\sum_t \omega_{ij}x_i-\theta_i)]^{-1}$ to calculate each output value;The third step is to adjust the weight coefficient (d_i-y_i) according to the difference ω between the known output data and the data calculated above.

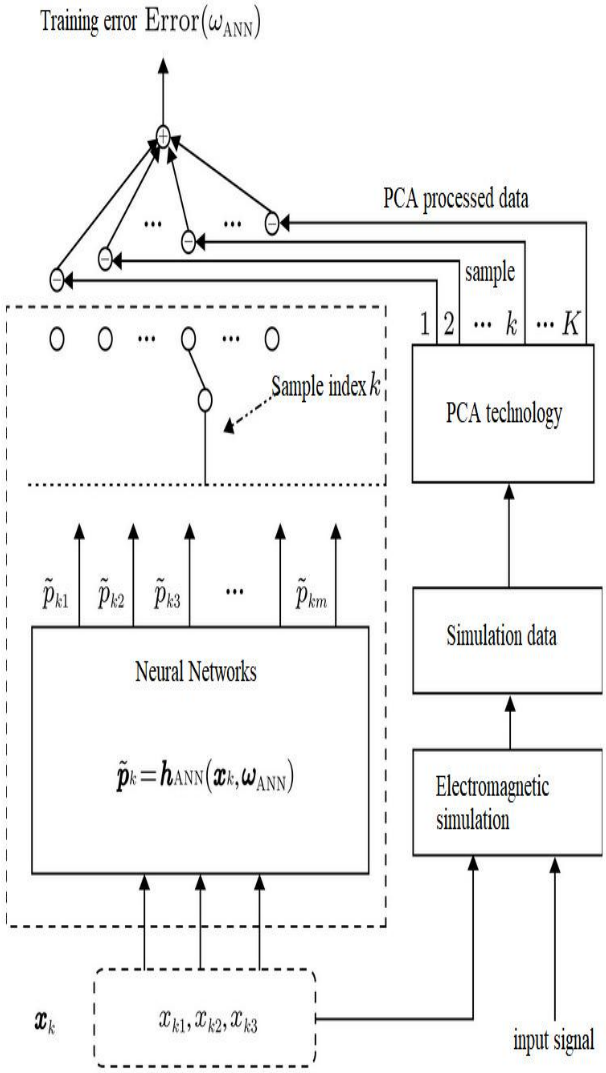


Figure 1: Neural network structure model diagram

3.6 Decision support systems

DSS consists of four parts, including dialogue subsystem, data subsystem, model subsystem and method subsystem.

1. Dialogue subsystem structure: The purpose of the decision support system (DSS) dialogue subsystem is to generate a set of data structures, describe the form of statistical reports or job evaluation reports, generate output functions for the specific software commands used, and generate the required information. Send data to DSS to process common input functions and other components and store output [13]. As shown in Figure 2.

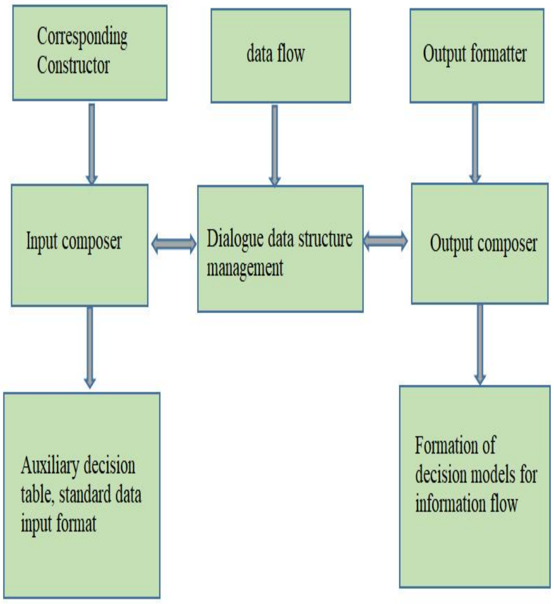


Figure 2: Dialog subsystem structure diagram

2. Data subsystem structure: The Decision Support System (DSS) information system converts all internal and external system information into a standard data format. The internal information of the system is mainly composed of the functional elements of the system. External system information is primarily collected of system environmental factors. DSS supports model definition by establishing logical data connections on multiple data streams, as shown in Figure 3.

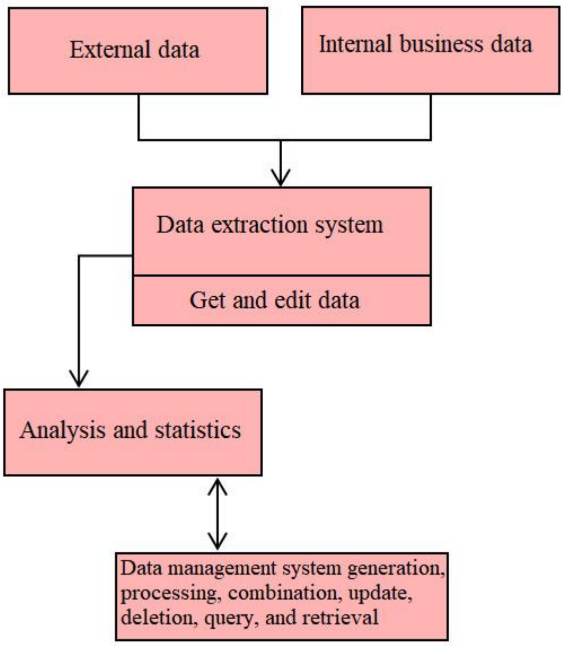


Figure 3: Data subsystem structure diagram

3. Model subsystem structure: The decision support system (DSS) model subsystem is the core of DSS, because it is related to whether DSS can truly play a decision support role. The model subsystem mainly integrates the data of the data subsystem and combines it into an efficient functional model. Figure 4 shows an example inventory management decision model.

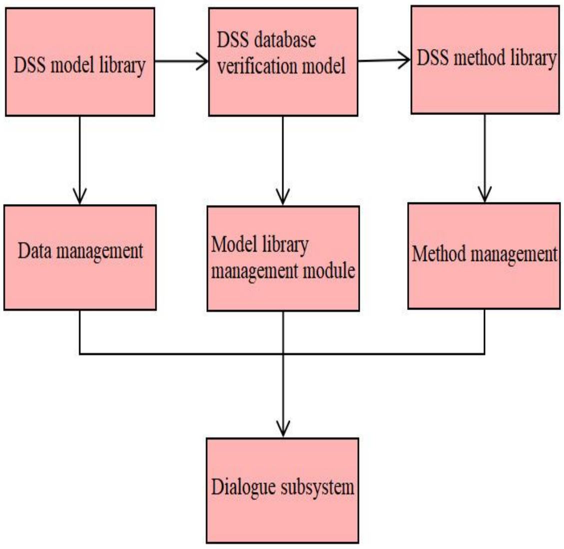


Figure 4: Inventory management decision-making model

4. Method subsystem structure: The purpose of the method subsystem of the Decision Support System (DSS) is to analyze and teach how to manage data and models as methods and information, and then make decisions according to human rules according to the personality and risk perspective of different decision makers [14]. As shown in Figure 5.

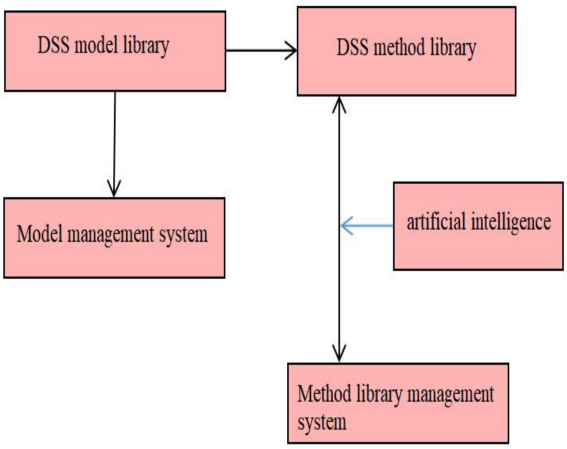


Figure 5: Method subsystem structure diagram

Features of decision support system

Decision support system is the technological crystallization of electronic technology and human intelligence technology, and it has very specific characteristics.

First, it "supports" decision making, not a substitute for decision making. From a functional point of view, it is an extension of the human brain, but this extension is currently relatively limited. Decision-making options are the reference of decision-makers, without any wisdom or "experience”. Therefore, the decision-making options it provides are procedural results. If the program itself is well designed, the result will give a relatively large reference value. If the program design is not very reasonable, the reference value obtained will be relatively small, sometimes it will give completely wrong results, too much will lead to no reference value. Only in the case of dependence or even superstition, the decision will fail. Therefore, it cannot replace a person's final decision.

Secondly, the object supported by the decision support system is mainly semi-structured decision-making, which refers to the decision-making that cannot be completely solved by mathematical models or formulas. Computers require computers to process large amounts of data efficiently. On the other hand, they are inseparable from human participation. Data can be processed independently, there is no need to participate in the data processing process in time, and finally a decision support system is formed, which has limited or no support for decision-making options.

The third is that the decision support system has powerful numerical calculation functions and powerful data processing functions, which greatly improves the efficiency of decision-making. In practice, decision-making is often an iterative calculation of process data, although it is often impossible to complete it all at once. Decision-making can be done with the help of a computer-based decision support system. This means that target definition, plan preparation, analysis and evaluation, and simulation verification can all be done with the help of a computer. Human-computer interaction can be used in this process, and decision makers can provide different parameters from different modes and select a mode [15].

4 Proposed fuzzy for VR tourism

There are a lot of papers that only describe the general area where things were seen. Knowledge about the location characterizations of observer-to-object spatial relationships must form the basis for the transformation process that transforms these imprecise location descriptions into representable fuzzy spatial regions. This transformation is necessary for location information to be represented in geographic information systems (GISs). The associated information is difficult to describe or collect because, instead of coming from a particular fuzzy function, an observer-perspective location description is subjective and will vary from person to person. This study presents a technique for extracting geographic information from subjective descriptions using virtual reality (VR) and fuzzy spatial relations.

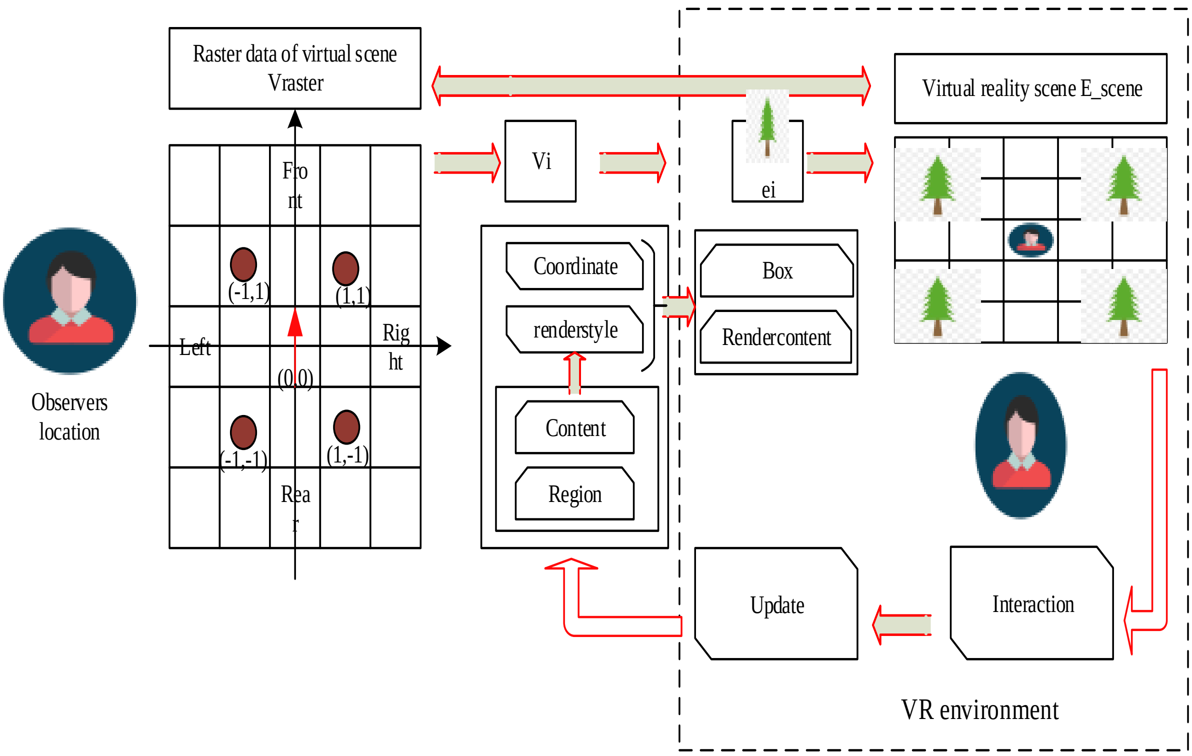


Figure 6: Proposed VT Environment

The inference issue for observer-centered imprecise location descriptions remains unsolved, despite the many accomplishments in fuzzy spatial connection extraction and fuzzy location representation.

When it comes to expressing opinions like these, traditional fuzzy membership systems fall short. Using the following methods, we may deduce the observer's meaning of the above nebulous description:

(1) Identify a certain nebulous description and get fuzzy spatial related knowledge.

Fuzzy spatial relation knowledge may be kept after a connection between a certain imprecise location description and its associated representable fuzzy area is established. This information allows for the transformation of imprecise descriptions into fuzzy areas amenable to GIS representation.

(2) Connect the dots between fuzzy spatial connection information and the unique traits of defined categories.

For instance, perspectives on spatial connections may vary between individuals due to differences in height, age, and health. More precise understanding of their descriptions of spatial connections may be achieved by acquiring distinct information for each group.

This approach is straightforward and quick to execute, but as 2D map drawings clearly vary much from how one perceives spatial connections in the actual world, the data collected in this manner cannot be certain to represent one's actual perspective.

The gold standard for reliably extracting subjective spatial perspectives on the relations between objects and observers is to set up physical on-site experiments, wherein both the items and observers are placed in specific spots across a big area, and the observers' opinions on whether the location of an object matches an imprecise description are continuously recorded along with the relative positions of the observers and objects. Acquiring the relevant spatial knowledge requires a number of such placement as well as recording procedures. There will be certain challenges with practical implementation, but this technique can guarantee that the information collected conforms to an individual's subjective spatial vision:

(1) A huge space is needed for the experiment.

Finding a big enough, somewhat uncluttered space to record item placement and description tests is challenging. Site space, budget, and participant count have to be calculated in relation to the breadth of the interest descriptors. Therefore, due to constraints on both location and finance, it is challenging to gather the essential information from a real-world setting.

(2) There is a lack of efficiency in gathering information.

Performing the time-consuming steps of placing items, measuring their coordinates, and recording them is an integral part of any spatial knowledge collecting procedure. The location descriptions are intentionally ambiguous, which makes it very difficult to characterize even the most basic description without collecting massive amounts of data. This becomes much more problematic when dealing with several groups and descriptions, as it becomes more impossible to finish collection in a fair length of time.

Collecting fuzzy spatial connection information from actual situations is challenging for the reasons mentioned above. Virtual reality offers a fresh approach to resolving this issue. With virtual reality, we may create a test environment in the lab from a given location description; the tester can then drop things into the scene at will, and the system will keep track of their relative positions. Data collection effectiveness is adequate in this virtual setting since participants are not limited by time, money, location, or other factors. Therefore, the purpose of this study is to provide virtual reality technology for the purpose of extracting information about fuzzy spatial relations from observer-centered, imprecise item location descriptions.

Steps for VT-Fuzzy model

(1) Creating the digital interactive setting

In order to characterize the virtual reality setting, VT-Fuzzy use the raster dataset $V_{\text{faser}} = \{V_1, V_2, \ldots, V_n\}$, where v_i depicts the hue and item positioned inside the matching raster area; it also includes detailed information about areas and items. The material in V_"raserer "is transformed into the VR scene E_"scene "by VT-FUZZY using a virtual interactive scene generating approach.

(2) Acquistion of individual spatial knowledge through virtual interactions

A virtual reality headset allows the observer m to move about in the E_"scene ". Virtual objects are placed in E_"scene "by m for a given location description d in such a way that their spatial interactions with m match the spatial relations indicated in d. The geographic area R $_{\text{ind}}$ "that results from the placement of many items represents the individual's subjective perception of the spatial connection. A combination of R_"ind ", m, and d yields the relevant kind of individual spatial knowledge. Following many K_{ind} collections, VT-FUZZY is able to acquire a dataset including individual spatial knowledge. $K_{\text{ind}} = \{k_1, K_2, \ldots, K_n\}$.

(3) Extracting information from fuzzy spatial relations

The second-step knowledge set K"hd ", which does not possess the feature of generalization, just represents the spatial knowledge of a particular person. We need to do additional statistical analysis as well as fusion on K_{ind} to get fuzzy spatial relation information that is really representative. Data from various K_{ind} sets are categorized according to location descriptions and observer attributes (such as age and height). A broad set of fuzzy spatial connection knowledge may be generated by combining all of the groups, each of which corresponds to a specific subset of this information $k_{\text{knowedge}} = \{k_1, k_2, \dots, k_n\}$ where each k_i includes fuzzy zones that match a certain set of observers and a specified description of the place. Inferring spatial connections from descriptions is possible with the help of VT-FUZZY and these k_i

(4) Assumption based on imprecise location description
By applying Knowedge to an input descriptor d, the relevant geographical area may be inferred. Locating relevant information is the first step in this inference process K_i in K_{know} locate the odge that corresponds to the observer and location description associated with d, and then find the R_{ind} that corresponds to this ki. To get the resultant area, the position and orientation of the observer are used to convert R_{ind} to actual GIS location coordinates.

Figure 4 shows that the "raster area" width in V"raster " is P_"scale ", and that each "raster area" is characterized through a tuple v_i= (coordinate, renderstyle, content, membership) that contains four important components.:

(1) coordinate: The coordinate field of v_i describes its position in V_{raster} In VT-FUZZY, a raster area v_{center} is chosen as the spot where the observer would be standing, with coordinates = (0,0); v_{centier} serves as the point of reference for the x- and y-axes, and the x- and y-coordinates of each vb are adjusted according to the distance from the grid to v_{centier}

(2) renderstyle: The renderstyle parameter specifies the desired style for displaying vi in the virtual environment. The block's position, color, and height in the virtual scene are all controlled by this attribute.

(3) content: The content property specifies a list of items that must be attached to v_i. The matching objects will be put on v_i.when content is more than or equal to zero, and on F when content is less than or equal to zero. v_i.

(4) membership: It is possible to assign v_i to a specific area in every interaction among m and the VR environment, and membership maintains the value of its membership for that region. The membership value may be anywhere from 0 to 1, with 0 indicating that v_i does not correlate to the related location description and 1 indicating that this raster region clearly belongs to this location descriptor.
You may classify the aforementioned four components into two categories. The coordinate and renderstyle variables are used to create or alter the virtual reality setting inside the virtual scene content group $E_{\text{scene}} = \{e_1, \theta_2, \dots, e_n\}$. Every v_i is directly matched with its corresponding e_i={box, rendercontentf. The box here represents v_i's location and range in the virtual reality setting; its width is P_"scale ", and its position is $(x, y) = (v_i$ coordinate $x \times P_{\text{scale}}\, v_i$ coordinate. $y \times P_{\text{scase}})$. In order to set the color of the box and its contents, the renderstyle property of v_k is directly correlated with the rendercontent property of e_i. Through the interaction between the observer m and E_"scene ", the content and membership characteristics of each v_i will be updated in the interactive modifying group. Changes to E_"scene" may be triggered by coordinate and renderstyle, whereas the VT-FUZZY technique can alter v_i's renderstyle according to content and membership. 'Generation -> interaction -> generation' is the cycle that is produced by this technique.

All location descriptions are composed of a collection of n_"deesc " components, as seen in Figure 6. $D = \{d_1, d_2, \dots, d_{\text{ndesce}}\}$, and every single observer may be subdivided into n_"fh " pieces based on their unique physical attributes (like height, for example) $S = \{s1.\ s_2, \dots, s_{n+h}\}$; then, $D \times S$ can form a set of $n_{\text{desc}} \times n_{\text{th}}$ elements $kg_i = \{k_1, k_2, \dots, k_n\}$, where each k_1 may be used to choose a specific piece of spatial information from K_"ind "and the associated combined spatial area $R_{\text{cmo}} = \{r_1, r_2, \dots, r_n\}$ is in a way that looks like this:

$$R_{\text{cnb}} = \frac{\sum_d^n k_1 \cdot R_{\text{ed}}}{n} \quad (3)$$

The values of the elements of R_{cme} also fall inside the interval [0,1]; in order to lessen the disparities between the R_{cme} found for various k_i, thus VT-FUZZY must establish discrete values of in order to make the retrieved spatial information more interpretable R_{emb}. In this way, 0, 0.1, 0.5, or 1 are assigned to the values of the elements ri. :

$$r_i = \begin{cases} 0 & r_i = 0 \\ 0.1 & 0 < r_i \leq 0.1 \\ 0.5 & 0.1 < r_i \leq 0.5^{\cdot} \\ 1 & r_i > 0.5 \end{cases} \quad (4)$$

We may find the mapped area using Formula (2). $R_{\text{knd}} = \{r_1; r_2; \dots, r_n\}$.

Mathematical model of factor analysis

An object's real factors, or the possible relationships between its properties, may be studied using factor analysis. If the amounts of m chemical components like Cu, Pb, Zn, and Ag are considered random variables, then studying the specific procedure of ore body building in geology may be seen as studying the connection between these contents [5].

The sample value represents the original data. A and B are represented by two random variables, x and y, respectively. We measure the content of the n examples according to the formula (5):

$$\vec{x}=(x_1,x_2,\cdots\cdots,x_n);\quad \vec{y}=(y_1,y_2,\cdots\cdots,y_n); \tag{5}$$

First, standardize the sample, and calculate the mean and variance according to the following formulas as shown in formulas (6) and (7):

$$\bar{x}=\frac{1}{n}\sum_{i=1}^{n}x_i,\bar{y}=\frac{1}{n}\sum_{i=1}^{n}y_i \tag{6}$$

$$\sigma_x^2=\frac{1}{n}\sum_{i=1}^{n}(x_i-\bar{x})^2,\sigma_y^2=\frac{1}{n}\sum_{i=1}^{n}(y_i-\bar{y})^2 \tag{7}$$

Let the values of x'_i and y'_i be as shown in formula (8):

$$x'_i=\frac{x_i-\bar{x}}{\sigma_x},y'_i=\frac{y_i-\bar{y}}{\sigma_y},i=1,2,\cdots\cdots,n \tag{8}$$

The standardized sample complies with formulas (9) and (10):

$$\bar{x}'=\frac{1}{n}\sum_{i=1}^{n}x'_i=0,\bar{y}'=\frac{1}{n}\sum_{i=1}^{n}y'_i=0 \tag{9}$$

$$\sigma_{x'}^2=\frac{1}{n}\sum_{i=1}^{n}x_i'^2=1,\sigma_{y'}^2=\frac{1}{n}\sum_{i=1}^{n}y_i'^2=1 \tag{10}$$

Here $\vec{x}$ and $\vec{y}$ are used to depict the samples after normalization, and formula (11) allows one to compute their variance as well as correlation coefficient:

$$\begin{cases}\sigma_x^2=\frac{1}{n}\sum_{i=1}^{n}x_i^2=\frac{1}{n}\vec{x}'\vec{x}=1\\ \sigma_y^2=\frac{1}{n}\sum_{i=1}^{n}y_i^2=\frac{1}{n}\vec{y}'\vec{y}=1\\ Y_{xy}=\frac{1}{n}\sum_{i=1}^{n}x_iy_i=\frac{1}{n}\vec{x}'\vec{y}\end{cases} \tag{11}$$

Because Yxy=0, which is algebraically equal to their inner product, and because the two vectors are orthogonal from a geometrical standpoint, it is clear that and are uncorrelated random variables [6].

The original data matrices can be seen in formula (12) for n samples with m variables per sample:

$$X=\begin{bmatrix}x_{11} & x_{12} & \cdots & x_{1m}\\ x_{21} & x_{22} & \cdots & x_{2m}\\ \cdots & \cdots & \cdots & \cdots\\ x_{n1} & x_{n2} & \cdots & x_{nm}\end{bmatrix}=\left[\vec{x}_1,\vec{x}_2,\cdots,\vec{x}_m\right]$$

(12)

For the right-hand side of the equation, we can see the column vector in formula (13).

$$\vec{x}_j=(x_{1j},x_{2j},\cdots,x_{nj})',j=1,2,\cdots,m \tag{13}$$

If the sample data is standardized data, that is, X is a standardized matrix, as shown in formulas (14) and (15):

$$\vec{x}_j=\frac{1}{n}\sum_{i=1}^{n}x_{ij}=0 \tag{14}$$

$$\sigma_j^2=\frac{1}{n}\sum_{i=1}^{n}x_{ij}^2=\frac{1}{n}\vec{x}_j'\vec{x}_j=1,2,\cdots,m \tag{15}$$

As seen in formula (16), the correlation coefficient matrices R is made up of the correlation coefficients among m variables:

$$R=\begin{bmatrix}r_{11} & r_{12} & \cdots & r_{1m}\\ r_{21} & r_{22} & \cdots & r_{2m}\\ \cdots & \cdots & \cdots & \cdots\\ r_{m1} & r_{m2} & \cdots & r_{mm}\end{bmatrix}=\frac{1}{n}x'x \tag{16}$$

The factor analysis technique begins with the correlation coefficient matrix, and analyzing the structure of this matrix is the key substance of factor analysis. Along with the aforementioned m random variables, factor analysis often incorporates the correlation coefficient matrices involving two sets of variables, supposing the presence of additional p random variables [17]. In formula (18) the matrix is then displayed:

$$y=\begin{bmatrix} y_{11} & y_{12} & \cdots & y_{1p} \\ y_{21} & y_{22} & \cdots & y_{2p} \\ \cdots & \cdots & \cdots & \cdots \\ y_{m1} & y_{m2} & \cdots & y_{np} \end{bmatrix}=\left[\vec{y}_1,\vec{y}_2,\cdots,\vec{y}_p\right]$$

(17)

$$S_{kj}=\frac{1}{n}\vec{y}_k'\vec{x}_j, k=1,2,\cdots,p; j=1,2,\cdots,m$$

(18)

Written in matrix form as shown in formula (19):

$$S_{pxm}=\begin{bmatrix} s_{11} & s_{12} & \cdots & s_{1m} \\ s_{21} & s_{22} & \cdots & s_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ s_{p1} & s_{p2} & \cdots & s_{pm} \end{bmatrix}$$

$$=\begin{bmatrix} \frac{1}{n}\vec{y}_1\vec{x}_1 & \frac{1}{n}\vec{y}_1\vec{x}_2 & \cdots & \frac{1}{n}\vec{y}_1\vec{x}_m \\ \frac{1}{n}\vec{y}_2\vec{x}_1 & \frac{1}{n}\vec{y}_2\vec{x}_2 & \cdots & \frac{1}{n}\vec{y}_2\vec{x}_m \\ \cdots & \cdots & \cdots & \cdots \\ \frac{1}{n}\vec{y}_p\vec{x}_1 & \frac{1}{n}\vec{y}_p\vec{x}_2 & \cdots & \frac{1}{n}\vec{y}_p\vec{x}_m \end{bmatrix}$$

$$=\frac{1}{n}\begin{bmatrix} \vec{y}_1' \\ \vec{y}_2' \\ \vdots \\ \vec{y}_p' \end{bmatrix}\left[\vec{x}_1,\vec{x}_2,\cdots,\vec{x}_m\right]=\frac{1}{n}Y'X$$

(20)

The common factor of factor analysis can actually be expressed in linear algebra form as shown in formula (21):

$$\begin{cases} \vec{x}_1=a_{11}\vec{f}_1+a_{21}\vec{f}_2+\cdots+a_{p1}\vec{f}_p+\mu_1\vec{\varepsilon}_1 \\ \vec{x}_2=a_{12}\vec{f}_1+a_{22}\vec{f}_2+\cdots+a_{p2}\vec{f}_p+\mu_2\vec{\varepsilon}_2 \\ \cdots \\ \vec{x}_m=a_{1m}\vec{f}_1+a_{2m}\vec{f}_2+\cdots+a_{pm}\vec{f}_p+\mu_m\vec{\varepsilon}_m \end{cases}$$

(21)

Formula (16) can be abbreviated to formula (22):

$$\vec{x}_j=\sum_{k=1}^{p}a_{kj}\vec{f}_k+\mu_j\vec{\varepsilon}_j, j=1,2,\cdots,m \qquad (22)$$

Factor loading

Assume that the common factor $\vec{f}_k=(k=1,2,\cdots\cdots,p)$ and single factor $\varepsilon_j(j=1,2,\cdots\cdots,m)$ due to the fact that every common variable and the single component have a correlation value of 0 and are standardized variables [8]. Formula (23) then shows the relationship:

$$\begin{cases} \frac{1}{n}\sum_{i=1}^{n}f_{ik}=0, k=1,2,\cdots,p \\ \frac{1}{n}\sum_{i=1}^{n}\varepsilon_{ik}=0, k=1,2,\cdots,m \\ \frac{1}{n}\vec{f}_k'\vec{f}_\ell'=\delta_{k\ell}=\begin{cases}1, k=\ell \\ 0, k\neq\ell\end{cases} k,\ell=1,2,\cdots,p \\ \frac{1}{n}\vec{\varepsilon}_j'\vec{\varepsilon}_q=\delta_{jq}=\begin{cases}1, j=q \\ 0, j\neq q\end{cases} j,q=1,2,\cdots,m \\ \frac{1}{n}\vec{f}_k'\vec{\varepsilon}_j=0, k=1,2,\cdots,p; j=1,2,\cdots,m \end{cases}$$

(23)

Factor analysis of tourism resources for proposed fuzzy comprehensive evaluation algorithms

Factor analysis is a statistical analysis technique, which is used to check the possible correlation between the attributes of objects in the sample. Now it is widely used in statistical analysis in various fields. This method uses statistical analysis of the variables in the sample, and then finds out the internal relationship of the variables in the sample, renames them, and gives corresponding explanations. This is the goal of factor analysis [1]. Nowadays, more and more researchers no longer simply use factor analysis to study problems, but often use other analysis methods to analyze the relationship between the variables obtained by factor analysis, so as to draw further conclusions. The combination of factor analysis and fuzzy mathematics is the current mainstream trend, and its application in China is slightly slower than that in foreign countries.

Dimensions of Presence: The components of presence throughout the virtual reality experience were determined via factor analysis. The data is explained by 80% of the variation in two dimensions, each with four items, as shown in Table 1. Departure and SelfLocation were the names given to these components. Every single item has a factor loading greater than.80. The components are internally consistent as their Cronbach's alpha values are greater than.90. The first component, "Departure," represents the participants' mental state throughout the virtual reality encounter; in this case, they felt more immersed in the VR world than in the real one. According to this theory, spatial presence is more accurately described as "being there" (at the destination) than "being here" (in the experiment room).

Table 1: Dimensions of presence

Presence	Factor Loading	Eigen-value	Cum. %	Alpha
Factor 1: Departure		3.260	40.752	.922
During the VR experience, the sense of being in VR environment was stronger than being elsewhere.	.894			
During the VR experience, there were times when I felt I was actually there.	.831			
During the VR experience, I felt the sense of being there.	.830			

During the VR experience, I often thought to myself that I was actually there.	.827			
Factor 2; Self-Location		3.172	80.403	.912
It seemed as though I actually took part in the action (sightsecing).	.860			
I felt like I was actually in the VR environment.	.855			
I felt as though I was physically present in the VR environment.	.821			
It was as though my location had shifted into the VR environment.	.800			

Factors influencing presence: The influence of Attention Allocation and Spatial Ability, types of virtual reality stimuli (e.g., Google Cardboard/Tokyo vs. Samsung Gear VR/Porto), prior visitation (e.g., visited vs. never visited), and the interaction between these variables on departure and self-location were all examined using two-way, between-subjects ANOVAs. The findings showed that Attention Allocation significantly affected Departure

(Effect Size =.288, p =.000; R2 =.319), as shown in Table 2. But none of the other variables made a difference. One possible conclusion is that the more immersed one is in a virtual reality encounter, the more one feels like they're leaving the real world behind. The predicted marginal means of departure using different VR stimuli and prior visits are shown in Figure 1. Mean variances between the groups do not reach statistical significance; for example, respondents used Samsung Gear VR reported a larger presence, especially for those who had never been to the place before.

Table 2: Between-subjects effects on departure

	Type III Sum of Squares	df	Mean Square	F	Sig.	Effect Size
Corrected Model	62.951	5	12.590	18.199	.000	.319
Intercept	1.677	1	1.677	2.245	.121	.012
Attention Allocation	54.273	1	54.273	78.450	.000	.288
Spatial Ability	1.310	1	1.310	1.894	.170	.010
Device/Stimuli	.951	1	.951	1.374	.243	.007
Prior Visitation	.000	1	.000	.982	.982	.000
Device X Prior Visitation	.106	1	.106	.154	.695	.001
Error	134.211	194	464			
Total	2078.563	200				
Corrected Total	156.090	199				

The impacts of Attention Allocation, Spatial Ability, Types of VR Stimuli, through Prior Visitation on Self-Location were identified using two-way, between-subjects ANOVA, which is shown in Tables 1 and 2. Attention Allocation significantly impacted self-location, according to the data (Effect Size =.410, p =.000; R2 =.423). But none of the other variables made a difference. Consistent with the previous element of presence, it stands to reason that participants are more inclined to report a robust feeling of self-location in the VR setting when they direct their whole attention towards it throughout the encounter. See how various kinds of virtual reality stimuli and previous visits affect self-location estimates in Figure 2. Using the Samsung Gear VR resulted in a greater degree of felt self-location amongst those who had never been to the place before. The difference in means, nevertheless, does not reach statistical significance.

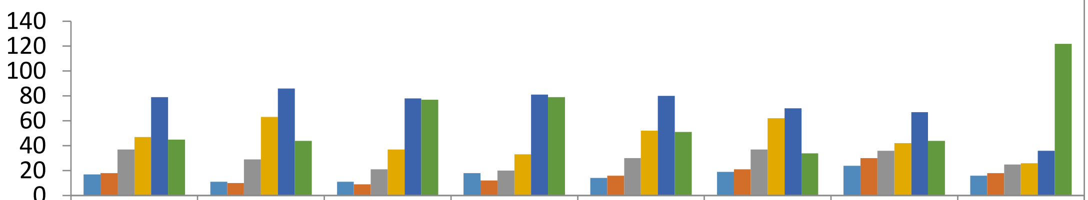
Table 3: Between-subjects effects on self-location

	Type III Sum of Squares	df	Mean Square	F	Sig.	Effect Size
Corrected Model	66.023	5	13.205	28.442	.000	.423
Intercept	2.560	1	2.560	5.515	.020	.028
Attention Allocation	62.575	1	62.575	134.783	.000	.410
Spatial Ability	.642	1	.642	1.382	.241	.007
Device/Stimuli	.055	1	.055	.008	.731	.001
Prior Visitation	.294	1	.294	.633	.427	.003
Device X Prior Visitation	90.55	1	.045	.097	.756	.000
Error	2351.174	200	464			
Total	156.090	199				
Corrected Total						

5 Results and discussion

Virtual reality has become more popular in modern culture, being used in many different industries, one of which being the travel business. The general public's familiarity with and reliance on virtual reality (VR) in the entertainment industry sets the stage for its inevitable incorporation into the travel industry. To be more precise, this means creating a new kind of tourism that relies only on virtual reality technology, which has the potential to change the way people traditionally think about travel. A new triadic place for persons is created by VT, which consists of the physical destination, the tourist, and the virtual destination.

Recognizing VT as a distinct sort of tourism requires investigating whether prospective customers are aware of its benefits over conventional tourism as well as any biases they may have. A six-point A Likert scale was employed for the purpose of collecting this sort of data. Figure 7 shows the level of agreement or disagreement that participants had with the following assertions, and the fact that this scale does not include a neutral choice led to its selection. The table shows the total number of votes for each option as numbers. The row with the most votes is bold, while the row with the fewest votes is underlined.



	VT is cheaper	VT is easier to plan and arrange	VT allows people to travel to places that are hard to reach	VT allows people to travel to places that do not exist	VT is safer	VT is more sustainable	VT is more inclusive	There are no technologies that can recreate real experience
Strongly Disagree	17	11	11	18	14	19	24	16
Disagree	18	10	9	12	16	21	30	18
Slightly Disagree	37	29	21	20	30	37	36	25
Slightly Agree	47	63	37	33	52	62	42	26
Agree	79	86	78	81	80	70	67	36
Strongly Agree	45	44	77	79	51	34	44	122

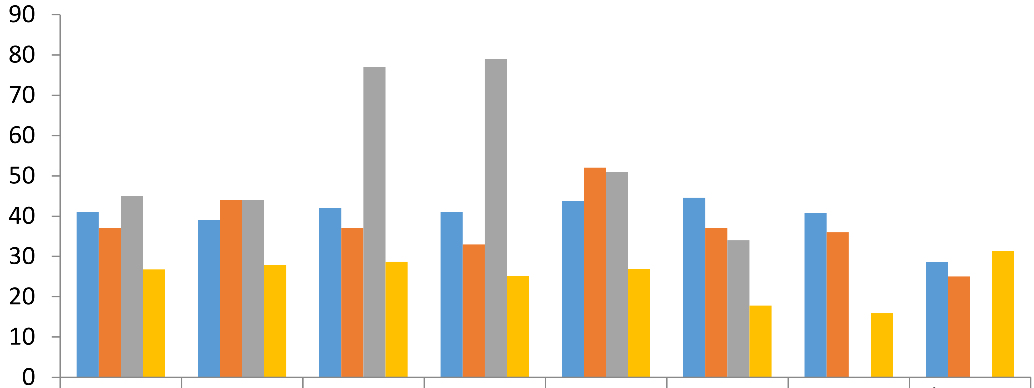
Strongly Disagree, Disagree, Slightly Disagree, Slightly Agree, Agree, Strongly Agree

Figure 7: Likert scale of virtual tourism (VT) compared to traditional tourism

To examine the collected data, we computed the median, mode, and mean for every statement to ascertain the respondents' inclination. The variety in the replies was further shown by calculating the standard deviation. Here are the formulae that were used in this analysis:

- Mean = (sum of all responses)/(total number of respondents)
- Median is the middle value of the responses when the data are arranged in order from lowest to highest
- Mode represents the most common response
- Standard deviation (St. Dev.) = sqrt ((sum of (response-mean) ^2)/ (total number of respondents—1)

Here is a visual representation of the data that was collected from the questionnaire's Likert scale questions.



	VT is cheaper	VT is easier to plan and arrange	VT allows people to travel to places that are hard to reach	VT allows people to travel to places that do not exist	VT is safer	VT is more sustainable	VT is more inclusive	There are no technologies that can recreate real experience
Mean	41	39	42	41	43,8	44,6	40,8	28,6
Median	37	44	37	33	52	37	36	25
Mode	45	44	77	79	51	34	0	0
St. Dev.	26,8	27,9	28,7	25,2	26,9	17,8	15,9	31,4

■ Mean ■ Median ■ Mode ■ St. Dev.

Figure 8: Likert scale analysis of the received data

We can confidently state that the replies are overwhelmingly favorable based on this study. In most cases, those who take part in VT see its benefits; the only thing they have reservations about is the technical side of it. People do not think that the technology that are now available can replace actual travel experiences.

There was a range of responses to the following open-ended question about VT. Proponents of virtual reality (VT) emphasized the technology's potential benefits for those with physical limitations, those unable to utilize conventional transportation, and for trips to unique or inaccessible locations, including space. Opponents of VT, on the other hand, made it plain that, in their opinion, virtual reality cannot replace first-hand encounters. Respondents said that although they can see VT's potential, current technical advancements are insufficient to make it a reality. The high degree of skepticism around VT as a fresh kind of tourism is understandable given its relative youth. It has already been stated that only a tiny fraction of customers are immediately willing to test a new product.

We have answered all of the research questions and proven all of the hypotheses in our present study: (1) The tourism sector is already making use of virtual reality in a variety of ways, from marketing and organizing tools to attractions itself. (2) VT has the potential to develop into a new kind of tourism by using VR and other state-of-the-art technologies. Virtual reality (VT) allows users to have emotional experiences that are similar to those of real travel, but without the risks and difficulties that physical visitors face. All possible locations may be considered virtual ones in VT, even those that do not exist, are very far away, or are completely made up. Virtual tourism (VT) is a model of inclusive and eco-friendly travel. (3) Some people are skeptical about the rise of VT, according to preliminary primary data analysis. This might be because they don't use VR much or don't know what it can do. Their capacity to see the potential benefits of VT remains intact, especially when it comes to accommodating those with impairments, those having little financial resources, or those who are interested in imaginary places.

5 Conclusions

At present, the tourism industry has broad prospects. With the rapid development of the world economy, China's economic and industrial structure is transforming. It is an inevitable choice to actively develop tourism with a low pollution index. This not only conforms to the scientific development concept and people-oriented concept put forward by the country, but also conforms to the modern economic development model that takes into account the benefits of "society-environment-economy". Through fuzzy comprehensive evaluation algorithm combined with immersive virtual reality technology to analyze tourism resources, it is concluded that China's tourism resources development potential is huge. The market prospect is broad, and it meets the needs of the public and scientific investigations at this stage. Therefore, China's tourism industry should be vigorously developed.

Future work

This research adds to our knowledge of spatial presence by illuminating its causes and effects on user attitudes in contexts where actual tourist spots are shown. The findings of this study provide credence to previous research that has hypothesized the use of virtual reality (VR) in the tourist industry. Destination marketers may utilize this research to support their investment in virtual reality by providing a theoretical explanation for how VR influences users' responses to marketing stimuli. The sample size is small since the majority of the participants were young women who made purchases. Expanding the sample size and variety of devices/stimuli used in future studies is necessary to ensure that the results are applicable to a broader population.

Data availability

On request, the corresponding author may provide the data utilised to support the study's conclusions.

Conflicts of interest

The authors declare no conflicts of interest

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References

[1] Stefan Gossling, 1999. Eco-tourism: A Meansto Safeguard Bio-diver site and Ecosystem Functions. Ecological Economics. (29):74-76. https://doi.org/10.1016/s0921-8009(99)00012-9

[2] Choong-Ki Lee, 1999. Valuation of Nature-base Tourism Resources Using Dielmtomous Choice ConationValuation Method [J], *Tourism Management,* (3):84-88. https://doi.org/10.1016/s0261-5177(97)00076-9

[3] Kleber Bladimir Machado, 2001. Willingness to Pay for Conservation Programs: A Contingent YaluationStudy of the Galapagos, *National Park*, (8):21-26.

[4] Deying Zhou,John F.Yanagida,Ujayant Chakravorty, 1997. Estimating economic impacts from tourism[J], *Annals of Tourism Research*,24(1):76-89. https://doi.org/10.1016/s0160-7383(96)00035-7

[5] Dogan Gursoy, Claudia Jurowski, 2003. Competitive potential of tourism in destinations[J]. *Annals of TourismResearch*,30(3): 720-740.

[6] Elbakidze , Angelstam , Axelsson, 2007. Sustainable forest management as an approach to regionaldevelopment in the Russian Federation: State and trends in Kovdozersky Model Forest in the Barentsregion[J]. *Scandinavian Journal of Forest Research*,22(6): 568-581. https://doi.org/10.1080/02827580701804179

[7] Fahey, 1989. Evaluation of the recreational benefits of major dams in Queensland,Australia[J]. *Water Scienceand Technology*,21(2):229-235. https://doi.org/10.2166/wst.1989.0055

[8] George N, 1996. Wallace.An evaluation of ecotourism in Amazonas,Brazil[J].*Annals of Tourism Research*,23(4):843-873. https://doi.org/10.1016/0160-7383(96)00009-6

[9] loras , Muica,Turmock, 2001. Approaches to sustainable forestry in the Piatra Craiului National Park[JJ.*Geolournal*,55(2-4): 579-598. https://doi.org/10.30638/eemj.2010.230

[10] Julianna, 2001. Assessment of natural resources for nature-based tourism: the case of the Central CoastRegion of Western Australia[J], *Tourism Management*,22(6):637-648. https://doi.org/10.1016/s0261-5177(01)00039-5

[11] M.r. Phillips, 2006. Erosion and tourism infrastructure in the coastal zone: Problems,consequences andmanagement[J]. *Tourism Management*,27(3): 517-524. https://doi.org/10.1016/j.tourman.2005.10.019

[12] Schelhas,Sherman, Fahey, et al, 2002. Linking community and national park development: A case from theDominican Republic[J], *Natural Resources Forum*, 26(2): 140-149. https://doi.org/10.1111/1477-8947.00014

[13] Sheng-hshiung Tsaur , Yu-chiang Lin, 2006. Evaluating ecotourism sustainability from the integratedperspective of resource, community and tourism[J], *Tourism Management*,27(4):640-653. https://doi.org/10.1016/j.tourman.2005.02.006

[14] Sheng-hshiung Tsaur , Yu-chiang Lin, 2006. Evaluating ecotourism sustainability from the integratedperspective of resource, community and tourism[J], *Tourism Management*,27(4):640-653. https://doi.org/10.1016/j.tourman.2005.02.006

[15] Sheryl Ross, 1999. Evaluating ecotourism:The case of North Sulawesi,Indonesia[J], *Tourism Management*,20(6): 673-682. https://doi.org/10.1016/s0261-5177(99)00040-0

[16] Jamgade, S., & Jayaprakash, A. (2023). Strategic E-Value Co-creation through Virtual Reality in the Travel and Tourism Industry of India. *Journal of Tourismology*. https://doi.org/10.26650/jot.2023.9.2.1328025

[17] Charista, E., Christopher, N., Gui, A., & Wijaya, R. (2023). *The Influence of Virtual Reality on User Intention in Indonesia Tourism Industry*. 2023 IEEE 8th International Conference on Recent Advances and Innovations in Engineering (ICRAIE), 1-6. https://doi.org/10.1109/icraie59459.2023.10468393

[18] Tan, K., Hii, I.S., Zhu, W., Leong, C., & Lin, E. (2022). The borders are re-opening! Has virtual reality been a friend or a foe to the tourism industry so far? *Asia Pacific Journal of Marketing and Logistics*. https://doi.org/10.1108/apjml-05-2022-0417

[19] Lin, L., & Yeh, H. (2022). Using ZMET to explore consumers' cognitive model in virtual reality: take the tourism experience as an example. *Current Issues in Tourism*, 26, 2250 - 2264. https://doi.org/10.1080/13683500.2022.2084048

[20] Suroso, J.S., Wang, G., Suroso, M.F., Astaman, F.P., Budhaye, L.M., & Bustoni, W. (2022). *Applying 360° Live Virtual Reality Tour in Taman Safari Indonesia Tourism Industry: Enterprise Architecture Approach*. 2022 IEEE International Conference of Computer Science and Information Technology (ICOSNIKOM), 1-7. https://doi.org/10.1109/icosnikom56551.2022.10034885

[21] Muwandeniya, W.A., & Eranda, B.A. (2022). Virtual Reality for Enhancing Customer Value in Sri Lankan Hospitality and Tourism Industry: Perspective of Industry Experts. *Sri Lanka Journal of Marketing*. https://doi.org/10.4038/sljmuok.v8i2.102

[22] Polishchuk, E., Bujdosó, Z., El Archi, Y., Benbba, B., Zhu, K., & Dávid, L.D. (2023). The Theoretical Background of Virtual Reality and Its Implications for the Tourism Industry. *Sustainability. https://doi.org/10.3390/su151310534*