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Innovation of activation and regeneration mechanism of industrial heritage tourism resources and optimization of cultural value transmission path

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SUMMARY: *Against the backdrop of continuously deepening the protection and utilization of industrial heritage and accelerating the integration of digital cultural tourism, the revitalization and regeneration of industrial heritage tourism resources face problems such as inadequate resource identification, inaccurate mechanism configuration, and poor cultural dissemination links. This article focuses on the innovation of the activation and regeneration mechanism of industrial heritage tourism resources and the optimization of cultural value dissemination paths. It constructs a resource element classification model, an activation and regeneration mechanism innovation model, and a cultural value dissemination path optimization model, and introduces computer methods such as multi-source data processing, feature fusion, and dynamic feedback updates into the analysis process. This paper evaluates the resource type identification, mechanism applicability and information transmission performance of the industrial site sample area. The results showed that the classification accuracy of the resource element classification model reached 91.83%, with an F1 value of 90.75%; The comprehensive activation benefit of the innovative model for activating and regenerating mechanisms is 0.88, and the accuracy of mechanism matching reaches 93.27%; The dissemination reach rate and node matching accuracy of the cultural value dissemination path optimization model reached 91.38% and 92.57%, respectively, and the secondary visit rate increased to 41.83%. The results show that computer-aided analysis methods can help improve the classification accuracy of industrial heritage tourism resources, enhance the matching degree between activation paths and resource attributes, and improve the organizational efficiency and diffusion stability of cultural value dissemination.*
Povzetek: Članek obravnava aktivacijo in regeneracijo virov industrijske dediščine ter optimizacijo poti širjenja kulturnih vrednosti. Z uporabo večvišinskega podatkovnega povezovanja, združevanja značilk in dinamičnega povratnega posodabljanja so oblikovani modeli za razvrščanje virov, mehanizemsko ujemanje in širjenje vsebin. Rezultati kažejo izboljšano natančnost prepoznavanja, učinkovitost aktivacije ter stabilnost digitalnega komuniciranja.

KEYWORDS: *Industrial heritage tourism; Activation regeneration; Cultural value dissemination; Digital optimization*

1 Introduction

Industrial heritage is not just abandoned factories, machinery and equipment, or production

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ancillary spaces. When the original manufacturing industry system migrates, disappears or transforms, a large number of factory land is transformed from a productive place to a stock cultural resource to be excavated, and the value judgment standard of "whether it can continue to be used for production" is replaced by "whether it can be identified, protected, reconstructed and regenerated". Current research has found that industrial site tourism is not only related to the balance between heritage protection and tourism development, but also related to regional development and renewal, cultural identity construction and sustainable development [1]. How to transform the tourism resources of industrial heritage from simple protection to activation and regeneration, and realize the efficient, accurate and long-term promotion of its cultural value in digital communication has become an urgent problem to be solved in the research of industrial heritage and cultural tourism activities.

From the existing achievements, the academic community has conducted solid discussions on the types of industrial heritage tourism resources, adaptive reuse, spatial renewal strategies, tourist perception, and authenticity construction. Xie studied the actual way to develop industrial heritage tourism [2]. Kerstetter et al first realized the relationship between the attraction types of industrial sites and their tourists [3]. Perfetto et al expounded the logic of tourism organization of industrial sites from the perspective of management [4], while some recent studies further incorporated sustainability, regional policy coordination, community participation and spatial integration into their analysis framework [5, 6]. In addition, studies on the perception of authenticity, perceived value, local attachment, tourists' emotion and environmental responsibility behavior are also increasingly in-depth, indicating that industrial site tourism is no longer a simple tour of the old factory, but a multi-dimensional cultural consumption process that includes experience occurrence, cultural and identity identification and behavioral response [7]. The relevant research provides a relatively sufficient theoretical basis for the protection and utilization of industrial heritage, but the discussion on the continuous relationship between 'resource classification activation mechanism propagation path' is still insufficient, especially the lack of a systematic analysis framework that embeds computer technology into the entire process of industrial heritage activation.

With the continuous maturity of technologies such as digital surveying, knowledge graphs, text mining, recommendation algorithms, virtual reality, and augmented reality, the conditions for identifying, organizing, and disseminating industrial heritage tourism resources have undergone significant changes. On the one hand, industrial heritage elements themselves have cross type, cross scale, and cross semantic characteristics, including material information such as factory layout, architectural form, and equipment systems, as well as non-material content such as process flow, industry system, worker memory, and local narrative. The traditional classification method based on manual experience is difficult to fully reveal the strength of the correlation and transformation potential between different resource units [9]. In addition, under the background of the integrated development of culture and tourism, the objects of industrial heritage information dissemination extend from real tourists to network users, potential consumers, scientific research and teaching groups and residents, etc., and the channels of information dissemination also extend from on-site explanations to media forms such as short videos, VR glasses, electronic guide screens and intelligent recommendation machines [10]. Such different information transmission environments make cultural inheritance no longer a simple follow-up link, but one of the important preconditions affecting the degree of resource activation [11].

Therefore, the revitalization and regeneration of industrial heritage tourism resources should not only be limited to spatial restoration, format introduction, or visual updates, but should establish a comprehensive model that takes into account resource identification, mechanism linkage, and communication feedback [12, 13]. As for the resource side, it is necessary to use multi-source data integration technology to structurally express the spatial form, historical information, usage status, accessibility conditions, cultural narrative, and tourist perception of industrial heritage, in order to form a more explanatory resource element classification system. On the conversion side, it is necessary to break through the binary thinking of "protection" and "development", and build a dynamically adjustable activation and regeneration mechanism around the interactive relationship between heritage ontology protection, scene updating, content curation, community participation, industry collaboration, and digital empowerment. As for the dissemination end, optimizing the dissemination path should be regarded as an important component of realizing the value of industrial heritage. Through user profile recognition, content label matching, media scene distribution, and behavioral feedback correction, the efficiency of cultural information outreach, narrative adaptation, and sustained dissemination ability can be improved.

Based on the promotion methods of relevant research and combined with the practical characteristics of industrial heritage tourism resources, this article believes that there are at least three areas in the current research that need to be further deepened. Firstly, many studies have noticed that industrial heritage resources have composite attributes, but the identification of internal heterogeneity of resources still mostly remains at the level of empirical stratification, lacking the support of computable, comparable, and transferable classification models. Secondly, discussions about the activation and regeneration mechanism are commonly found in planning texts or case summaries, which can explain why the mechanism chain is effective. However, the modeling expression that can explain under what conditions it is more effective is still insufficient. Thirdly, in cultural communication research, industrial heritage is often included in general discussions on urban image dissemination, museum storytelling, or tourism marketing. However, there is no stable paradigm for research on how the unique technological history, labor history, and local industrial civilization of industrial heritage can be differentiated through digital platforms.

Based on this, this article takes industrial heritage tourism resources as the research object. On the basis of absorbing the research results of industrial heritage tourism, adaptive reuse, authentic experience, and digital cultural tourism communication, it attempts to introduce computer-aided analysis ideas and construct a three-layer research framework consisting of resource element classification, innovative activation and regeneration mechanisms, and optimized cultural value dissemination paths. Specifically, this article intends to establish a classification model for industrial heritage tourism resource elements based on the organization of multi-source heterogeneous data, in order to improve the refinement of resource identification and value judgment; Further focus on variables such as spatial updates, content reconstruction, subject collaboration, and digital empowerment to construct an innovative model for activating and regenerating mechanisms, in order to analyze the adaptation relationship of resource transformation under different mechanism combinations; At the same time, combining user behavior analysis, content tag organization, and intelligent recommendation logic, an optimization model for the dissemination path of industrial heritage cultural values is established to enhance the accessibility, understanding efficiency, and dissemination stickiness of cultural information. The research approach of this article is shown in Table 1.

Table 1: Summary of the research context and entry points related to the introduction stage of this article

Research Dimension	Representative Research Content	Existing Understanding	Current Limitations	Entry Point of This Study
Basic Research on Industrial Heritage Tourism	Concepts of industrial heritage tourism, resource types, and development pathways [1–4]	Clarifies the research object and basic value of industrial heritage tourism	Lacks refined characterization of resource heterogeneity and inter-element relationships	Constructs a resource element classification model to enhance identification and comparison capabilities
Sustainable Renewal and Adaptive Reuse	Regional renewal, policy coordination, and reuse models [5–12]	Explains the linkage between industrial heritage revitalization and regional development	Lacks dynamic coupling analysis of revitalization mechanisms	Establishes an innovation model for revitalization and regeneration mechanisms to analyze the linkage effects among elements
Tourist Experience and Authenticity Communication	Authenticity, perceived value, satisfaction, and environmental behavior [13–17]	Reveals the influence path of cultural experience on tourist behavior	Focuses more on outcome variables, with less attention to the communication mechanism itself	Incorporates cultural value communication into the internal revitalization system for integrated examination
Application of Digital Cultural Tourism Technologies	VR/AR, virtual experience, recommendation systems, and digital media [18–20]	Provides a technical foundation for immersive display and precise communication	Adaptation research for industrial heritage scenarios remains insufficient	Introduces user behavior analysis and path optimization models to improve communication effectiveness

In summary, this article does not view industrial heritage tourism resources as static objects waiting to be packaged, but rather as a composite cultural system that can be identified, reorganized, activated, and disseminated. Based on this understanding, the following will construct the classification mode of industrial heritage tour resource elements, the innovation mode of activation and regeneration, and the optimization mode of cultural transmission path from the methods and data, in order to provide more convincing and practical theoretical basis and strategy reference for the high-quality activation and utilization of industrial heritage tour resources and the long-term transmission of its cultural value.

2 Methods and Materials

2.1 Classification Model of Industrial Heritage Tourism Resource Elements

Industrial heritage tourism resources are not a linear collection composed of a single type of element, but a composite system interwoven with multiple types of information such as spatial form, production relics, technological memory, narrative symbols, environmental atmosphere, and tourist perception. If traditional manual recognition and experience stratification methods are still used, although resource census and qualitative judgment can be completed, it is difficult to reveal the strength of the correlation, value differences, and activation potential between different resource units, and it is also not conducive to the design of subsequent regeneration mechanisms and matching of propagation paths. Based on this, this article introduces computer-aided analysis methods in the identification process of industrial heritage tourism resources, constructs a resource element classification model for activation and regeneration research, and converts heterogeneous resource information into computable, comparable, and renewable structured data to improve the precision of resource classification and the pertinence of subsequent decision-making.

Three types of data are used for the information collection of industrial heritage tourism resources. One is the static basic data, including the location, age, area, equipment retention, structural integrity and grade of the factory. The second is semantic narrative data, including historical archives, local Chronicles, oral biography, guide's explanation manuscript, media news, testimonials after the tour, etc. The third is the corresponding dynamic behavior data, which mainly includes the data of tourists 'stay time in the scenic spot, visiting path, photo location, network retrieval times and social media interaction activity. These types of data show three different expression-numerical class, character class and time class, which will lead to the confusion of measurement scale, hierarchical meaning and type division when they are used indiscriminantly. Therefore, starting from the technical link, we adopt the strategy of "multi-source acquisition, feature extraction, comprehensive coding, clustering discrimination-type judgment" to conduct multi-dimensional discrimination of industrial heritage tourism resources, and obtain the basic element types of industrial heritage tourism resources.

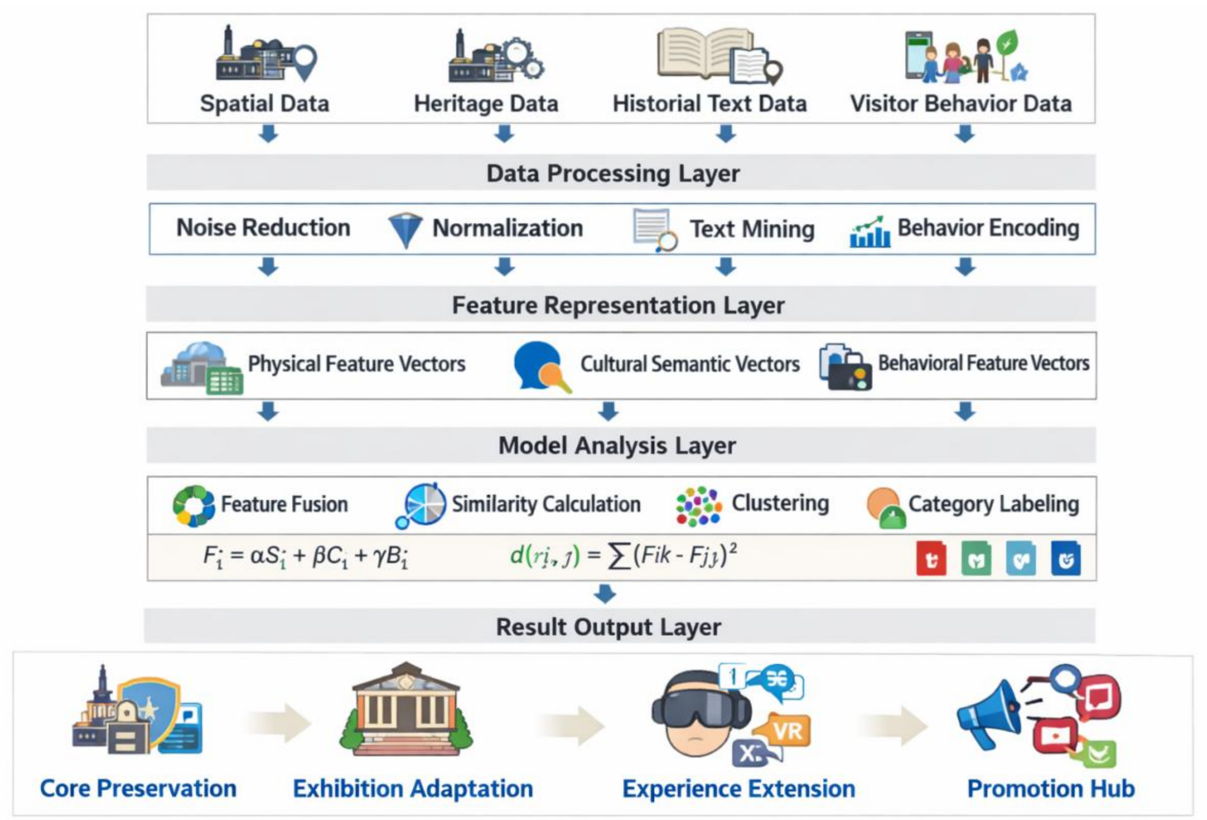

Figure 1: Classification Model Framework for Industrial Heritage Tourism Resource Elements

As shown in Figure 1, the model takes multi-source resource data as input, and after completing data preprocessing, it expresses features of different dimensions of information separately. For spatial and relic data, normalization is used to eliminate dimensional differences; For text and narrative data, use the word frequency inverse document frequency method to extract core semantic features; For tourist behavior data, indicators such as visit frequency, stay depth, and interest bias are extracted through time-series statistical methods. After feature extraction, the model maps various types of information into a unified vector space, and then uses clustering algorithms to identify the similarity relationships between resource units, thereby achieving classification result output. The sample set of industrial heritage tourism resources is set as

$$R = \{r_1, r_2, \cdots, r_i\} \tag{1}$$

Among them, r_i represents the i-th resource unit. For any resource unit, this article represents its characteristics as

$$X_i = [S_i, C_i, B_i] \tag{2}$$

In the formula, S_i represents the spatial form and relic ontology feature vector, C_i represents the cultural semantic feature vector, and B_i represents the tourist behavior and interaction feature vector. To avoid bias in the calculation of data from different dimensions, the original variables are first standardized:

$$Z_{ij} = \frac{x_{ij} - \mu_j}{\sigma_j} \tag{3}$$

In the formula, x_{ij} is the original value of the i-th sample on the jth indicator, μ_j and σ_j represent the mean and standard deviation of the indicator, and Z_{ij} is the standardized result.

Considering that the value of industrial heritage resources is not only influenced by material preservation status, but also closely related to cultural narrative density and tourism perception intensity, this article adopts a weighted fusion method to construct a comprehensive feature expression:

$$F_i = \alpha S_i + \beta C_i + \gamma B_i \tag{4}$$

In the formula, F_i is the comprehensive feature vector of the resource unit, and α, β, and γ represent the weights of the material dimension, cultural dimension, and behavioral dimension, respectively, and satisfy α+β+γ=1. In this study, the premise of resource activation is that "heritage can be identified", and the basis of dissemination and diffusion is "value can be translated". Therefore, in terms of weight allocation, the cultural semantic dimension is no longer treated as an auxiliary term, but maintains similar weights to the spatial ontology dimension, and the behavioral dimension is used to correct the real attractiveness and dissemination response. After completing feature fusion, this article uses the Euclidean distance between resource units to measure their similarity:

$$d(r_i, r_j) = \sqrt{\sum_{k=1}^{m} (F_{ik} - F_{jk})^2} \tag{5}$$

In the formula, $d(r_i, r_j)$ represents the distance between resource units ri and rj in the comprehensive feature space, and m is the total number of feature dimensions. The smaller the distance, the closer the two types of resources are in terms of relic form, cultural narrative, and experiential perception, and can be classified into the same category. Further combining the clustering results, expert interpretation, and category verification results, this article divides industrial heritage tourism resources into four categories: first, core protection type, mainly characterized by high integrity of relics, dense historical information, and strong authenticity, suitable as the core of heritage cognition and protection display; The second type is display conversion type, with strong visualization foundation and spatial transformation conditions, suitable for transformation into cultural and tourism scenes such as exhibitions, displays, and education; The third type is experiential extension, which has high potential in interactivity, scene creation, and tourist participation, and is suitable for introducing immersive experiences and digital navigation systems; The fourth type is communication driven, with distinct visual symbols, strong storytelling, and high potential for online interaction, making it suitable as a cultural communication node and brand output unit.

2.2 Innovative Model for Revitalization and Regeneration Mechanism of Industrial Heritage Tourism Resources

The basic idea of the model is to view the process of revitalizing industrial heritage as a closed-loop system consisting of "resource input mechanism coupling scene transformation feedback correction". The resource input end adopts the classification results formed in section 2.1 to identify the differences in heritage integrity, cultural density, experiential potential, and dissemination elasticity among different resource units; The mechanism coupling end focuses on handling the relationship between protection strength, functional reorganization, digital display, community participation, and operational linkage; On the scene transformation end, the model output is mapped to specific activation scenarios such as exhibition displays, educational research, immersive experiences, and cultural and creative consumption; The feedback correction end adjusts the mechanism parameters based on tourist stays, interaction frequency, satisfaction, and online communication response, in order to avoid the activation strategy staying at the one-time design level for a long time. Its structure is shown in Figure 2.

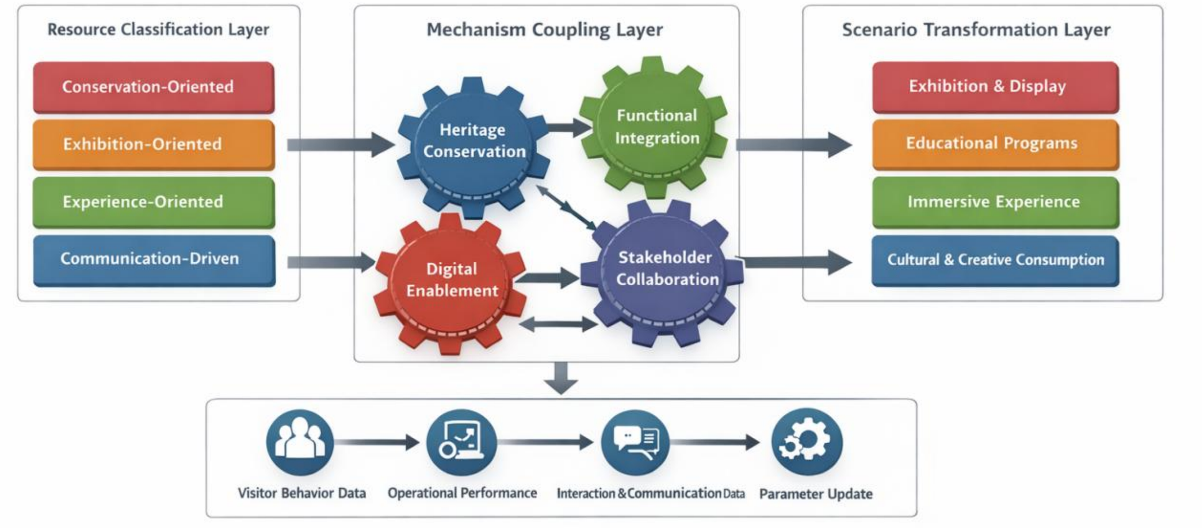

Figure 2: Innovative Model Framework for Revitalization and Regeneration Mechanism of Industrial Heritage Tourism Resources

As shown in Figure 2, the key to running the model is not to stack several types of mechanisms in parallel, but to analyze the coupling strength and adaptation order between each mechanism. Therefore, this article introduces a mechanism adaptation function to quantitatively express the degree of matching between industrial heritage resource units and activation mechanisms. If the comprehensive feature vector of the i-th resource unit is F_i and the feature vector of the j-th activation mechanism is M_j, then its adaptation value can be expressed as:

$$A_{ij} = \frac{F_i \cdot M_j}{||F_i||\,||M_j||} \tag{6}$$

In the formula, A_{ij} represents the adaptation coefficient between resource unit i and mechanism j. The larger the value, the higher the coupling degree between the resource and the mechanism. This formula essentially uses the vector angle relationship to determine the consistency between resource characteristics and mechanism requirements, which can better avoid the bias caused by single indicator judgment.

Considering that the revitalization of industrial heritage is not a static execution process, but will be continuously influenced by tourist feedback, operational status, and digital communication performance, this article further introduces a dynamic update term to iteratively revise the mechanism's effectiveness. If the activation efficiency value of resource unit i after the t-th round of operation is $E_i^{(t)}$, then there is

$$E_i^{(t+1)} = \lambda E_i^{(t)} + \mu U_i^{(t)} + \nu C_i^{(t)} \tag{7}$$

In the formula, $U_i^{(t)}$ represents the feedback value of tourist behavior in the t-th round, including duration of stay, depth of interaction, and willingness to repeat visits; $C_i^{(t)}$ represents the response value of cultural dissemination, including online clicks, shares, comments, and content reproduction; λ. The weight parameters of μ and ν, and the expression of $\lambda+\mu+\nu=1$, indicate that the activation effect is not only determined by initial planning, but will be continuously adjusted driven by feedback data.

In the specific operation of the model, this article divides different mechanisms into four core modules. The heritage protection mechanism mainly focuses on maintaining authenticity, preserving key components, and fully expressing historical information; The functional implantation mechanism emphasizes the re matching between idle space and tourism, education, commerce, and community activities; The digital empowerment mechanism mainly relies on 3D modeling, virtual navigation, interactive display, and intelligent commentary systems to enhance visualization and participation; The main collaborative mechanism deals with the relationship connection between the government, operating agencies, community residents, cultural and heritage departments, and tourists. For any industrial heritage resource, not all four types of mechanisms should be equally involved, but the dominant and auxiliary mechanisms should be determined based on the resource classification results and the degree of adaptation. In order to express the combined effect of mechanisms more clearly, this article measures the overall effectiveness of mechanism innovation using a comprehensive activation benefit function:

$$R_i = \alpha P_i + \beta T_i + \gamma D_i + \delta S_i \tag{8}$$

where: R_i represents the overall activation value of each specific resource; P_i is the protection performance factor; T_i stands for utility function coefficient; D_i is the number expression coefficient; S_i represents the coefficient of community cooperativity. At the same time, four weight factors α, β, γ, δ are set to represent the important influence level of each element. This equation can incorporate cultural and heritage protection, tourism development and technical support and other factors into it. When considering cultural facilities transformation programs, it is no longer only based on human flow or economic benefits as the evaluation index, but more reflects its cultural, geographical, nostalgic and other characteristics.

2.3 Optimization Model for the Transmission Path of Industrial Heritage Cultural Value

The system consists of four subsystems: content analysis, path adaptation, location deployment and feedback correction. The first part is content analysis, that is, the material remains, scientific and technological information, memory emotion, value concept and other contents of industrial heritage are classified and extracted, and certain symbols are used to design transmission components. The second part is path adaptation, which mainly refers to the fit and correlation analysis between different cultures and media carriers. Copywriter, image, video, simulation guide and human-computer interaction are unified into the same configuration model. The third layer nodes are sorted according to the importance level of each culture under different audience preferences, access channels and scenarios. The fourth layer of dynamic update optimizes the overall communication path according to the audience operation information (including click volume, browsing time, forwarding frequency, comment tendency, return visit rate). Through this process, the dissemination of industrial heritage culture has shifted from a one-way display mode to a multi node linkage and dynamic optimization mode. Set the collection of cultural content units for industrial heritage as

$$G = \{g_1, g_2, \cdots, g_i\} \tag{9}$$

The set of communication media nodes is

$$D = \{d_1, d_2, \cdots, d_k\} \tag{10}$$

Among them, g_i represents the i-th cultural content unit, and d_k represents the kth propagation node. To depict the degree of adaptation between cultural content and communication nodes, this article introduces a communication carrying function:

$$L_{jk} = \omega_1 V_{jk} + \omega_2 N_{jk} + \omega_3 I_{jk} \tag{11}$$

In the formula, L_{jk} represents the propagation carrying capacity of cultural content unit g_i on node d_k, V_{jk} represents the degree of visual expression of content, N_{jk} represents the clarity of narrative organization, I_{jk} represents the level of interaction support, and ω_1、$\omega_2$and ω_3 are corresponding weights, satisfying $\omega_1 + \omega_2 + \omega_3 = 1$. This formula is used to determine which media form is more suitable for conveying a certain type of industrial heritage cultural content, in order to avoid the mismatch between the transmission carrier and the content attributes.

In the process of path optimization, only examining the media carrying capacity is still insufficient to reflect the propagation efficiency, and the transmission relationship between nodes needs to be included. Based on this, this article represents the process of cultural dissemination as a directed network, and describes the operational characteristics of the dissemination chain using the transition probability between nodes. If the transition probability from node d_k to node d_l is p_{kl}, then the path propagation strength of any cultural content unit can be expressed as

$$Q_j = \sum_{k=1}^{n} \sum_{l=1}^{n} L_{jk} \, p_{kl} \tag{12}$$

In the formula, Q_j represents the path diffusion strength of cultural content units g_j in the overall communication network. The larger the value of this indicator, the easier it is for the content to form a continuous transmission chain after being distributed through node combinations, thereby improving the coverage and depth of cultural information.

Considering that the cultural dissemination effect of industrial heritage has obvious feedback dependence characteristics, this article further modifies the dissemination path based on actual response data. Let the comprehensive feedback value of the kth propagation node be

$$F_k = \frac{\rho_1 C_k + \rho_2 S_k + \rho_3 T_k + \rho_4 B_k}{\rho_1 + \rho_2 + \rho_3 + \rho_4} \tag{13}$$

In the formula, C_k represents the number of clicks, S_k represents the duration of stay, T_k represents the forwarding rate, B_k represents the secondary visit rate, and ρ_1、ρ_2、$\rho_3$and ρ_4 are the weights of each feedback indicator. This formula is used to comprehensively measure the actual performance of different propagation nodes to identify the difference between efficient nodes and inefficient nodes. On this basis, the propagation path weight update rule is set as

$$p_{kl}^{(t+1)} = p_{kl}^{(t)} + \eta(F_l - \bar{F}) \tag{14}$$

In the formula, $p_{kl}^{(t)}$ and $p_{kl}^{(t+1)}$ represent the path weights in the t-th and t+1st iterations, respectively. η represents the update coefficient, and F represents the mean feedback value of all nodes. If the feedback level of the target node is higher than the overall average, the weight of the path is enhanced; On the contrary, it will weaken accordingly. Through this update mechanism, the propagation system can continuously optimize node configuration and path combinations based on actual operational results.

This model mainly focuses on the problem of transforming the transmission of industrial heritage culture from a single content transmission to a purposeful path design, not considering the role of a medium, but paying more attention to the interaction between the content itself, the media relationship and the feedback. For industrial heritage, technical historical records, local manufacturing memories, cultural expression of workers, and urban renewal values cannot be fully conveyed in the same way. Based on the construction of dissemination load function, path dissemination intensity index and feedback update criterion, the best dissemination node and transmission path can be found for different cultures and information, and the integration degree and efficiency of industrial heritage cultural value dissemination system can be improved.

3 Results

3.1 Performance analysis of the classification model for activated regeneration elements

In order to test and evaluate the discrimination ability of the classification model of tourism resources elements of industrial heritage for each category and the stability of classification results, the basic information of some industrial heritage examples in Kaifeng city and surrounding areas was selected as samples. Moreover, relevant industry experts are invited to score as external validity indicators to construct a resource sample set based on geographical location morphology, material remains, historical events, environmental characteristics and tourism behavior. The total sample size is 240 resource units, with the training set, validation set, and test set divided in a ratio of 7:1:2. The data preprocessing stage has completed missing value filling, outlier removal, text segmentation encoding, and multi-source feature normalization processing; In the model training stage, clustering purity, contour coefficient, classification accuracy, and F1 score are used as the main evaluation indicators. At the same time, the model in this paper is compared with K-means, hierarchical clustering, and random forest classification methods to examine its adaptability in complex industrial heritage scenarios.

The model parameters are set as follows: the feature embedding dimension is set to 64, the initial number of cluster centers is set to 4, the learning rate is set to 0.001, the number of iterations is 200, and the regularization coefficient is set to 0.01. To reduce the disturbance of the results caused by a single partition, a 10 fold cross validation was used in the experiment, and the mean of each indicator was taken as the final result. The experimental results show that the model proposed in this paper exhibits high classification consistency in the joint recognition of multidimensional resource attributes, especially when cultural narrative features and spatial features are jointly involved in the calculation. The boundary recognition between resource units is clearer, and the dispersion within categories is significantly reduced.

Table 2: Performance Comparison of Classification Models under Different Parameter Conditions

Learning Rate	Feature Dimension	Classification Accuracy / %	F1 Score / %	Silhouette Coefficient
0.01	64	84.26	82.94	0.621
0.001	64	91.83	90.75	0.748
0.0001	64	88.41	87.16	0.701
0.001	32	89.67	88.45	0.713
0.001	128	90.12	89.03	0.726

As shown in Table 2, when the learning rate is 0.001 and the feature dimension is 64, the model performs the best overall, with a classification accuracy of 91.83%, an F1 value of 90.75%, and an improved silhouette coefficient of 0.748. When the learning rate is too high, the model fluctuates greatly during the iteration process, and the category boundaries are prone to drift; If the learning rate is too low, it will slow down the convergence speed of parameters, resulting in a decrease in overall recognition accuracy although the classification results are relatively stable. The higher the feature dimension, the better. When the dimension is expanded to 128, some low correlation features are included simultaneously, which actually weakens the aggregation effect of resource categories.

To further validate the effectiveness of the model, this paper compares the constructed model with three commonly used classification methods, and the results are shown in Figure 3.

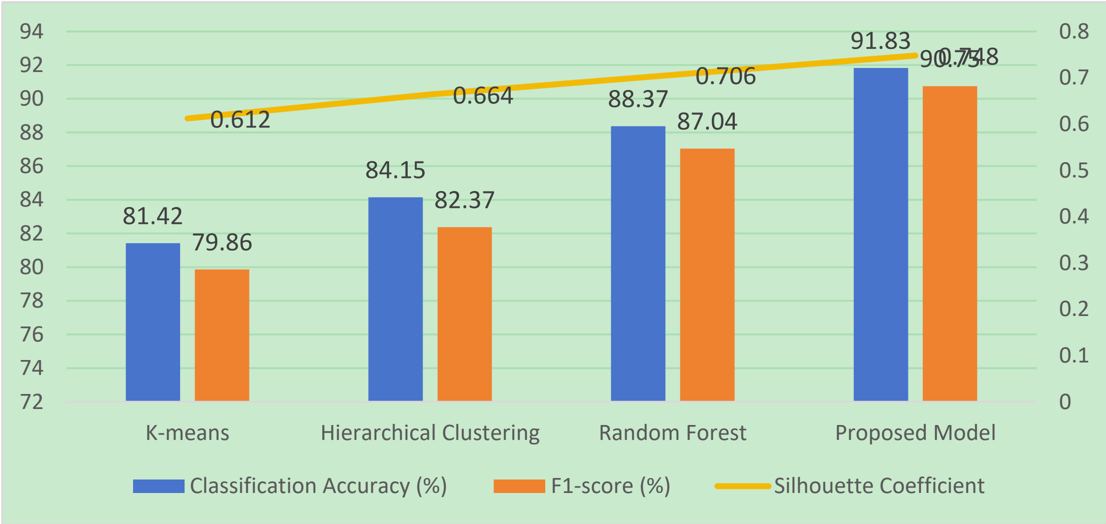

Figure 3: Performance Comparison of Different Models in Industrial Heritage Resource Classification Task

In the comparative experiment, the classification accuracy of the K-means model was 81.42%, the hierarchical clustering model was 84.15%, and the random forest model was 88.37%, all lower than the model in this paper. In particular, for the distinction between "performance translation" and "publicity driven" resources, traditional methods rely on clear digital features, and have limited comprehensive discrimination functions in terms of historical narrative density, image transmission and visitor involvement, which are prone to misjudgment. The model proposed in this paper combines multiple attributes and adds the language dimension to unify the material heritage information and cultural transmission attributes in one expression space, so as to realize the integrity of the classification.

In terms of types, the core protection class accounts for 22.5%, the display translation class accounts for 31.7%, the experience extension class accounts for 26.3%, and the propagation guidance class accounts for 19.5%. This result is basically consistent with the actual situation of the sample, indicating that the model can better identify the differences in protection value, development conditions, and dissemination potential of different industrial heritage resources. Further observation of the confusion matrix reveals that there is still a small amount of overlap between the core protected type and the display transformed type. The main reason for this is that some samples not only retain relatively complete residual ontology, but also have strong display transformed conditions, and the category boundaries have a certain degree of continuity. This phenomenon is not a model failure, but rather indicates that industrial heritage resources themselves have composite attributes, and subsequent mechanism innovation analysis needs to further refine path matching based on classification.

3.2 Efficiency analysis of innovative models for activating and regenerating mechanisms

To test the applicability and stability of the innovative model for the revitalization and regeneration mechanism of industrial heritage tourism resources, this paper selects 48 industrial heritage sample units in Kaifeng and surrounding areas for simulation testing based on the classification results of resource elements mentioned above. The experimental dataset is constructed by combining the protection status, spatial conditions, narrative density, digital foundation, and tourist behavior feedback. The samples are divided into training set, validation set, and testing set in a ratio of 8:1:1. In this paper, the fitness is 0.65, the feedback update rate is set to 0.12, the number of iterations is set to 150, and the parameter weights are initialized by the average distribution method. The total effective activation ability, the success rate of scene switching, the feedback convergence speed and the fitness accuracy are selected as the evaluation functions of the actual performance of this type of model for different types of resources. In order to further enhance the comparability, this paper introduces the one-time static matching method based on fixed rules and the single weight evaluation method, and brings the traditional AHP method into the comparison scope.

The experimental results show that the proposed method has better activation effect and model matching rate than other methods, and the advantages are more obvious for heterogeneous resource sets. The reason is that the matching algorithm based on static rules is simple and easy to implement, but it is not sensitive to the changes of resource characteristics and user feedback. The single weight evaluation model can get a preliminary ranking, but it cannot reflect the relationship among protection demand, digitization level and information dissemination potential. Although the AHP method can be used for large-scale decision making, its response efficiency is relatively low under the condition of multiple rounds of feedback correction. In contrast, the model proposed in this article is capable of forming a continuous iterative process between resource input, mechanism coupling, and feedback correction, making it more suitable for the scenario of industrial heritage activation where multiple factors are intertwined.

Table 3: Comparison of the Efficiency of Different Models in Activation and Regeneration Tasks

Model	Comprehensive Revitalization Benefit	Scenario Conversion Success Rate / %	Mechanism Matching Accuracy / %	Average Number of Convergence Iterations
Static Rule-Matching Model	0.71	78.36	80.42	34
Single-Dimension Weighted Scoring Model	0.75	81.27	84.18	29
Analytic Hierarchy Process Model	0.79	84.63	86.91	26
Proposed Model	0.88	91.54	93.27	18

As shown in Table 3, the comprehensive activation benefit of our model reached 0.88, the scene conversion success rate was 91.54%, the mechanism matching accuracy was 93.27%, and the average convergence rounds were controlled at 18 rounds, which is overall better than the other three models. This result indicates that after introducing dynamic feedback and multi mechanism collaboration, the model can not only improve the adaptability between resources and activation paths, but also shorten the parameter adjustment process and enhance operational efficiency. Especially in the display of conversion and experience extension resources, the model in this article is more sensitive to the combination recognition of functional implantation mechanisms and digital empowerment mechanisms, and can quickly form stable solutions.

To further observe the impact of different mechanism modules on overall efficacy, this study conducted mechanism ablation experiments. The complete model is denoted as A, the model with removed digital empowerment mechanism is denoted as B, the model with removed subject collaboration mechanism is denoted as C, and the model with removed feedback update mechanism is denoted as D. The experimental results are shown in Figure 4.

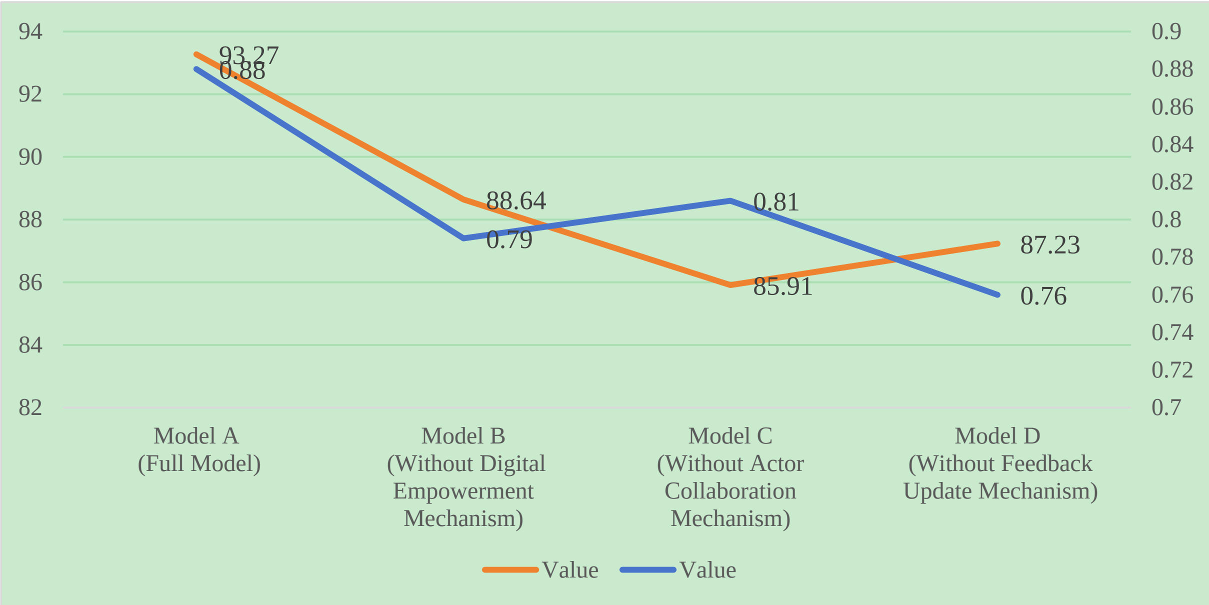

Figure 4: Comparison of Model Efficiency under Different Mechanism Combinations

From Figure 4, it can be seen that the complete model A is at the highest level in both the comprehensive activation benefit and mechanism matching accuracy indicators, with a comprehensive activation benefit of 0.88 and a mechanism matching accuracy of 93.27%. After removing the digital empowerment mechanism, Model B showed a decrease in two indicators to 0.81 and 89.46%, respectively. Among them, the comprehensive activation benefit decreased by 0.07 compared to the complete model, with a decrease of 7.95%. This indicates that modules such as digital display, virtual navigation, and interactive interface have a significant positive effect on the scene transformation and value release of industrial heritage resources. After removing the subject collaboration mechanism, Model C's comprehensive activation benefit decreased to 0.79, and the mechanism matching accuracy decreased to 85.14%. The latter decreased by 8.13 percentage points compared to the complete model, with the most significant decrease, indicating that the collaborative relationship between the government, community, operating agencies, and tourists has a direct impact on the adaptation quality of the activation plan. After removing the feedback update mechanism, Model D achieved a comprehensive activation benefit of 0.76, a mechanism matching accuracy of 86.02%, and an average convergence cycle increased from 18 cycles of the complete model to 31 cycles. It shows that although the dynamic correction mechanism does not determine the formation of the initial output, it plays a fundamental role in the subsequent optimization efficiency and scheme stability.

3.3 Feasibility analysis of optimization model of cultural value transmission path

In the industrial heritage tourism scenario, the dissemination effect of cultural value is not only affected by the scale of content supply, but also closely related to the content type, the organization mode of media nodes and the matching degree of user feedback links. Based on the 48 industrial heritage samples obtained in the previous section, this article further extracts four cultural content units: architectural heritage display, process narrative, local industrial memory, and value symbol expression. Combined with five media nodes including graphic pages, short video entrances, virtual guide interfaces, thematic display pages, and social communication ports, a transmission path test set is constructed. During the experiment, a total of 192 cultural content units, 640 sets of dissemination node sequences, and 12680 user interaction records were formed. The model's performance was analyzed using dissemination reach rate, node matching accuracy, average dwell time, and secondary visit rate as measurement indicators.

From the overall results, the path optimization model exhibits high adaptability in multi node propagation environments. After three rounds of iteration, the overall reach rate of the sample propagation increased from 78.64% in the initial stage to 91.38%, the node matching accuracy increased from 81.27% to 92.57%, the average dwell time increased from 96 s to 143 s, and the secondary visit rate increased from 29.84% to 41.83%. Compared with the static advertising method, the model increased the reach rate by 12.74 percentage points and the secondary visit rate by 13.67 percentage points, indicating that the introduction of path restructuring and feedback correction has significantly improved the dissemination efficiency and sustained attractiveness of industrial heritage cultural content. The main reason is that the model did not evenly distribute all content to each node, but differentiated the distribution chain based on content attributes, forming a more stable correspondence between media carrying forms and cultural information structures.

Table 4: Results of the Optimization Model for Cultural Value Communication Paths

Metric	Initial Stage	1st Iteration	2nd Iteration	3rd Iteration
Reach Rate / %	78.64	84.15	88.73	91.38
Node Matching Accuracy / %	81.27	86.94	90.26	92.57
Average Dwell Time / s	96	118	132	143
Repeat Visit Rate / %	29.84	34.72	38.95	41.83

There are significant differences in the performance of different content types in the dissemination nodes, as shown in Table 5. The dissemination advantage of architectural heritage content is most prominent on image display pages and virtual navigation nodes, with an average reach rate of 93.12% and an average user stay time of 151 seconds. The performance of process content is more stable on interactive demonstration nodes, with a node matching accuracy of 91.46%, significantly higher than its 82.08% on ordinary graphic and text pages; The forwarding rate of local industrial memory content is relatively high on short video entry and social media channels, with an average forwarding rate of 18.64%, which is 4.37 percentage points higher than the overall average; Value symbol content is more suitable for entering thematic display pages and in-depth explanation nodes, with a secondary visit rate of 44.11%, ranking at the highest level among the four types of content. This indicates that the dissemination of industrial heritage culture is not suitable for a single path of homogeneous push, and a hierarchical dissemination chain should be established based on the nature of the content.

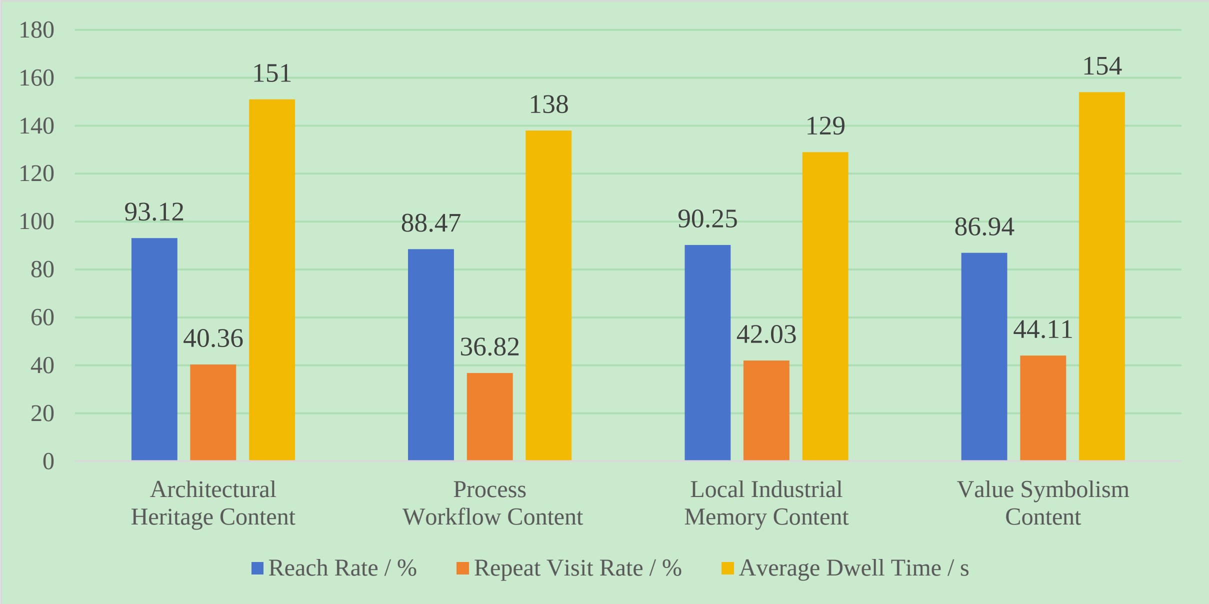

Figure 5: Differences in the Performance of Different Types of Cultural Content in Major Communication Nodes

In the process of restructuring the propagation path, the role of the feedback update module is particularly evident. Experimental records show that when feedback correction is not enabled, high popularity nodes will continue to gather similar content. Although the short-term click through rate is high, the path stability is only 0.74, and the user stay time decreases in the later stage; After incorporating feedback updates, the model is able to adjust path weights based on metrics such as clicks, shares, comments, and revisits, resulting in an increase in path stability to 0.86. The flow between nodes becomes more balanced, and the phenomenon of content duplication and accumulation is somewhat alleviated. Especially in the dissemination of local memory and value symbol content, the feedback corrected recommendation path is more likely to form a continuous behavior chain of "browse stay forward re-enter", showing strong dissemination stickiness.

4 Discussion

This article focuses on the revitalization and regeneration of industrial heritage tourism resources and the dissemination of cultural values. It constructs a classification model for resource elements, an innovative model for revitalization and regeneration mechanisms, and an optimization model for dissemination paths. The results showed that the classification accuracy of the resource element classification model reached 91.83%, the F1 value was 90.75%, and the contour coefficient was 0.748, indicating that the multi-source feature fusion method can effectively identify the type differences of industrial heritage resources. The comprehensive activation benefit of the innovative model of activation and regeneration mechanism reached 0.88, the success rate of scene transformation was 91.54%, the accuracy of mechanism matching was 93.27%, and the average convergence rounds were 18 rounds, demonstrating good mechanism adaptation ability and operational efficiency. The dissemination reach rate of the cultural value dissemination path optimization model reached 91.38%, the node matching accuracy was 92.57%, and the secondary visit rate increased to 41.83%, indicating that the dissemination path optimization method has good feasibility in the digital dissemination scenario of industrial heritage. Overall, the three types of models have achieved relatively stable test results in resource identification, activation configuration, and value dissemination, with a classification accuracy of 91.83%, mechanism matching accuracy of 93.27%, and dissemination reach rate of 91.38%. Compared with existing research on industrial heritage, the characteristic of this article is to place resource classification, activation mechanisms, and dissemination pathways in the same analytical chain. Previous studies have mostly focused on single dimensions such as industrial heritage protection and renewal, spatial reuse, authenticity experience, or tourist perception, with relatively insufficient discussion on the continuous mechanism between resource identification and dissemination and diffusion of industrial heritage. This article uses computer methods such as multi-source heterogeneous data processing, feature fusion, mechanism matching, and feedback updates to conduct a linkage analysis of the activation conditions and propagation capabilities of different resource units, thus to some extent filling the gap between "classification and utilization" and "separation of activation and propagation" in traditional research. Especially in the construction of communication paths, this article does not stop at general media diffusion, but combines content attributes, node carrying capacity, and feedback data, which helps to enhance the pertinence and sustainability of industrial heritage cultural information dissemination.

From a practical perspective, the model presented in this article has certain application value. The resource element classification model helps to improve the efficiency of early identification and screening of industrial heritage, and reduce the bias caused by relying solely on empirical judgment; The innovative model of activation and regeneration mechanism can provide differentiated path combinations for different types of resources, reducing the tendency towards homogenization in activation scheme design; The propagation path optimization model can rely on user behavior data and platform feedback results to dynamically adjust the cultural content distribution chain, thereby enhancing the digital display effect and cultural dissemination depth in industrial heritage tourism scenes. This paper has a certain role in improving the problems of single content, unbalanced information transmission and insufficient response use in the current industrial heritage tourism development. However, we also have some limitations: the selected cases are mainly in Kaifeng and surrounding cities, and there are not many geographical types and industry categories involved, so the applicability of this model in different regions needs to be verified. Secondly, some parameter Settings need to be corrected according to the experiment, and the level of interpretation involved is still relatively low. The evaluation of information value only considers the value of information from the user's click rate, stay time and access frequency, but the expression of cultural connotation, the enlightenment of tacit knowledge and long-term information circulation is not sufficient. In the future, knowledge graph, graph neural network and interpretability methods can be combined to explore the coupling path of culture and value transmission in the reactivation and regeneration of industrial heritage tourism resources in a wider range.

5 Conclusions

In summary, this paper focuses on the relationship between the activation and regeneration of industrial heritage tourism resources and the dissemination of cultural values, establishes the classification model of industrial heritage tourism resources elements, the innovation model of activation and regeneration mechanism and the optimization model of transmission path, and systematically discusses the aspects of resource identification, mechanism configuration and communication organization. Research has shown that by incorporating computer methods such as multi-source data processing, feature fusion, and dynamic feedback updates, the classification accuracy of industrial heritage tourism resources is improved, the matching degree between activation paths and resource attributes is further enhanced, and the efficiency of node configuration and sustained diffusion ability in cultural value dissemination are also improved. The relevant results indicate that the value realization of industrial heritage tourism resources should not be limited to static protection or single link development, but should form a more coherent technical support chain between resource identification, activation and utilization, and dissemination organization. This study not only improves analysis accuracy and propagation efficiency, but also increases the data processing intensity and parameter configuration difficulty during model operation, and puts forward higher requirements for sample integrity, calculation conditions, and application scenario adaptability. Due to limitations in sample size, regional types, and indicator acquisition conditions, the cross regional generalization ability and long-term propagation effect of the model in this article still need further testing. Subsequent research can continue to optimize the model structure and parameter system based on expanding the sample coverage, and combine knowledge graphs, graph neural networks, and lightweight computing methods to enhance the model's generalization ability, interpretability, and practical deployment level.

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