Empirical Study on the Impact of Authenticity Evaluation in the Adaptive Reuse Process of Industrial Heritage

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Abstract. Authenticity is considered closely related to local uniqueness, historical inheritance, and traditional culture, and can increase the value of heritage protection. Research has pointed out that adaptive reuse helps to protect the authenticity of historical heritage during urban renewal, while providing impetus for the sustainable development of industrial heritage. The research method combines qualitative and quantitative methods, including on-site investigations, interviews, and data analysis, to collect the evaluation of the authenticity of industrial heritage by observers. The research results indicate that conceptual, material, and aesthetic aspects have varying degrees of influence in the expression of authenticity in industrial heritage, and adaptive reuse plays an important role in the transmission of authenticity in industrial heritage. Adaptive reuse not only maintains the material and cultural characteristics of heritage sites, but also meets modern functional needs, while promoting a renewed understanding of heritage value and identity among tourists and residents. The results emphasize that in order to enhance the authenticity of industrial heritage, it should be tailored to local conditions from three aspects: conceptual, material, and aesthetic, while incorporating considerations such as the age of industrial heritage, the mode and function of adaptive reuse, and the greening rate, so that the authenticity of industrial heritage can be reinterpreted and given new life in the new context of use.

Keywords: industrial heritage, urban renewal, sustainable development, authenticity, adaptive, reuse

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1 Introduction

Industrial heritage plays an important role as a social and economic asset in cities, and is considered a resource for local development strategies[1]. After many industrial facilities in Europe lost their use in the second half of the 20th century, some were transformed into new functions, such as offices or shops, but these renovations often did not preserve their original authenticity[2]. Since the late 1990s, there is a certain level of social awareness and recognition of the importance and value of industrial heritage in Europe. It is shown in numerous studies on industrial heritage using diverse scientific methods and rich research perspectives and content[2]. The Nara document of 1994 emphasized the importance of determining the authenticity of heritage in cultural contexts and was included in the Operational Guidelines of the World Heritage Convention in 2005. The definition of authenticity has been expanded to include multiple dimensions: form and design, materials and texture, use and function, tradition and customs, technology and management systems, location and environment, language and other intangible cultural heritage, spirit and emotion, and other influencing factors. Meanwile, the concept of "integrity" is introduced into heritage protection, and the continuity and compatibility should become qualified conditions for integrity. They maintain the integrity of heritage, the good preservation state and the maintain cultural and natural importance including outstanding universal values of heritage, and achieve sustainable development together[3].

Adaptive reuse (AR) of industrial heritage is considered a thriving conservation strategy as it is a restorative, regenerative, and sustainable way of preserving intangible and tangible assets. It promotes the tradition and responsibility and preserve the cultural value for future generations. AR plays a strategic role in stimulating the process of regional renewal in large cities, not only affecting buildings, but also being an economically efficient, energy-saving and emission reducing sustainable development strategy.

In Chinese cities, the adaptive reuse of historical areas has become popular in urban tourism, leisure and creative projects[4]. It is often seen as a form of sustainable urban regeneration and break the conservation and redevelopment challenges faced by many historical areas[5]. These adaptive reuse sites are believed to enable the preservation of historical heritage and the appreciation for future generations. They not only help to enhance consumer experiences and destination marketing, but also reshape city image and counter the trend of urban homogenization in the process of modernization[67]. This study is based on the adaptive reuse of industrial heritage, and conducts empirical research on the authenticity evaluation and mechanism of industrial heritage by observers from the demand side.

2 Overview

2.1 Authenticity of Industrial Heritage Protection and Utilization

There are often local uniqueness, historical inheritance, and close connection with traditional culture and heritage in places with high authenticity the protection of cultural

identity, and the absence of excessive commercialization or artificialization[8]. Authenticity can enhance the ability of storytelling and help visitors form a sense of value [5].

To measure the authenticity of an object, researchers have used various methods and measures to evaluate its cultural, historical, and experiential attributes. In addition, qualitative methods such as interviews and focus groups were used to explore tourists' interpretations and meanings of real locations, as well as the role of specific cultural elements or experiences in enhancing authenticity[9]. In recent years, researchers have also utilized digital and social media data analysis to understand the perception and depiction of authenticity in destination images and tourist reviews[1011]. These methods provide insights into online discourse and real-world location representation [12].

Scholars have pointed out that authenticity in heritage protection can be reflected in the interaction of three types of authenticity: conceptual, material, and aesthetic[13]. Conceptual authenticity focuses on intangible domains, such as the strong connection between place and individual identity, which includes cognitive and emotional elements and collectively forms a sense of place. Therefore, local culture can provide individuals with opportunities to identify with themselves and express their sense of identity. Material authenticity generally exists in the originality of architecture, which is related to the history of architecture and the essence of physical materials. Aesthetic authenticity seeks to create a unified artistic experience and provide tourists with a complete image of cultural relics.

2.2 Adaptive Reuse of Industrial Heritage

The adaptive reuse of historical heritage plays a significant role in protecting historical heritage in rapidly developing Asian cities. AR not only extends the service life of buildings and reduces demolition waste[1415], but also brings social, economic, and environmental benefits to local communities [16].

Adaptive reuse is a process of transforming old buildings into new uses[17], which has continuity and compatibility. Although various physical changes may be made to the building during renovation[16], the basic structure and appearance of the building are usually preserved . In practical operation, many regions around the world often apply adaptive reuse to tourism purposes. An interview in Dawu Town, Lingchuan County, Guangxi showed that heritage tourism has become an important source of income for local residents[18]. With a focus on tourism heritage, scholars have evaluated the tourism model of industrial heritage through a combination of theory and case studies[19]. For example, using the Polish industrial heritage route as a case study, the main business models in tourism heritage were described and discussed[20]; Wei et al. [21]used the S-O-R theory and used the Nanjing Quarry as a case study to systematically constructe a model and evaluate the dimension of experience quality for industrial heritage tourism sites[21].

Without the recognition of heritage sites that have undergone adaptive reuse by tourists, any adaptive reuse for tourism purposes is unlikely to succeed[22].The adaptive reuse of heritage sites provides tourists with a fusion experience of traditional and modern cultural elements, which may differ from the findings of traditional heritage tourism research. For example, although traditional views suggest that education and learning

are fundamental elements of heritage tourism, learning may not be the main motivation in adaptive reuse heritage sites . Adaptive reuse of heritage buildings involves actively incorporating modern elements into historical environments, preserving the "past" while incorporating the characteristics of "modernity" [23]. This approach aims to maintain the historical value of the building while adding new functions and attractiveness to meet the needs of contemporary society and economy[5].

The adaptive reuse (AR) of industrial heritage has become increasingly important in current protection policies, and a large number of scholars have conducted relevant research from different directions. First are the topics of good policies and practices in heritage protection, adaptive reuse, and protection and reuse[25 26], as well as the strategies and evaluations for adaptive reuse of industrial heritage[1924 27]. For example, a study constructed an evaluation system for the adaptive reuse potential of industrial heritage and conducted empirical research, providing targeted suggestions for guiding urban regeneration[28]; Another example is a study of exploring the design and implementation methods of adaptive reuse strategies for abandoned industrial heritage [29]; The third exaple is a study proposing reasonable policy network planning can effectively enhance the investment value of commercial transformation and development of heritage sites[30]. The second topic is to focus on a certain industrial heritage case and conduct in-depth analysis of its development status, transformation direction, and renewal strategy. For example, a study conducted a research on the transformation path and regeneration mechanism of urban industrial heritage[3132]; Another example is a study about the quantitative evaluation of the industrial site reuse of the "Second Factory Cultural and Creative Park" project for the reconstruction of the original site of Chongqing Printing Factory[33]. With the increasing attention paid to the sustainable development of cultural heritage in academia[343536], the third topic is researching on industrial heritage from a sustainable development perspective[2037]. such as the research focusing on promoting the sustainable development of cultural heritage through digitization[38 393440]; and the study of exploring important factors for the sustainable development of industrial or cultural heritage[41423543]; Moreover, some studies use quantitative methods to quantitatively analyze the sustainable development of industrial heritage[36].

With the popularization of adaptive reuse in heritage protection, the authenticity of the traditional "object centered" historical dimension is constantly challenged by the definition of experiential authenticity in the field of urban heritage protection[44]. How to use industrial heritage to enhance urban image and promote urban revitalization while protecting its authenticity and integrity and eliminate opposition and achieve balance between protection and development is an important proposition for the sustainable development of industrial heritage[45]. From the perspective of demand side, there is little empirical research on the authenticity of adaptive reuse of industrial heritage. Different subjects are influenced by their educational background, living environment, interest demands, demand levels, work environment, etc., and there are significant differences in their perception of the authenticity of industrial heritage[46]. This study will focus on evaluating the authenticity of industrial heritage for different types of observers.

3 Research Design

3.1 Research questions

This article studies the impact of conceptual, material, and aesthetic factors on the evaluation of the authenticity of industrial heritage experience, as well as the impact of different adaptive reuse models on the evaluation of industrial heritage authenticity. Based on these two research questions, we propose three hypotheses.

Assumption 1: The higher the score of conceptual indicators such as the degree of revealing the local connotation of industrial heritage, the consistency between commercial and cultural goals, and the inheritance and transformation of urban style, the higher the citizen's evaluation of the authenticity of industrial heritage.

Assumption 2: The higher the score of indicators that reflect the materiality of industrial heritage, such as commodity craftsmanship, tourist souvenirs, and suitability for walking, the higher the evaluation of the authenticity of industrial heritage by citizens.

Assumption 3: The higher the aesthetic value and compatibility with neighboring environments of industrial heritage, the higher the evaluation of the authenticity of industrial heritage by citizens.

Assumption 4: The adaptive reuse mode, age, greening rate, internal commercial and cultural facilities of industrial heritage have a significant impact on the authenticity evaluation of industrial heritage.

3.2 Research Area

The selection of industrial heritage in Hangzhou is mainly based on cultural relics and historical buildings that can represent the development history of Hangzhou's industry, and key protection is carried out for 41 industrial heritage sites listed in the protection list at all levels; In addition, the list of industrial heritage also includes 28 modern buildings that can to some extent reflect the industrial development process of Hangzhou, without affecting the construction of the main municipal facilities in the city. The development of industrial heritage follows the principles of protection priority and moderate utilization. Based on sufficient protective restoration, the corresponding development mode is determined according to the degree of preservation and functional type. The industrial heritage of Hangzhou is mainly concentrated in the Shangcheng District and Gongshu District, scattered in Xihu District, Binjiang District, and Yuhang District, while other administrative regions have not been selected. The study selected 9 types of industrial heritage with different adaptive development models in Hangzhou as the research area, and conducted questionnaire surveys on 20 observers of industrial heritage.

Table 1. The Spatial Distribution of Hangzhou's Industry Heritage Sites

District	Total number of industrial heritage	Number of items included in the protection list	Number of items not yet listed in the protection list

Shangcheng Disrict	25	21	4
Gongshu Disrict	31	11	20
Xihu Disrict	9	5	4
Binjiang Disrict	1	1	-
Yuhang Disrict	3	3	-
Summation	69	41	28

Table 2. Types and related attributes of adaptive reuse of industrial heritage names in the study area

Heritage Name	Time	Adaptive reuse mode	Development mode
Zhejiang Hangzhou Petroleum Company Xiaohe Oil Depot Complex	1960s -1980s	Park	Government-led
Hangzhou Huafeng Paper Industry Co., Ltd. Political Building	the Republic of China	Park	Government-led
Building Complex of Ship Repair and Building Factory of Zhejiang Waterway Construction Engineering Department	1950s -1960s	Park	Government-led
Hangzhou Blue Peacock Chemical Fiber Co., Ltd. Acrylic Factory Building (Structure) Complex	1960s -1980s	Cultural and Creative Office	Market-oriented
Hangsi Lian Architecture	1950s -1960s	Cultural and Creative Office	Market-oriented
National Factory Silk Reserve Warehouse	1950s -1960s	Hotel	Market-oriented
Hangzhou Heavy Machinery Co., Ltd. Building (Structure) Group	1960s -1980s	Culture and Art	Government enterprise cooperation
Hangzhou Xielian Thermal Power Co., Ltd. Building (Structure) Complex	1960s -1980s	Culture and Art	Government enterprise cooperation
Hangzhou Changzheng Chemical Plant Complex	1960s -1980s	Commercial block	Market-oriented
Hangzhou Dahe Shipyard Complex	1960s -1980s	Commercial street	Market-oriented
Buildings on the former site of Hangzhou Electric Company	1950s -1960s	Commercial block	Market-oriented
The former site of Tongyi Gong Cotton Mill	Qing dynasty - Republic of China	Museum	Government-led
Dujinsheng Museum	1980s -1990s	Museum	Government-led
Hangzhou Honglei Silk Weaving Factory Building Complex	1960s -1980s	Museum	Government-led

Hangzhou Minsheng Pharmaceutical Group Co., Ltd. Building (Structure) Group	1960s -1980s	Education industry	Market-oriented
Sanglu	the Republic of China	Education industry	Market-oriented
Former site of Zhejiang Jiangxi Railway Bureau	the Republic of China	Social undertakings	Government-led
Zhejiang Hemp Textile Factory Building	1950s -1960s	Social undertakings	Government-led
Hangzhou Oxygen Co., Ltd. Building (Structure) Complex	1950s -1960s	Undeveloped	Government-led
Hangzhou Meat Union Factory Employee Dormitory Complex	1950s -1960s	Undeveloped	Government-led

3.3 Research Methods

Based on the principles and requirements of authenticity in the International Convention on Industrial Heritage, a questionnaire evaluation standard system for the adaptability of industrial heritage was developed. A questionnaire survey was conducted on tourists, surrounding residents, internal merchants, park management or staff, as well as local government departments and relevant experts and scholars of industrial heritage. A total of 1200 questionnaires were distributed, and 1174 valid questionnaires were collected.

Table 3. Evaluation Criteria System for Survey Questionnaire on the Authenticity of Industrial Heritage

Connotation	Authenticity indicators and international conventions for reference	Scoring criteria
Authenticity	**The overall authenticity of industrial heritage** *47484950 51 52 5354*	5: The historical background is real and is a specific historical product; The connotation of industrial culture is real and complete, and the historical and cultural carrier is highly continuous and compatible, reflecting the industrial characteristics of a specific period of time 4: The completeness of industrial culture connotation is good, and the continuity and compatibility of historical and cultural carriers can better reflect history, industry, and regional culture 3: The completeness and continuity carried by historical culture are average, which can roughly reflect the real history and industrial culture

		2: Less reflection of real history and industrial culture 1: Almost unable to reflect the relevant historical and industrial cultural connotations
Conceptuality	**The degree of revealing the local connotation of industrial heritage** *Charter on the Protection of Local Spirits (Quebec Charter)(2011)*[51]	5: It is an important component of industry and city history and culture, carrying the important memories and emotions of local people towards the industry 4: It is relatively important in the development history, with a high level of historical protection, and the local people have a deep impression of it 3: The historical status is relatively average, and the local people have a general impression of it 2: The historical protection level is relatively low, and the local people have little impression of it 1: Not playing a significant role in revealing the connotation
	Consistency between commercial and cultural objectives of industrial heritage *Declaration of San Antonio(1998)*[47]	5: Extremely high, with a deep integration of commercial atmosphere and cultural characteristics 4: High, there is a good combination of commercial formats and cultural atmosphere 3: Generally, there is a combination of commercial formats and cultural atmosphere 2: There is a combination of commercial formats and cultural atmosphere, but not many 1: Not very good, too commercialized
	Inheritance of Industrial Heritage and Transformation of Urban Style *Draft recommendation by UNESCO on historical urban landscapes(2011)*[50]	5: The architectural style is highly consistent with the urban style, and the spatial layout is integrated with the city, which is a witness and record of urban development 4: The architectural style has undergone some renovation, and the spatial layout is more consistent with urban development 3: Partially inheriting the urban style, with moderate adaptability to the city 2: The symbolic urban style can be vaguely seen 1: Same as some shopping malls or public places, the urban style is almost indistinguishable
Materiality	**The commodity craftsmanship of industrial heritage** *The first World Heritage*	5: It is the representative and essence of industrial heritage manufacturing technology, with good technology and collection and memorial value

	Committee meeting held in Paris(1978)[38]	4: Inheriting or reflecting the previous manufacturing technology is relatively complete, with good craftsmanship 3: Able to showcase some manufacturing technologies, reflecting a certain industrial style, and the process is still acceptable 2: It can be seen that the previous manufacturing technology has been largely covered by modern technology 1: It has been replaced by a new process and has no special commemorative value
	Tourism souvenirs of industrial heritage *《The International Declaration of Jerusalem》(2006)*[52]	5: Souvenirs can reflect local culture well, with a complete variety and a large quantity 4: Souvenirs can reflect local culture, with a wide variety and quantity 3: Souvenirs can reflect some cultures, and the types and quantities are average 2: Souvenirs reflect a low cultural level and a limited number of types 1: No souvenirs or low quality souvenirs
	The suitability of walking on industrial heritage sites *Memorandum on World Heritage and Contemporary Architectural Management of Historical Urban Landscape in Vienna(2005)*[54]	5: Extremely high, with excellent walking experience, changing scenery and pleasant environment, suitable for walking and playing in multiple seasons and periods 4: High, good walking experience, integrated with multiple functions 3: Generally, it can be used as an occasional walking and recreational area 2: Need for optimization, lack of landscape or facility experience during walking 1: Very poor, the environment is not suitable for walking, and there is almost no landscape or facility experience during walking
Aesthetics	**The Aesthetic Value of Industrial Heritage** *Burra Charter(1999)*[53]	5: Greatly inheriting historical heritage and industrial culture, the harmonious integration of artificial and natural landscapes, the strong modern or artistic atmosphere of architectural structure and colorful style, and the abundance of industrial style art or landscape architectural sketches, presenting the vitality and diversity of the community very well 4: Revealing historical and cultural heritage, beautiful architectural design style, with some artistic sketches, overall vitality is good 3: The overall environment is beautiful and has a certain artistic atmosphere 2: The commercial atmosphere dominates, making it difficult to see traces of past industrial heritage

	Compatibility between Industrial Heritage and Adjacent Environment *Venice Charter(1964)*[49]	1: It has been basically modernized, with little historical inheritance and related aesthetic value 5: Perfectly integrated with neighboring environments 4: Coordinate with neighboring environments 3: Relatively harmonious with the neighboring environment 2: Lack of coordination with neighboring environment, requiring strengthened renovation 1: Almost uncoordinated with the neighboring environment

The overall authenticity evaluation score of industrial heritage by the respondents after the questionnaire survey is used as the dependent variable of the sample, and the degree of revealing the local connotation of industrial heritage, the consistency of commercial and cultural goals of industrial heritage, the inheritance and transformation of urban style of industrial heritage, the commodity technology of industrial heritage, tourism souvenirs of industrial heritage, the suitability of industrial heritage walking, the aesthetic value of industrial heritage, compatibility with neighboring environment, and the adaptive reuse mode of industrial heritage are used as independent variables.

In addition, other factors that may be related to the authenticity evaluation of industrial heritage were measured, such as the adaptive redevelopment model of industrial heritage, age, greening rate, the proportion of internal commercial and commercial buildings to total land use, and the proportion of internal cultural facility buildings to total land use, and these factors were used as control variables.

3.4 Data Analysis

According to the descriptive statistical analysis results of the questionnaire survey data on the overall authenticity of industrial heritage, there are significant differences in the authenticity evaluation of industrial heritage under different adaptive reuse modes. Therefore, based on the research question, the influence of different factors on the overall perception of authenticity in industrial heritage was analyzed using the Ordinary Least Squares (OLS) regression analysis method by R.

Table 4. Descriptive statistical analysis of questionnaire survey data on the overall authenticity of industrial heritage

Variables	Calculation method	Range	Mean	Standard deviation
The overall authenticity of industrial heritage	Questionnaire survey statistics score	1-5	3.92	1.00
The degree of revealing the local connotation of industrial	Questionnaire survey statistics score	1-5	4.06	0.91

heritage				
Consistency between commercial and cultural objectives of industrial heritage	Questionnaire survey statistics score	1-5	3.66	1.13
Inheritance of industrial heritage and transformation of urban style	Questionnaire survey statistics score	1-5	4.11	0.90
The commodity craftsmanship of industrial heritage	Questionnaire survey statistics score	1-5	3.43	1.29
Tourism souvenirs of industrial heritage	Questionnaire survey statistics score	1-5	3.24	1.35
The suitability of walking on industrial heritage sites	Questionnaire survey statistics score	1-5	4.21	0.90
The Aesthetic Value of Industrial Heritage	Questionnaire survey statistics score	1-5	4.14	0.95
Compatibility between industrial heritage and adjacent environment	Questionnaire survey statistics score	1-5	4.12	0.98
Greening rate	Remote sensing measurement, (industrial heritage green space area/total industrial heritage land area) × 100%	0-1	0.27	0.16
The proportion of internal commercial and commercial buildings to total land use	Remote sensing measurement (internal commercial and commercial building area/total industrial heritage land area) × 100%	0-1	0.26	0.21
The proportion of internal cultural facilities to total land use	Remote sensing measurement, (internal cultural facility construction area/total industrial heritage land area) × 100%	0-1	0.19	0.16

4 Results

4.1 The influence mechanism of independent variables

This article examines the impact of conceptual, material, and aesthetic factors on the evaluation of authenticity in industrial heritage experiences and concurrently analyzes the effect of control variables on the assessment of authenticity. From the model results in Table 5, it can be seen that all 8 indicators have significant impacts on the sense of authenticity at the 1% level. According to the coefficient (influence size) of each indicator, the order from highest to lowest is: the degree of local connotation disclosure of industrial heritage (0.710), aesthetic value (0.588), inheritance and transformation of urban style (0.507), compatibility with neighboring environment (0.435), suitability for walking (0.301), and consistency between commercial and cultural goals (0.368) Product craftsmanship (0.356), tourist souvenirs (0.301).

Overall, the coefficients of various indicators are significantly positive, which can promote the authenticity evaluation of industrial heritage. From the perspectives of conceptualization, materiality, and aesthetics, conceptual indicators (degree of connotation disclosure, inheritance and transformation of urban style) and aesthetic indicators (aesthetic value, compatibility with neighboring environment) have a significant promoting effect. Conceptual indicators increase by an average of 1 point, while realistic scores increase by 0.528 points and 0.515 points respectively; The promotion effect of material indicators (suitability for walking, commercial craftsmanship of industrial heritage, and tourist souvenirs) is relatively small, with an average increase of 1 point and a 0.355 point increase in realism score.

From a conceptual internal analysis, the degree of local connotation disclosure has a relatively high promoting effect on authenticity evaluation. The degree of local connotation disclosure has increased by 1 point, and the authenticity score has increased by 0.710 points. Inheriting and transforming urban style has a relatively high promoting effect on authenticity evaluation, and inheriting and transforming urban style has increased by 1 point, and the authenticity score has increased by 0.507 points; In the aesthetic indicators, the promotion effect of aesthetic value is relatively high, with an increase of 1 point in aesthetic value and a 0.588 point increase in realism score; In terms of material indicators, the promotion effect of walking suitability is relatively high, with a 1 point increase in walking suitability and a 0.407 point increase in realism score.

4.2 The influence mechanism of control variables

The control variables have different impacts on the authenticity. From the perspective of the adaptive reuse model of industrial heritage, when analyzed based on the adaptive reuse model of museums, all models have a higher impact on the authenticity evaluation of industrial heritage compared to museums. The coefficient of industrial heritage as a model for park reuse is positive and significant at the 1% level, indicating that the use of industrial heritage sites as parks can significantly increase their overall realism rating. This may be because parks can provide direct interactive space for the public, increasing the experiential value of heritage. Similarly, among all models, the model of industrial heritage development and educational industry reuse has a positive and highly significant impact, indicating that using industrial heritage for educational purposes can effectively enhance its authenticity, possibly because educational activities increase people's understanding of history and the transmission of value. As industrial heritage that is reused by hotels, it has a significant positive impact on overall realism ratings in most models, indicating that hotel operations help maintain and enhance the authenticity of heritage. Most models show that industrial heritage as a commercial district has a significant positive impact on the overall realism score, which may indicate that a certain balance can be achieved between commercial activities and cultural heritage protection. The development of social undertakings in industrial heritage has inconsistent coefficients in different models, and most of them are not significant, indicating that the impact of social undertakings as a new use of industrial heritage on its

authenticity score is not significant or changes significantly. Industrial heritage for cultural and creative office development, this indicator is significantly positive in most models, indicating that using industrial heritage as a cultural and creative office space can improve its overall realism score. All models show that the development of cultural and artistic formats in industrial heritage has a significant positive impact on the overall authenticity score, indicating that cultural and artistic activities can enhance the authenticity and attractiveness of industrial heritage. The indicator of undeveloped industrial heritage is significant in some models and not significant in others. Undeveloped industrial heritage may have the potential to improve authenticity ratings, but it may also decrease authenticity due to a lack of proper management.

From a chronological perspective, industrial heritage from the 1960s to 1980s had a significant positive impact on authenticity, while heritage from the Republic of China period showed a negative impact, indicating differences in the perception of authenticity among industrial heritage from different historical periods. Heritage from the Republic of China period may have a reduced perception of authenticity due to improper renovation and management.

In all models, the greening rate has a positive impact on the overall realism score of industrial heritage, and is significant at the 1% level in most models, only at the 5% level in model (7). This indicates that as the greening rate increases, the authenticity score of industrial heritage also increases, possibly because greening can improve environmental quality, enhance the natural beauty of industrial heritage, and thus enhance the overall perceived authenticity of visitors.

All models indicate that the increase in the proportion of internal commercial and commercial buildings is positively correlated with the authenticity score of industrial heritage, and is significant at the 1% level. This may mean that moderate commercial development can bring new functions and vitality to industrial heritage, making heritage sites more in line with modern usage needs without losing their historical authenticity.

Similarly, the increase in the proportion of cultural facility buildings is significantly positively correlated with the realism score of industrial heritage in all models, and is significant at the 1% level. The increase in internal cultural facilities may strengthen the education and cultural value of industrial heritage, enhance public perception of heritage value, and therefore have a positive impact on authenticity ratings.

Table 5. Regression analysis results of the authenticity of industrial heritage

	Dependent variable:							
	Overall authenticity rating of industrial heritage							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
The degree of revealing local connotations	0.710***							
	(0.025)							
Consistency between business and cultural goals		0.368***						
		(0.024)						

Inheriting and transforming urban style			0.507***					
			(0.030)					
Product craftsmanship				0.356***				
				(0.021)				
Tourism souvenirs					0.301***			
					(0.020)			
The suitability of walking						0.407***		
						(0.030)		
Aesthetic value							0.588***	
							(0.025)	
Compatibility with neighboring environments								0.435***
								(0.030)
Park	0.901***	1.315***	1.246***	1.270***	1.395***	1.636***	1.044***	1.467***
	(0.269)	(0.319)	(0.314)	(0.313)	(0.321)	(0.325)	(0.287)	(0.321)
Education industry	2.032***	2.848***	2.368***	2.742***	2.690***	3.318***	1.790***	3.000***
	(0.494)	(0.585)	(0.578)	(0.574)	(0.591)	(0.596)	(0.530)	(0.590)
Hotels	0.627***	0.808***	0.756***	0.823***	0.847***	0.890***	0.597***	0.811***
	(0.227)	(0.269)	(0.265)	(0.264)	(0.271)	(0.275)	(0.243)	(0.272)
Commercial Block	0.434***	0.592***	0.463***	0.542***	0.535***	0.622***	0.506***	0.535***
	(0.169)	(0.201)	(0.197)	(0.197)	(0.202)	(0.205)	(0.181)	(0.203)
Social undertakings	0.172	0.259	-0.192	0.481**	0.480**	0.148	0.214	-0.049
	(0.183)	(0.218)	(0.216)	(0.214)	(0.220)	(0.223)	(0.196)	(0.221)
Uncultivated	0.464*	0.643**	0.626**	0.622**	0.743**	1.062***	0.442	0.844***
	(0.252)	(0.299)	(0.294)	(0.293)	(0.301)	(0.305)	(0.269)	(0.301)
Cultural and Creative Office	0.308	0.519**	0.443*	0.494**	0.530**	0.799***	0.374*	0.623**
	(0.202)	(0.240)	(0.236)	(0.235)	(0.241)	(0.245)	(0.216)	(0.242)
Culture and Art	0.836***	1.288***	1.151***	1.297***	1.214***	1.603***	1.033***	1.454***
	(0.248)	(0.293)	(0.289)	(0.287)	(0.296)	(0.299)	(0.264)	(0.296)
1960s -1980s	0.283***	0.432***	0.369***	0.490***	0.558***	0.438***	0.335***	0.461***
	(0.087)	(0.103)	(0.101)	(0.100)	(0.103)	(0.105)	(0.092)	(0.104)
1980s -1990s	0.251	0.475**	0.606***	0.335	0.593**	0.559**	0.686***	0.532**
	(0.198)	(0.235)	(0.231)	(0.230)	(0.236)	(0.240)	(0.211)	(0.237)
The Republic of	0.223	0.244	0.594**	0.081	0.286	0.509**	0.254	0.535**

China	(0.169)	(0.202)	* (0.198)	(0.199)	(0.203)	(0.205)	(0.181)	* (0.203)
Qing Republic - Republic of China	-0.131 (0.186)	-0.209 (0.221)	-0.424* (0.218)	-0.245 (0.217)	-0.135 (0.223)	-0.317 (0.226)	-0.208 (0.199)	-0.355 (0.224)
Greening rate	1.847*** (0.634)	2.334*** (0.756)	2.478*** (0.741)	2.064*** (0.742)	2.288*** (0.762)	3.408*** (0.766)	1.731*** (0.680)	3.287*** (0.756)
The proportion of internal commercial and commercial buildings to total land use	2.477*** (0.751)	3.259*** (0.895)	3.401*** (0.877)	2.817*** (0.879)	3.058*** (0.904)	4.536*** (0.906)	2.387*** (0.806)	4.357*** (0.895)
The proportion of internal cultural facilities to total land use	4.203*** (0.951)	6.143*** (1.127)	6.514*** (1.103)	5.576*** (1.107)	5.822*** (1.139)	7.909*** (1.141)	5.080*** (1.014)	7.527*** (1.127)
Constant	-1.716** (0.734)	-1.215 (0.873)	-1.981** (0.857)	-0.762 (0.857)	-0.795 (0.881)	-2.770*** (0.894)	-1.448* (0.785)	-2.579*** (0.882)
Observations	1,146	1,146	1,146	1,146	1,146	1,146	1,146	1,146
R^2	0.511	0.309	0.333	0.337	0.299	0.278	0.441	0.296
Adjusted R^2	0.504	0.300	0.323	0.328	0.290	0.268	0.433	0.287
Residual Std. Error (df = 1129)	0.704	0.837	0.823	0.820	0.843	0.856	0.753	0.845
F Statistic (df = 16; 1129)	73.646***	31.628***	35.173***	35.865***	30.164***	27.170***	55.662***	29.739***

Note: *p<0.1; **p<0.05; ***p<0.01

5 Conclusion and Discussion

5.1 Discussion

The four hypotheses set in the study have been positively validated. In terms of conceptualization, the degree to which local connotations are revealed and the inheritance and transformation of urban style are considered the most important factors in the first three assumptions, indicating that a deep understanding of industrial heritage and its ability to integrate with urban culture are key to evaluating its authenticity. Extended research can explore how to increase public awareness of these conceptual factors through education and community participation. From an aesthetic perspective, the compatibility between aesthetic value and neighboring environment has a significant impact on authenticity, indicating that when protecting and reusing industrial heritage, it is not only important to pay attention to its historical value, but also to consider its

aesthetics and the harmony of the surrounding environment. Future research can explore different design and planning methods to enhance the aesthetic and environmental compatibility of industrial heritage. From a material perspective, although the impact of walking suitability and other material indicators is relatively small, they cannot be ignored. This means that the functionality and convenience of industrial heritage are equally important for enhancing authenticity. Further research could focus on optimizing the functional layout of industrial heritage and enhancing the tourist experience.

From the fourth assumption, the authenticity of industrial heritage is not only influenced by conceptual, material, aesthetic and other factors, but also closely related to its urban environment and adaptive reuse methods, such as historical period, protection status and functional utilization methods, greening rate, proportion of internal commercial and commercial buildings and cultural facilities, etc., which are important considerations. Protecting and reasonably utilizing industrial heritage, enhancing its authenticity, is crucial for promoting the sustainable development of industrial heritage.

From the perspective of adaptive reuse models, reuse models as parks, educational venues, hotels, and commercial areas have a positive impact on realism ratings. Effective adaptive reuse will promote the authenticity of industrial heritage, transform conditional industrial heritage into characteristic hotels, and develop the cultural and tourism industry. Efforts should be made to preserve the original industrial characteristics, while satisfying modern comfort and allowing tourists to experience the historical atmosphere of heritage. Transforming industrial heritage into cultural and artistic spaces, strengthening the cultural and artistic functions of industrial heritage, can significantly improve its authenticity rating. It is recommended to develop the cultural and artistic functions of industrial heritage, and enhance its cultural value and public participation through art exhibitions, performances, workshops and other activities. Educational activities can enhance public understanding and awareness of the history of industrial heritage, use industrial heritage in the education industry, promote the educational function of industrial heritage, such as establishing research and education centers, which can effectively enhance its authenticity. The transformation of industrial heritage into commercial districts and social undertakings can also enhance its authenticity rating. Multi functional commercial and social service facilities should be provided in conjunction with community development. For undeveloped industrial heritage, in the process of utilizing its development potential, caution should be exercised in planning its future use to ensure that its historical characteristics are protected. Further research can focus on how these patterns can be combined with the historical attributes of industrial heritage, maintaining their authenticity while meeting modern functional needs.

From the perspective of historical influence, the impact of industrial heritage on authenticity varies in different historical periods, which may be related to the construction materials, design concepts, and protection status at that time. Next, we can study the characteristics of heritage in specific periods and their specific impact on authenticity.

From the perspective of greening rate, an increase in greening rate has a positive impact on realism. Future research can explore how to improve greening rate through landscape design without affecting the historical sense of industrial heritage.

From the perspective of the proportion of commercial and cultural facilities, the appropriate increase in commercial and cultural facilities is positively correlated with authenticity. Subsequent research can further explore the balance between the two and how to design these spaces to enhance the authenticity of industrial heritage.

5.2 Conclusion

Through in-depth analysis of the adaptive reuse process of industrial heritage and its impact on authenticity evaluation, this study reveals the application value of a multidimensional authenticity framework in the protection and reuse of industrial heritage. The research results indicate that the adaptive reuse of industrial heritage is not only related to the protection and utilization of material aspects, but also to the inheritance of culture and identity, closely related to social memory and identity recognition. In the process of protecting and utilizing industrial heritage, the enhancement of authenticity should focus on enhancing conceptual and aesthetic aspects, enhancing the degree of revealing the connotation of industrial heritage, strengthening the inheritance and transformation of urban style of industrial heritage, enhancing the aesthetic value of industrial heritage and its compatibility with neighboring environments.

Firstly, maintaining authenticity is the key to achieving successful adaptive reuse of industrial heritage. Authenticity is not only reflected in the material attributes of heritage, such as form and design, materials and texture, but also in intangible cultural aspects, such as usage and function, tradition and customs, technology and management systems, and spirit and emotion. These dimensions together constitute the integrity of heritage and are the basis for evaluating its authenticity.

Secondly, in the process of adaptive reuse, attention to authenticity should not be limited to the material preservation of buildings and the environment, but should also focus on the continuity of cultural and social dimensions. Non material factors, including local culture, community participation, and stakeholder awareness, play a crucial role in enhancing the authenticity and sense of place of tourist experiences.

In addition, the economic and social benefits brought by adaptive reuse should not overlook its impact on local uniqueness and historical inheritance. In the process of urbanization and modernization, maintaining the uniqueness and historical continuity of industrial heritage is an important way to avoid urban homogenization and cultural distortion.

In summary, the adaptive reuse of industrial heritage requires a multi-party and multi strategy management strategy. Based on empirical research, it is suggested that future industrial heritage protection and adaptive reuse projects should comprehensively consider multiple dimensions of authenticity, strengthen community participation and public education, and protect the authenticity of heritage through policy support and technological innovation. Meanwhile, utilizing digital and social media tools can more effectively disseminate the value of industrial heritage and stimulate public awareness and respect for it. Through these measures, we can not only preserve tangible industrial heritage for future generations, but also inherit its intangible cultural values and spiritual connotations, contributing to the sustainable development of cities.

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