

# On Value Assessment Model Building for Jadeaware in the Neolithic Age

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**Abstract**—Value assessment for jadeaware in the Neolithic age faces many problems. Under such circumstances, building a sound and rational value assessment model that conforms to value connotations becomes a realistic demand of promoting the management of jadeaware in the Neolithic age. In this study, a value assessment model of a hierarchical structure is constructed from three perspectives of substantive value, artistic value, and historical and cultural value. By combining group decision-making and the analytic hierarchy process, an effective approach can be provided for weight calculations of various indexes. Additionally, empirical tests are also conducted to verify the reasonability and feasibility of the proposed model.

**Keywords**-Jadeaware in the Neolithic age; value assessment model; analytic hierarchy process; group decision-making

## 1 Introduction

Through the ages, cultural relics have not been subjected to profound value assessment in the field of museology. Now, we still follow cultural relics grading standards issued in 2001, which makes it less likely to meet actual needs. During grading and relevant assessment, unique features are still analyzed in most cases, including the era to which a cultural relic belongs, artistic characteristics, peculiarities, significance, and social functions. As a habitual practice, we use some fuzzy concepts (e.g., “huge value”, “invaluable” and “national treasure”) to describe how valuable a cultural relic is, but fail to investigate the cultural relics quantitatively. Jadeaware in the Neolithic age is the source of jadeaware culture in China. As a carrier of high-grade, high-precision, advanced technology in society at that time, jadeaware has a history of nearly ten thousand years. In addition to reflecting socio-economic levels at that time, jadeaware also embodies deep religious ideas and has a rich color of deity worship. Without a doubt, the value of jadeaware is extremely great and cannot be reproduced. Therefore, it is necessary to build a value assessment model for jadeaware in the Neolithic age and thus provide a basis for relevant assessment management.

Analytic hierarchy process (AHP)<sup>[1]</sup> is a rather mature multi-criteria decision-making analysis method. Featuring clear thinking, simplicity, and strong systematicness, it has been widely applied in different fields. In terms of group decision-making (GDM)<sup>[2]</sup>, it is a decision-making approach according to which multiple experts participate in decision-making jointly based on principles of scientization and democratization. The present study incorporates GDM into AHP, so that judgement made by lots of experts can be summed up by a weighted arithmetic mean of results achieved by these experts. This can effectively reduce subjective bias generated by

obvious subjectivity existing in AHP, and further provide a valid approach to building the value assessment model for jade ware in the Neolithic age.

## 2 Value assessment model building for jade ware in the Neolithic age

### 2.1 Hierarchical structure of the index system

Based on features of and expert opinions on jade ware in the Neolithic age, value assessment indexes for such jade ware form a three-layer assessment model containing 3 primary indexes, 10 secondary indexes, and 15 tertiary indexes, as presented in Figure 1 below. [3, 4]

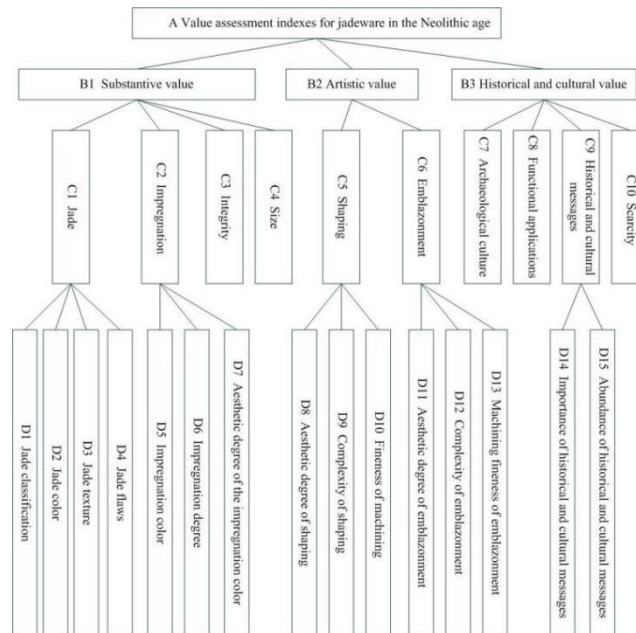


Figure 1 Value assessment indexes for jade ware in the Neolithic age

### 2.2 Pairwise judgment matrix building

After the hierarchical value assessment model has been established, we need to construct a pairwise judgment matrix of various layers. Here,  $n$  factors involved in comparison were designed. Then, the pairwise judgment matrix can be expressed in  $A=(a_{ij})_{n \times n}$ ; and the matrix meets the following conditions:  $a_{ij}>0$ ,  $a_{ji}=1/a_{ij}$ , and  $a_{ii}=1$ . [5] In the present study, the classic 1-9 scaling method was utilized to denote values of  $a_{ij}$ , as shown in the following Table 1.

Table 1 Scales of the judgment matrix

Serial No.	Importance	$A_{ij}$ value
1	Factors $i$ and $j$ are equally important	1

2	Factor i is slightly more important than Factor j	3
3	Factor i is obviously more important than Factor j	5
4	Factor i is significantly more important than Factor j	7
5	Factor i is extremely more important than Factor j	9
6	Factor i is not slightly more important than Factor j	1/3
7	Factor i is not obviously more important than Factor j	1/5
8	Factor i is not significantly more important than Factor j	1/7
9	Factor i is not extremely more important than Factor j	1/9
If $a_{ij}$ is assigned with 2, 4, 6, 8, or their reciprocal values, it signifies that importance or unimportance falls in between.		

### 2.3 Weight sets based on GDM

According to the principles of GDM, 8 experts were selected, including scholars of relevant specialities in higher education institutions, museum researchers, and ancient jade artifact collectors. By means of a questionnaire survey, data of judgment made by different experts were collected.

Taking Expert 1 for example, consistency check results of pairwise judgment matrixes have been listed in Table 2.

**Table 2** Consistency check results of judgment matrixes of Expert 1

<b>Judgment matrix</b>	<b><math>\lambda</math></b>	<b>CR</b>
<i>Judgment matrix A-B</i>	3.0649	0.0624
<i>Judgment matrix B1-C</i>	4.2640	0.0989
<i>Judgment matrix B2-C</i>	2.0000	0.0000
<i>Judgment matrix B3-C</i>	4.2500	0.0944
<i>Judgment matrix C1-D</i>	4.1981	0.0742
<i>Judgment matrix C2-D</i>	3.0536	0.0516
<i>Judgment matrix C5-D</i>	3.0536	0.0516
<i>Judgment matrix C6-D</i>	3.0000	0.0000
<i>Judgment matrix C9-D</i>	2.0000	0.0000

As can be seen from Table 2, random consistency ratios (CRs) of all judgment matrixes are below 0.1, signifying that the matrixes are consistent. Then, hierarchical ranking can be carried out. Likewise, the judgment matrixes of another 7 experts all pass the consistency check.

Weights obtained by 8 experts were subjected to weighted arithmetic averaging, producing combined weights of all indexes, as presented in Table 3.

**Table 3** Combined weights for indexes of jade ware in the Neolithic age

Destination layer	Primary index	Combined weight	Secondary index	Combined weight	Tertiary index	Combined weight
<i>A Value assessment indexes for jade ware in the Neolithic age</i>	<i>B1 Substantive value</i>	0.2026	<i>C1 Jade</i>	0.0726	<i>D1 Jade classification</i>	0.0261
					<i>D2 Jade color</i>	0.0178
					<i>D3 Jade texture</i>	0.0167
					<i>D4 Jade flaws</i>	0.0120
			<i>C2 Impregnation</i>	0.0273	<i>D5 Impregnation color</i>	0.0104
					<i>D6 Impregnation degree</i>	0.0043
					<i>D7 Aesthetic degree of the impregnation color</i>	0.0127
	<i>C3 Integrity</i>	0.0721				
	<i>C4 Size</i>	0.0306				
	<i>B2 Artistic value</i>	0.2860	<i>C5 Shaping</i>	0.1886	<i>D8 Aesthetic degree of shaping</i>	0.0749
					<i>D9 Complexity of shaping</i>	0.0536
					<i>D10 Machining fineness of shaping</i>	0.0601
			<i>C6 Emblazonment</i>	0.0974	<i>D11 Aesthetic degree of emblazonment</i>	0.0403
<i>D12 Complexity of emblazonment</i>					0.0312	
<i>D13 Machining fineness of emblazonment</i>					0.0258	

					<i>ent</i>		
	<i>B3 Historical and cultural value</i>	0.5114	<i>C7 Archaeological culture</i>	0.1376			
			<i>C8 Functional applications</i>	0.0603			
			<i>C9 Historical and cultural messages</i>	0.1546	<i>D14 Importance of historical and cultural messages</i>		0.0966
					<i>D15 Abundance of historical and cultural messages</i>		0.0580
			<i>C10 Scarcity</i>	0.1588			

According to the weighting results of the value assessment model, the value of jade ware in the Neolithic Age can be expressed in the following equation:

Value of jade ware in the Neolithic age = 0.0261 \* Jade classification + 0.0178 \* Jade color + 0.0167 \* Jade texture + 0.0120 \* Jade flaws + 0.0104 \* Impregnation color + 0.0043 \* Impregnation degree + 0.0127 \* Aesthetic degree of the impregnation color + 0.0721 \* Integrity + 0.0306 \* Size + 0.0749 \* Aesthetic degree of shaping + 0.0536 \* Complexity of shaping + 0.0601 \* Fineness of machining + 0.0403 \* Aesthetic degree of emblazonment + 0.0312 \* Complexity of emblazonment + 0.0258 \* Machining fineness of emblazonment + 0.1376 \* Archaeological culture + 0.0603 \* Functional applications + 0.0966 \* Importance of historical and cultural messages + 0.0580 \* Abundance of historical and cultural messages + 0.1588 \* Scarcity

Values of various indexes may be calculated in a hundred-mark or ten-point system, or self-defined in accordance with the preferences of evaluators. During the empirical study of this paper, they are figured out in a ten-point system.

### 3 Model validation

To validate the practical feasibility of the above value assessment model, a case of auctioning jade ware in the Neolithic age is taken for analysis. For this, 4 pieces of jade ware from the Neolithic age were selected from the same auction. After the influence of external factors (e.g., time, season, and location) on evaluation is eliminated, such four pieces of jade ware were graded within a range of 1~10 by an expert. The higher the grade is, the greater the value of the jade ware will be. For specifics, please refer to Table 4 below.

**Table 4** Case study for jadeware value assessment

Index layer	Combined weight	Average score of topaz head	Weighted score of topaz head	Average score of gray jade disc	Weighted score of gray jade disc	Average score of bird-shaped jade pendant	Weighted score of bird-shaped jade pendant	Average score of jade tomahawk	Weighted score of jade tomahawk
<i>Jade classification</i>	0.0261	9	0.2349	6	0.1566	8.75	0.2284	7.25	0.1892
<i>Jade color</i>	0.0178	8.75	0.1558	5	0.089	7.625	0.1357	6.75	0.1202
<i>Jade texture</i>	0.0167	8.5	0.1420	4.5	0.0752	8	0.1336	7.5	0.1253
<i>Jade flaws</i>	0.0120	7.25	0.0870	4.375	0.0525	6.25	0.0750	5.75	0.0690
<i>Impregnation color</i>	0.0104	5.125	0.0533	4.875	0.0507	7	0.0728	6	0.0624
<i>Impregnation degree</i>	0.0043	3.75	0.0161	6.625	0.0285	5.875	0.0253	5.875	0.0253
<i>Aesthetic degree of the impregnation color</i>	0.0127	5.25	0.0667	6.125	0.0778	7.125	0.0905	6.75	0.0857
<i>Integrity</i>	0.0721	9.375	0.6759	7.25	0.5227	8.625	0.6219	6.625	0.4777
<i>Size</i>	0.0306	8	0.2448	7.375	0.2257	7.875	0.2410	7	0.2142
<i>Aesthetic degree of shaping</i>	0.0749	9	0.6741	4.625	0.3464	8	0.5992	6.5	0.4869
<i>Complexity of shaping</i>	0.0536	7.75	0.4154	4	0.2144	6.375	0.3417	5.375	0.2881
<i>Machining fineness of shaping</i>	0.0601	8.125	0.4883	4.125	0.2479	7.125	0.4282	6	0.3606
<i>Aesthetic degree of emblazonment</i>	0.0403	8.625	0.3476	3.75	0.1511	7.75	0.3123	4.75	0.1914
<i>Complexity of emblazonment</i>	0.0312	7.25	0.2262	4.5	0.1404	6.5	0.2028	4.125	0.1287
<i>Machining fineness of emblazonment</i>	0.0258	8	0.2064	3.5	0.0903	8.125	0.2096	4.5	0.1161
<i>Archaeological culture</i>	0.1376	8.25	1.1352	7.875	1.0836	8.375	1.1524	6.875	0.9460
<i>Functional applications</i>	0.0603	7.75	0.4673	5.75	0.3467	7.125	0.4296	5.375	0.3241

<i>Importance of historical and cultural messages</i>	0.0966	8.625	0.8332	6.375	0.6158	8.125	0.7849	6	0.5796
<i>Abundance of historical and cultural messages</i>	0.0580	7.75	0.4495	5.75	0.3335	8.25	0.4785	6	0.3480
<i>Scarcity</i>	0.1588	9	1.4292	5.875	0.9330	8.625	1.3697	5.125	0.8139
<i>Total score of value assessment</i>	1	/	8.3488	/	5.7818	/	7.9330	/	5.9522

Based on the above calculation results of value assessment, it is clear that topaz head from Shijia He Culture achieves the highest score of 8.3488; and the score given to bird-shaped jade pendant from Hongshan Culture is rather high, that is 7.9330. However, both gray jade disc of Liangzhu Culture and the jade tomahawk of Longshan Culture are assigned with low scores; especially the former obtains the lowest score among them. This indicates that the above four pieces of jade ware can be ranked as follows in the opinions of most experts: Topaz head>Bird shaped jade pendant>Jade tomahawk>Gray jade disc. According to data from Artron auction net, the final sale prices of the topaz head, gray jade disc, bird-shaped jade pendant, and jade tomahawk are respectively RMB 5,267,075, RMB 190,188, RMB 1,006,875, and RMB 391,563. Clearly, rankings of their prices remain consistent with the order of their scores. Additionally, the score of the topaz head is only 0.4 higher than that of the bird-shaped jade pendant, while the price of the former is nearly 5 times that of the latter. The reason for such an obvious price difference is that jade ware of the Neolithic age, different from general merchandise, is deemed as remains of historical and cultural creative activities of human beings, and can no longer be reproduced. Under the influence of a supply-demand factor, the price may vary greatly.

In practice, values are not always consistent with prices. As shown by applications of the constructed value assessment model in four pieces of jade ware above, scores allocated to their values are basically consistent with those to their prices. This manifests that the proposed value assessment model is fundamentally established and has certain operability. Without a doubt, the application of such a model should be built on the premise of the jade ware to be evaluated as being genuine. If the jade ware itself is in doubt or considered counterfeit, the corresponding assessment results may be substantially deviated from the truth.

#### 4 Conclusions

In the present study, GDM and AHP are combined to construct a scoring method for value indexes of jade ware in the Neolithic age. By expressing complex and abstract jade ware values in visualized scores, parallel comparisons can be made in different archaeological cultures, different types of jade ware and different jades, etc. This may contribute to further research on the values of jade ware in the Neolithic age. Besides, based on value assessment results, the evaluator can carry out more profound studies provided that basic prices of the jade ware have

been obtained, then convert the prices into price correction indexes, and finally evaluate the prices in line with their price correction indexes. Moreover, jade ware in the Neolithic age holds rich economic, artistic and historical, and cultural values. Research on their value assessment may use value regression studies on jade ware from other times and even other cultural artworks mutually for references. Common prosperity of the research on values of various cultural artworks further facilitates effective management of relevant articles and enables culture to exert powerful actions.

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## References

- [1] Zhang Bingjiang. AHP and its application cases [M]. Beijing: Electronic Industry Press. 2014.
- [2] Xu Jiuping, Wu Wei. Theories and methods of multi-attribute decision-making [M]. Beijing: Tsinghua University Press. 2006.
- [3] Zhou Dichen. Research on the Construction and Application of the Value Evaluation System of Chinese Ancient Jade Carving Artworks from the Perspective of Cultural Economics [J]. China Assets Appraisal, 2019(10): 28-36.
- [4] He Ruhan, Wan Fangming, Xiang Lishuang, Su Yuyi. Construction of Cigarette Retailers Credit Index System Based on Group Decision and AHP[J]. Computer Applications and Software, 2019, 36(12): 81-86
- [5] Zhang Hao. Models and Methods of Management Science Research [M]. Beijing: Tsinghua University Press. 2016.