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# Application Research of AHP in Quantitative Evaluation of Urban Overpass Demolition Scheme

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## Abstract

With the development of urban construction, some urban overpasses built in the early stage gradually cannot meet the needs of urban traffic due to various reasons, and the demolition of urban overpasses is gradually concerned by urban management departments, construction enterprises and relevant experts and scholars. Aiming at the evaluation problem of urban overpass demolition scheme, this paper establishes a quantitative evaluation model of urban overpass demolition scheme by AHP. The model contains 5 standards and 15 evaluation indexes, and carries out systematic quantitative evaluation of urban overpass demolition scheme from the aspects of safety, schedule, cost, technology and circular degree. Three alternative schemes of overpass demolition in a city are mechanical demolition scheme, static demolition scheme and blasting demolition scheme. The scheme with the highest score is selected through quantitative evaluation of the scheme. The validity of the method is verified. It provides effective suggestions for the following urban overpass demolition project.

**Keywords:** Urban overpass; demolition scheme; quantitative evaluation; Analytic hierarchy process(AHP); pairwise comparisons; Expert score

## 1 Introduction

In recent years, urban transportation construction in mainland China is undergoing revolutionary changes. In the 1980s, the construction of overpasses began to rise gradually in major cities. With the development of the city, some overpasses built early can not meet the needs of urban traffic. Some urban overpasses are damaged by floods, earthquakessand other natural disasters due to the low planning and construction standards in the early stage, and some urban overpasses cannot continue to be used after the reasonable use period expires, and so on.

An Overpasses is located in the north ring section of the city Third Ring Road. It was built in 1994, but now the city municipal government has decided to demolish it. The demolition of urban overpasses has been gradually concerned by government departments, enterprises and scholars.

The demolition of urban overpass is first to interrupt its related traffic for a period of time. The important function of urban overpass in traffic determines the impact of its demolition on traffic. The larger the scale of urban overpass is, the longer the demolition time is generally required. The demolition of urban overpass will also affect the normal operation of above-ground and underground buildings and structures such as rain sewage pipes, communication cables, heating pipes, tap water, natural gas pipelines, pumping stations and so on, and then affect the lives of surrounding residents, and even bring disaster to the surrounding residents.

Secondly, dust, noise and sewage produced in the process of removing urban overpass will have a serious impact on the surrounding environment. The demolition of urban overpasses is generally an open-air operation, which requires the investment of a lot of large machinery and even the use of blasting. For the demolition of urban overpasses, manpower should be invested to build temporary facilities for office and life. Dust, noise, sewage and other pollutants will inevitably occur in the demolition of urban overpass for human, mechanical and blasting operations.

Demolishing urban overpasses again can cost hundreds of millions of dollars. Urban overpass demolition use large machinery, the use of manpower, the demolition cycle is long, but also need to go through all kinds of administrative approval procedures, take all kinds of temporary dust control, noise reduction, emission reduction, protection measures, as well as the demolition of urban overpass generated by a large amount of garbage needs to be absorbed, the demolition of the establishment of overpass need a lot of capital is inevitable.

There are demolition of urban overpass construction and mining, chemical hazards similar. Large machinery and explosives used to demolish urban overpasses are major hazard sources. The operation of large machinery and the use of explosives are special operations in the field of safety management, and the users of special operations are also major hazard sources. The dismantlement process requires the cooperation of personnel and machinery, and the management process is also full of challenges, requiring professionally trained and experienced personnel to undertake.

The problem of garbage consumption caused by the removal of urban overpasses has become one of the world's difficult problems troubling human existence. The garbage generated by the demolition of urban overpass is mainly concrete and reinforced concrete, and a small amount of steel. It is difficult to reuse the concrete, reinforced concrete and steel generated by the demolition of urban overpass, and transportation and consumption are difficult problems.

Therefore, it is necessary to study a systematic selection process of urban overpass demolition scheme, determine the evaluation standard and priority of urban overpass demolition scheme, and evaluate the urban overpass demolition scheme in safety, cost, environmental protection, technology, cycle and other aspects. The evaluation method of urban overpass demolition scheme should also reduce the time of evaluation scheme and reach consensus.

Zhang Yongling, Zhao Wan et al suggested using analytic Hierarchy Process (AHP) to solve the demolition scheme evaluation problem. They proposed analytic hierarchy process mainly because of its inherent ability to deal with qualitative and quantitative criteria used in the evaluation of demolition options. Moreover, it is easy for managers to understand and apply. At the same time, analytic hierarchy process can help improve the decision-making process. The hierarchy used in building the AHP model enables all members of the evaluation team to systematically visualize problems against relevant criteria and sub-criteria. If necessary, the team can also provide input to modify the hierarchy through additional standards. In addition, using analytic hierarchy process, evaluation teams can systematically compare and prioritize standards and substandards. Based on this information, the team can compare several demolition options and choose the best one for the urban overpass.

Taking a Bridge in a city as the research object, this paper discusses the feasibility of applying ahp to the evaluation of urban overpass demolition scheme, so as to make the project decision more logical and systematic. First of all, in section 2, we determine the key success factors of urban overpass demolition scheme evaluation, and the key evaluation factors will constitute the determination of important standards and sub-standards. In Section 3, these factors will be used to construct an AHP model to express the evaluation problem of urban overpass demolition scheme. In section 4, AHP model will be applied to the evaluation of rainbow Bridge demolition scheme in Zhengzhou to conduct a case study to demonstrate its application and test its effectiveness. The advantages of using the model presented in this article are also discussed in Section 4. Section 5 is the conclusion.

In order to determine the criteria and sub-criteria for the evaluation of urban overpass removal options, we conducted a survey, as described in Section 2. The purpose of this survey is to enumerate the key evaluation factors, which will constitute the basis for determining the evaluation criteria and sub-criteria of the urban overpass demolition scheme, in order to develop the AHP model. It is not used to determine the priority weights of criteria and sub-criteria, which is the main purpose of analytic hierarchy process.

## 2 Determine Standards and Sub-standards

Liu Xinzhong, Wang Senlin(2019) et al. determined four criteria for the evaluation of urban overpass demolition scheme, namely, safety, economy, degree of traffic impact, traffic impact time and construction period. According to the research of Fu Guangming and Ren Caiqing(2011) et al., the influencing factors for the evaluation of material blasting demolition scheme should mainly include: directional design scheme, blasting parameters, safety check and protection, initiation equipment and network, etc. In addition, zhang Yongling, Zhao Wan(2018) et al argued that the evaluation factors of the dismantling scheme of nuclear facilities include safety factors, waste amount, decommissioning funds, decommissioning cycle, technical factors, public recognition and other aspects. Their research can also be applied to the evaluation of urban overpass demolition scheme. These factors can be roughly divided into five categories: safety, cycle, technology, cost and environmental protection. Safety factors include equipment safety, personnel safety and construction process safety. Cycle factors include preparation cycle, construction cycle and recovery cycle; Technical factors include originality, applicability, maturity and contribution; Expenses include relocation expenses, demolition expenses, temporary facilities expenses, office expenses and consumption expenses. Environmental protection includes dust, noise, sewage, light pollution, etc.

We conducted a survey of 20 people, including leaders of government departments, industry experts and scholars from universities and research institutions, who were directly involved in the evaluation of the demolition scheme. As mentioned in Section 1, the purpose of this survey is to evaluate and determine the above-mentioned safety, cycle, technology, cost and environmental protection factors as relevant standards and sub-standards for formulating AHP model. A questionnaire containing these factors was designed for the survey. Before conducting the survey, we conducted a pilot test with two industry experts. Based on the comments received, the questionnaire was adjusted and some additional criteria were added. The new questionnaire was sent to randomly selected respondents. To determine the relevant criteria, respondents were asked to evaluate each factor on a three-point scale of "not important," "somewhat important," and "very important" when choosing an urban overpass demolition option. The survey results are summarized in Figure 1, where the average for each factor is determined by multiplying the percentage of respondents by the values of 1, 2, and 3 related to "unimportant," "somewhat important," and "very important," respectively, plus the resulting data. The criteria are listed in descending order of their average, using 2.3 as the threshold and identifying those factors with an average greater than or equal to 2.4 as the relevant criteria. As can be seen from Figure 1, the value of 2.4 seems to be the natural turning point, since it is the average of the highest (2.9, see Figure 1) and lowest (1.9, see Figure 1) average rating values for all factors in the survey. The existence of too many standards leads to a huge amount of work in evaluating the construction scheme of urban overpass demolition by pair comparison. As explained in Section 3.1 and 5, this may also lead to the evaluation deviation of the evaluator. To overcome these problems, a threshold approach is needed to reduce the number of standards. Fifteen criteria were selected to construct the analytic hierarchy Process model.

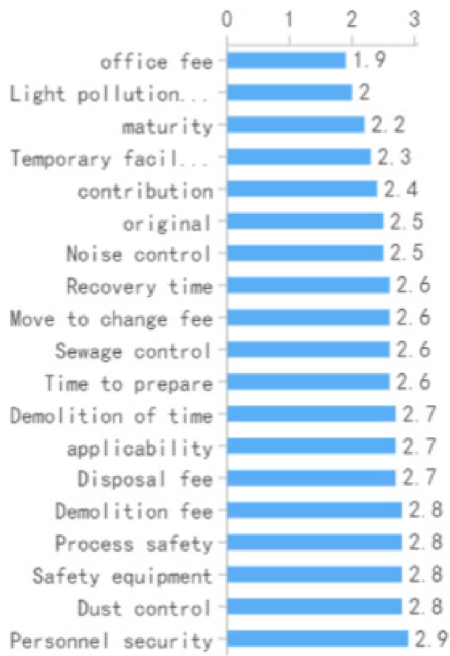


Figure. 1.Factorsaffecting the selectiong of urban overpass demolition scheme

## 3 Analytic Hierarchy Process Model

The modeling process of analytic hierarchy process includes the following stages: the construction of decision problem, measurement and data collection, determination of normalized weight and comprehensive solution of the problem. Using this method, we first developed an AHP model for quantitative evaluation of urban overpass removal scheme in this section, which can be applied to quantitative evaluation of any urban overpass removal scheme.

### *3.1 Evaluation of Urban Interchange Demolition Scheme*

This stage involves an appropriate hierarchy of the analytic hierarchy model, which consists of objectives, criteria and sub-criteria, and alternatives. The goal of our question is to select an urban overpass demolition scheme, which must meet the requirements of relevant government departments and bring profits to enterprises. This goal is placed at the first level of the hierarchy, as shown in Figure 2. The second level of the hierarchy is safety, cycle, technology, cost and environmental protection. The third tier consists of 15 sub-standards, identified in Section 2 above, and combined with the criteria occupying the second tier, as shown in Figure 2.

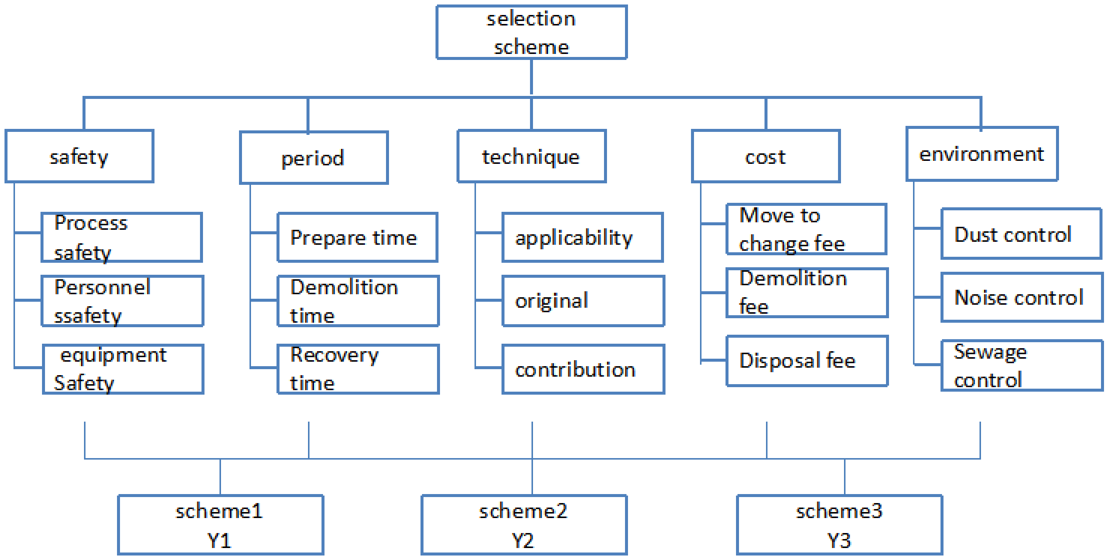


Figure. 2.AHP model for quantitative evaluation of urban overpass demolition scheme

For the convenience of description, each factor is numbered in Table 1.

Table 1: The code of criterion

| Code | Meaning | Code | Meaning |
|---|---|---|---|
| X1 | Safety | X11 | Process safety |
| | | X12 | Personnelsafety |
| | | X13 | Equipment safety |
| X2 | Period | X21 | Prepare time |
| | | X22 | Demolition time |
| | | X23 | Recovery time |
| X3 | Technique | X31 | Applicabiltiy |
| | | X32 | Original |
| | | X33 | Contribution |
| X4 | Cost | X41 | Move to change fee |
| | | X42 | Demolition fee |
| | | X43 | Disposal fee |

The criteria and sub-criteria used in these two levels of the AHP hierarchy can be evaluated using the basic AHP method, where elements in each level are compared in pairs with each parent element located above one level. You can then determine a set of global priority weights for each child standard by multiplying the local weights of the child standard by the weights of all the parent nodes above.

Saaty et al. suggested quoting numbers 1-9 and their reciprocal as scales, as shown in Table 2.

Interpolated 9-point rating tables of equal importance, slightly important, obviously important, much more important and absolutely important and their adjacent judgments were used. The priority weights of these ratings can be determined by pairwise comparison in Section 3.3 below. A potential complication can be reduced when using a 9-point rating system to assign rating scales. For example, the relative ratings of "equally important" and "slightly important" may vary according to different criteria. Interpolation 2 of 1 and 3 can be selected in the judgment. Use them to determine local and global priority weights, as described in sections 3.3 and 3.5 below

Table 2: Quoting numbers 1-9 and their reciprocal as scales

| Scale | Meaning |
|---|---|
| 1 | Indicates that two factors are of equal importance when compared |
| 3 | Refers to the comparison of two factors, one of which is slightly more important than the other |
| 5 | When two factors are compared, one is significantly more important than the other |
| 7 | When two factors are compared, one is much more important than the other |
| 9 | When two factors are compared, one is absolutely more important than the other |
| 2、4、6、8 | As the median value of the adjacent judgment above |
| Reciprocal of the numbers above | The inverse ratio of another factor to the original factor |

Interpolated 9-point rating tables of equal importance, slightly important, obviously important, much more important and absolutely important and their adjacent judgments were used. The priority weights of these ratings can be determined by pairwise comparison in Section 3.3 below. A potential complication can be reduced when using a 9-point rating system to assign rating scales. For example, the relative ratings of "equally important" and "slightly important" may vary according to different criteria. Interpolation 2 of 1 and 3 can be selected in the judgment. Use them to determine local and global priority weights, as described in sections 3.3 and 3.5 below

The lowest level of the hierarchy includes alternatives, which are the evaluation of different demolition options in order to select the best option for urban overpass removal. As shown in Figure 2, we use three demolition scenarios to represent any three scenarios we wish to evaluate. The AHP model shown in Figure 2 is generally applicable to issues where the team wishes to evaluate options for urban overpass removal, as it covers key criteria and sub-criteria. Therefore, when the team needs to choose a demolition plan, it can evaluate the demolition plan through the rating plan described above and determine the priority weight of the demolition plan to select the best demolition plan. As explained earlier in Section 1, the model provides the feasibility of including any specific criteria, as well as goals and criteria that the team may wish to consider in any other situation.

### *3.2 Measurement and Data Collection*

After building the AHP hierarchy, the next stage is measurement and data collection, which involves forming team assessments and assigning criteria and sub-criteria for comparison in pairs, as explained above. Saaty's 9-point scale was used to pairwise compare all elements at each level of the hierarchy. Typically each member assigns his or her pairwise comparison, which is translated into the corresponding pairwise comparison judgment matrix (PCJMs). To simplify the calculation, we used arithmetic to get the consensus PCMs of the whole team, or we could use geometric averaging to combine individual PCJMs to get a more accurate consensus PCMs of the whole team.

With this approach, it is important to establish assessment groups. Assessment team members should have experience in the evaluation of urban interchange demolition options. Two of the evaluators were senior engineers in the engineering industry, each with more than five years of experience. The other two were from universities and research institutions. One of them has been engaged in relevant teaching work for more than 20 years, and the other has been engaged in demolition construction related research for more than 20 years. The final evaluator is the operational head of the construction authority responsible for safety and technical supervision. Therefore, the evaluator has long experience in the evaluation of urban overpass demolition scheme, and is therefore qualified to assign pairwise comparison judgment.

We designed a questionnaire consisting of all criteria and sub-criteria at both levels of the AHP model to collect pair comparative judgments from all evaluation team members. This method has been found useful in collecting data. According to the attributes of a higher layer in the hierarchy, from the standard level to the sub-standard level, compare and judge the attributes of a layer in the hierarchy. The results collected from the questionnaire were used to form the corresponding pair comparison judgment matrix (PCJMs) to determine standardized weights, as described in the following section.

## *3.3 Determine the Weights*

As mentioned above, the pair comparison judgment matrices obtained by five evaluators in the measurement and data acquisition stages are combined by arithmetic mean method at each level to obtain corresponding consistent pair comparison judgment matrices. Then, each matrix is transformed into the corresponding maximum eigenvalue problem, and the normalized and unique priority weight of each criterion is calculated, as shown in Table 3-8. Software systems are used to determine normalized priority weights. The consistency ratio (CR) of each PCJM is also shown under each matrix. It can be seen that the consistency of all PCJM is ≤ 0.1 empirical value. This obviously means that evaluators are consistent in assigning pairwise comparison judgments.

Table 3: Pairwise comparison judgment matrices of quantitative evaluation of demolition scheme

| A | X1 | X2 | X3 | X4 | X5 | Weights |
|---|---|---|---|---|---|---|
| X1 | 1 | 7 | 3 | 8 | 8 | 0.564 |
| X2 | 1/7 | 1 | 1/4 | 3 | 2 | 0.098 |
| X3 | 1/3 | 4 | 1 | 3 | 3 | 0.219 |
| X4 | 1/8 | 1/3 | 1/3 | 1 | 2 | 0.065 |
| X5 | 1/8 | 1/2 | 1/3 | 1/2 | 1 | 0.054 |
| CI | 0.068 | | | | | |
| RI | 1.12 | | | | | |
| CR | 0.061 | | | | | |

CR=0.061<0.1 It passes the consistency test

| X1 | X11 | X12 | X13 | Weights |
|---|---|---|---|---|
| X11 | 1 | 1/2 | 1 | 0.232 |
| X12 | 2 | 1 | 4 | 0.584 |
| X13 | 1 | 1/4 | 1 | 0.184 |
| CI | 0.027 | | | |
| RI | 0.58 | | | |
| CR | 0.047 | | | |

CR=0.047<0.1 It passes the consistency test

| X2 | X21 | X22 | X23 | Weights |
|---|---|---|---|---|
| X21 | 1 | 1/2 | 1 | 0.24 |
| X22 | 2 | 1 | 3 | 0.55 |
| X23 | 1 | 1/3 | 1 | 0.21 |
| CI | 0.009 | | | |
| RI | 0.58 | | | |
| CR | 0.016 | | | |

CR=0.016<0.1 It passes the consistency test

| X3 | X31 | X32 | X33 | Weights |
|---|---|---|---|---|
| X31 | 1 | 3 | 3 | 0.6 |
| X32 | 1/3 | 1 | 1 | 0.2 |
| X33 | 1/3 | 1 | 1 | 0.2 |
| CI | 0 | | | |
| RI | 0.58 | | | |
| CR | 0 | | | |

CR=0<0.1 It passes the consistency test

| X4 | X41 | X42 | X43 | Weights |
|---|---|---|---|---|
| X41 | 1 | 1/4 | 2 | 0.2 |
| X42 | 4 | 1 | 5 | 0.683 |
| X43 | 1/2 | 1/5 | 1 | 0.117 |
| CI | 0.012 | | | |
| RI | 0.58 | | | |
| CR | 0.021 | | | |

CR=0.021<0.1 It passes the consistency test

| X5 | X51 | X52 | X53 | Weights |
|---|---|---|---|---|
| X51 | 1 | 1 | 2 | 0.4 |
| X52 | 1 | 1 | 2 | 0.4 |
| X53 | 1/2 | 1/2 | 1 | 0.2 |
| CI | 0 | | | |
| RI | 0.58 | | | |
| CR | 0 | | | |

CR=0<0.1 It passes the consistency test

### *3.4 Solutions to Problems*

After calculating the normalized priority weight of each PCJM in the AHP hierarchy, the next stage is the solution of the comprehensive problem. Criteria for standardized local priority weights The sub-criteria obtained from the third stage are combined with all successive levels to obtain the global composite priority weights for all the sub-criteria used in the third level of the AHP model. As mentioned earlier, expert selection software systems are used to determine these global priority weights, as shown in table4.

Table 4: Composite priority weights for critical success factors

| Criteria | Local Weights | Subcriteria | Local Weights | Globle Weights |
|---|---|---|---|---|
| A-X1 | 0.564 | X1-X11 | 0.232 | 0.131 |
| | | X1-X12 | 0.584 | 0.329 |
| | | X1-X13 | 0.184 | 0.104 |
| A-X2 | 0.098 | X2-X21 | 0.24 | 0.024 |
| | | X2-X22 | 0.55 | 0.054 |
| | | X2-X23 | 0.21 | 0.021 |
| A-X3 | 0.219 | X3-X31 | 0.6 | 0.131 |
| | | X3-X32 | 0.2 | 0.043 |
| | | X3-X33 | 0.2 | 0.043 |
| A-X4 | 0.065 | X4-X41 | 0.2 | 0.013 |
| | | X4-X42 | 0.683 | 0.044 |
| | | X4-X43 | 0.117 | 0.007 |
| A-X5 | 0.054 | X5-X51 | 0.4 | 0.021 |
| | | X5-X52 | 0.4 | 0.021 |
| | | X5-X53 | 0.2 | 0.011 |

After calculating the global weights of each sub-criterion at level 2, see Table 5. It can be seen from the figure that the top two factors are safety and technology, human safety is the most important factor of safety, and applicability of technology is the most important factor of technology.

Table 5: Ranking of critical success factors

| Rank | Subcriteria | Globle Weights |
|---|---|---|
| 1 | X1-X12 | 0.329 |
| 2 | X1-X11 | 0.131 |
| 3 | X3-X31 | 0.131 |
| 4 | X1-X13 | 0.104 |
| 5 | X2-X22 | 0.054 |
| 6 | X4-X42 | 0.044 |
| 7 | X3-X32 | 0.043 |
| 8 | X3-X33 | 0.043 |
| 9 | X2-X21 | 0.024 |
| 10 | X2-X23 | 0.021 |
| 11 | X5-X51 | 0.021 |
| 12 | X5-X52 | 0.021 |
| 13 | X4-X41 | 0.013 |
| 14 | X5-X53 | 0.011 |
| 15 | X4-X43 | 0.007 |
| | total | 1.000 |

As mentioned above, the AHP model of the design criteria and sub-criteria, as well as their global priority weights, can be applied to any specific urban overpass demolition scheme selection problem. In section 4 below, we consider the selection of scheme provider for the removal of overpasses in three cities and show how to apply the model to select the best scheme for the removal of overpasses in cities.

# 4 AHP Model Is Applied to Solve the Problem of Choosing the Demolition Scheme of Rainbow Bridge in Zhengzhou

## *4.1 Scheme Evaluation*

After the demolition of Zhengzhou Rainbow Bridge was confirmed by the competent government department, the relevant engineering company provided three demolition schemes, namely mechanical demolition scheme, static demolition scheme and blasting demolition scheme. Each of these three schemes has its own advantages and disadvantages, and the owner, supervision company and dismantling enterprise are not in agreement. The owner unit, the supervision company and the dismantling enterprise decide to use AHP method to choose the dismantling scheme through consultation. The owner unit and the supervision company shall each send two experts, and the dismantling enterprise shall send one expert to form the decision-making group. The decision-making group evaluated the three schemes with the nine-point evaluation method, and summarized the scores of the five experts with the arithmetic mean method. The summary results are shown in Table 6.

Table 6: Expert score summary

| X11 | Y1 | Y2 | Y3 |
|---|---|---|---|
| Y1 | 1 | 3 | 1/3 |
| Y2 | 1/3 | 1 | 3 |
| Y3 | 3 | 1/3 | 1 |
| X12 | Y1 | Y2 | Y3 |

| | | | |
|---|---|---|---|
| Y1 | 1 | 3 | 7 |
| Y2 | 1/3 | 1 | 5 |
| Y3 | 1/7 | 1/5 | 1 |
| X13 | Y1 | Y2 | Y3 |
| Y1 | 1 | 3 | 7 |
| Y2 | 1/3 | 1 | 3 |
| Y3 | 1/7 | 1/3 | 1 |
| X21 | Y1 | Y2 | Y3 |
| Y1 | 1 | 1/3 | 1/7 |
| Y2 | 3 | 1 | 1/4 |
| Y3 | 7 | 4 | 1 |
| X22 | Y1 | Y2 | Y3 |
| Y1 | 1 | 3 | 7 |
| Y2 | 1/3 | 1 | 3 |
| Y3 | 1/7 | 1/3 | 1 |
| X23 | Y1 | Y2 | Y3 |
| Y1 | 1 | 1 | 1 |
| Y2 | 1 | 1 | 1 |
| Y3 | 1 | 1 | 1 |
| X31 | Y1 | Y2 | Y3 |
| Y1 | 1 | 1/3 | 1/5 |
| Y2 | 3 | 1 | 1/4 |
| Y3 | 5 | 4 | 1 |
| X32 | Y1 | Y2 | Y3 |
| Y1 | 1 | 3 | 1/5 |
| Y2 | 1/3 | 1 | 1/4 |
| Y3 | 5 | 4 | 1 |
| X33 | Y1 | Y2 | Y3 |
| Y1 | 1 | 1/3 | 1/5 |
| Y2 | 3 | 1 | 1/3 |
| Y3 | 5 | 3 | 1 |
| X41 | Y1 | Y2 | Y3 |
| Y1 | 1 | 1/3 | 1/5 |
| Y2 | 3 | 1 | 1/3 |
| Y3 | 5 | 3 | 1 |
| X42 | Y1 | Y2 | Y3 |
| Y1 | 1 | 1/3 | 1/7 |
| Y2 | 3 | 1 | 1/3 |
| Y3 | 7 | 3 | 1 |
| X43 | Y1 | Y2 | Y3 |
| Y1 | 1 | 1 | 8/9 |
| Y2 | 1 | 1 | 1 |
| Y3 | 1 | 1 | 1 |
| X51 | Y1 | Y2 | Y3 |
| Y1 | 1 | 1 | 1/5 |
| Y2 | 1 | 1 | 1/3 |
| Y3 | 5 | 3 | 1 |
| X52 | Y1 | Y2 | Y3 |
| Y1 | 1 | 3 | 1/5 |
| Y2 | 1/3 | 1 | 1/3 |
| Y3 | 5 | 3 | 1 |
| X53 | Y1 | Y2 | Y3 |
| Y1 | 1 | 1/3 | 1 |

| | | | |
|---|---|---|---|
| Y2 | 3 | 1 | 1 |
| Y3 | 1 | 1 | 1 |

### *4.2 Calculation and Analysis of Evaluation Results*

Table 8 Combined with the analysis in Section 3 of the article, the evaluation results are calculated: Y1 total score =0.416; Y2 total score =0.230; Y3 total score =0.354. The calculation process is shown in Table 7.

Table 7: Application of the AHP model

| Layer 1 | Layer 2 | Scheme | | | | | |
|---|---|---|---|---|---|---|---|
| Criteria | Local Weights | Subcrite-ria | Local Weights | Globle Weights | Y1 | Y2 | Y3 |
| A-X1 | 0.564 | X1-X11 | 0.232 | 0.131 | 0.33 | 0.14 | 0.528 |
| | | X1-X12 | 0.584 | 0.329 | 0.649 | 0.279 | 0.072 |
| | | X1-X13 | 0.184 | 0.104 | 0.669 | 0.243 | 0.088 |
| A-X2 | 0.098 | X2-X21 | 0.24 | 0.024 | 0.084 | 0.211 | 0.705 |
| | | X2-X22 | 0.55 | 0.054 | 0.669 | 0.243 | 0.008 |
| | | X2-X23 | 0.21 | 0.021 | 0.333 | 0.333 | 0.333 |
| A-X3 | 0.219 | X3-X31 | 0.6 | 0.131 | 0.101 | 0.226 | 0.674 |
| | | X3-X32 | 0.2 | 0.043 | 0.188 | 0.081 | 0.731 |
| | | X3-X33 | 0.2 | 0.043 | 0.105 | 0.258 | 0.637 |
| A-X4 | 0.065 | X4-X41 | 0.2 | 0.013 | 0.105 | 0.258 | 0.637 |
| | | X4-X42 | 0.683 | 0.044 | 0.088 | 0.243 | 0.669 |
| | | X4-X43 | 0.117 | 0.007 | 0.333 | 0.333 | 0.333 |
| A-X5 | 0.054 | X5-X51 | 0.4 | 0.021 | 0.156 | 0.185 | 0.669 |
| | | X5-X52 | 0.4 | 0.021 | 0.188 | 0.081 | 0.731 |
| | | X5-X53 | 0.2 | 0.011 | 0.333 | 0.333 | 0.333 |
| Total score | 0.416 | 0.230 | 0.354 | | | | |

The weight of criterion layer 1, criterion layer 2 and three weights of scheme layer are obtained by judgment matrix. The node weight of criterion layer 2 is the weight of criterion 1 multiplied by the link weight of criterion 2. The total score is obtained by multiplying the node weights of criterion 2 by each scheme weight.

Plan 1 is better

### *4.3 Overall Consistency Test*

The consistency test of each judgment matrix has been carried out in the preceding paragraph, that is, the CR value of each judgment matrix has been calculated. The overall conformance test calculates the cumulative CR value (top to bottom) to see if the CR3 value is less than 0.1

CI1=0.068 RI1=1.12 CR1=0.061

CI2=0.564*0.027+0.098*0.009+0.219*0+0.065*0.012+0.054*0=0.0016

RI2=0.564*0.58+0.098*0.58+0.219*0.58+0.065*0.58+0.054*0.58=0.58

CR2=CR1+CI2/RI2=0.0637

CI3=0.131*0.027+0.329*0.032+0.104*0.004+0.0204*0.016+0.054*0.004+0.021*0+0.131*0.043+0.043*0.032+0.043*0.019+0.013*0.019+0.044*0.004+0.007*0+0.021*0.015+0.021*0.032+0.011*0=0.01

RI3=0.58

CR3=CR2+CI3/RI3=0.0637+0.017=0.0807<0.1

CR3<0.1generally passed the consistency test.

5 Conclusions

The modeling process of analitc hierarchy process includes the following stages: the construction of decision problem, measurement and data collection, determination of normalized weight and comprehensive solution of the problem. Using this method, we first developed an AHP model for quantitative evaluation of urban overpass removal scheme in this section, which can be applied to quantitative evaluation of any urban overpass removal scheme.

From the results of the case study, it can be concluded that it is desirable to apply AHP to the selection of urban overpass demolition scheme to improve the team decision-making process. The AHP model established in this paper can be used as the basis of urban overpass demolition scheme selection.

It should be noted, however, that data collection and calculation problems will increase as the number of criteria and sub-criteria increases and as the number of urban overpass removal options are considered in the selection. This is one of the reasons why we suggest first listing the number of urban overpass removal schemes and then applying the AHP model. Again, as shown here, the number of success factors can be grouped to minimize the number of criteria and sub-criteria used to build an AHP model. The number of assessors can be increased to collect more data. In fact, we can increase the number of evaluators and collect data and set priorities to check if they change. In this way, we can perform sensitivity analysis and determine the best number of evaluators to use to collect data. However, several case studies using AHP in the literature indicate that between three and seven evaluators were used. In this way, the evaluator's bias in evaluating pairwise comparisons can be reduced.

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