Survey and Evaluation of Public Acceptance of Environmental Risk Based on Cloud Model——Take the heavy chemical PX project as an example

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Abstract. This paper takes the heavy chemical PX project as the research object, and builds an evaluation system based on environmental values, risk communication, system trust and risk perception. Use questionnaires to obtain real and extensive data, and use cloud models for case analysis. The results show that the public's acceptance of environmental risks in heavy chemical projects is at a medium level, indicating that there are insufficient environmental risk communication and public participation methods and channels in heavy chemical projects. The government should improve the communication mechanism of public participation in the decision-making of major projects and reduce the occurrence of environmental risk group incidents.

1. Introduction

According to statistics, in 2017, the national SO2 emissions were 8.754 million tons, the waste water discharge was 69.966 billion tons, and the number of environmental incidents was 302, including one major environmental accident [1]. With the continuous advancement of industrialization and the increasing awareness of public participation in environmental protection, risk-type group events related to environmental pollution in heavy chemical industry are increasing at a rate of more than 30% per year. It is characterized by public concern that the project operation or safety accidents will cause environmental pollution, and the implementation of the project will be resisted or continued when the environmental pollution phenomenon has not occurred [2].

Any project has certain environmental risks during the construction or operation stage. Foreign scholar Sverker (2017) analyzes the relationship between political trust, policy instruments and public acceptance of environmental policies [3]; Huang (2017) adopted the entropy cloud method obtains objective environmental risk influencing factors [4]. Compared with foreign countries, the research on environmental risks of heavy chemical projects in China has been deepening in recent years. Wang (2018) found that environmental knowledge, environmental pollution perception, social interaction, political participation, interpersonal trust and institutional trust have a significant impact on public environmental behavior [5]; Gong (2017) from the perspective of environmental risk technology, found risk perception, environment Values, system trust and risk communication mainly affect the public's acceptance of PX projects [6].
This paper uses Cloud Model to evaluate the transfer coupling mechanism that affects the public acceptance of environmental risk in heavy chemical projects. In this way, the factors affecting the public acceptance of heavy chemical projects can be grasped, and the level of public acceptance can be visually seen through cloud model map, which indicates the direction for national environmental risk group event and promotes the green and healthy development of heavy chemical industry.

2. Research Design

2.1. Research objects and data sources
"PX" is an abbreviation for Para-Xylene, which is commonly used in the production of plastics, poly-fibers and films. As of August 2018, China has built a total of 18 PX projects, forming a total of 14.83 million tons / year PX capacity, will form a total of 39.83 million tons / year PX capacity around 2021 [7]. The environmental pollution risk of the PX project originates from the treatment of industrial "three wastes". The waste water is produced in small quantities as oily waste water, which can be discharged through the system. The exhaust gas uses clean fuel gas to gradually reduce emissions; solid waste is entrusted with qualification. The unit is filled.

This questionnaire survey uses on-site paper questionnaires and online e-question questionnaires. In order to ensure the authenticity and extensiveness of the survey, respondents should cover different occupations and age groups. (Table 1). A total of 400 copies were distributed in this survey, and 356 were recovered. The effective recovery rate was 89.0%.

| Sample description (N=356) | Percentage (%) | Sample description (N=356) | Percentage (%) |
|---------------------------|----------------|---------------------------|----------------|
| Gender                    |                | Career                    |                |
| Male                      | 64.3           | Farmer                    | 0.5           |
| Female                    | 35.7           | Unemployed                | 1.2           |
| 18 or less                | 1.3            | Freelancers               | 0.7           |
| 18-25                     | 31.6           | Self-employed households  | 26.4          |
| 26-35                     | 24.8           | Corporate employee        | 31.6          |
| 36-45                     | 37.7           | Government staff          | 38.3          |
| 46-60                     | 3.9            | other                     | 1.3           |
| 60 and above              | 0.7            |                           |               |

2.2. Indicator selection and data processing
Public acceptance refers to the extent to which the public accepts and recognizes certain matters. It is the key to whether a certain matter can meet the public’s needs and meet public expectations. According to the principle of objectivity and feasibility, in the introduction decision stage, the influencing factors affecting the public acceptance of the environmental risks of heavy chemical projects are selected to construct the public acceptance index system for environmental risks of heavy chemical projects (Table 2).

| Evaluation index | Assignment criteria | %   | Score  |
|------------------|---------------------|-----|--------|
| Environmental values P1 | l=very important;2=important;3=not important;4=unrelated | 20.29 | 771.45 |
| The importance of the environment to life | 1=5000m or more;2=3000-5000m; 3=1000- | 10.44 | 396.94 |

Table 1. Survey sample data.

Table 2. Evaluation index and its evaluation criteria.
| projects to water sources | 3000m; 4=1000m |
|--------------------------|-----------------|
| The choice between environmental protection and economic development | 1 = environmental protection; 2 = equally important; 3 = economic development; 4 = unrelated | 18.44 | 700.96 |
| Impact of the EIA report on the acceptance of the project | 1=qualified, accept the project;2=qualified, do not accept the project;3=qualified, against the project;4=unrelated | 17.43 | 662.52 |
| Attitude towards environmental pollution | 1=timely stop;2=use media rendering; 3=let development; 4=unrelated | 22.51 | 855.82 |

| Risk communication P2 |
|-----------------------|
| Ways for environmental protection departments to disclose project environmental assessment information | 1= no; 2= singular; 3= diversification | 11.74 | 461.02 |
| The way the government discloses project location information | 1= no; 2= singular; 3= diversification | 13.06 | 512.99 |
| Public access to project poll information | 1= no; 2= singular; 3= diversification | 16.42 | 644.72 |
| Public channel for raising opinions/questions | 1= no; 2= singular; 3= diversification | 11.00 | 431.83 |
| Government's efficiency in handling public opinions | 1= no; 2= general efficiency; 3= high efficiency | 14.52 | 570.31 |
| Environmental accident emergency measures | 1=don't know;2=no; 3=yes | 14.02 | 550.73 |
| Media reports on environmental risk information | 1=no; 2=not timely; 3= timely | 19.24 | 755.43 |

| System trust P3 |
|------------------|
| Government's supervision of environmental pollution issues | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 7.64 | 870.06 |
| Government's ability to handle environmental opinions | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 8.61 | 980.07 |
| Government's punishment mechanism for environmental pollution | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 7.74 | 880.74 |
| Use of environmental protection equipment by operators | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 6.66 | 757.92 |
| Operator's ability to handle pollutants | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 8.27 | 941.26 |
| Operators should respond to sudden environmental risk mechanisms | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 8.76 | 996.81 |
| Operator's awareness of environmental responsibility | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 8.21 | 934.86 |
| The credibility of new media propaganda | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 8.08 | 919.55 |
| The credibility of traditional media propaganda | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 9.01 | 1025.64 |
| The media reveals the ability to violate the rules | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 8.95 | 1018.87 |
| EIA professional qualifications | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 9.35 | 1064.08 |
| EIA expert qualification / ability | 1=very distrustful; 2=less trust; 3=more trust; 4=very trust | 8.71 | 991.46 |
3. Model establishment and result analysis

3.1. Entropy weight cloud model

Table 3. Evaluation index digital characteristics and grades.

| Indicators                              | I    | II    | III   | IV    | Score   | Grade |
|----------------------------------------|------|-------|-------|-------|---------|-------|
|-water pollution                        | 6.72 | 513.35|
| Air Pollution                          | 6.14 | 469.56|
| Soil pollution                         | 10.16| 776.44|
| sound pollution                        | 10.25| 783.21|
| Solid waste treatment                  | 9.85 | 752.58|
| Liquid waste treatment                 | 7.60 | 580.64|
| Explosion/fire                         | 10.10| 771.81|
| Public health hazard                   | 9.27 | 708.04|
| Employee health and safety threats      | 5.87 | 448.24|
| Unusual migration of population        | 10.94| 835.89|
| Depreciation of surrounding industries | 13.11| 1002.41|

| Indicator threshold                     | 1= no effect; 2= not serious; 3= unclear; 4= more serious; 5= very serious |  |  |  |  |  |
|----------------------------------------|--------------------------------------------------------------------------|---|---|---|---|---|
| P1 (2136,356 0)                        |                                                                           |   |   |   |   |   |
|                                        | (3560,5340)                                                              |   |   |   |   |   |
|                                        | (5340,6764)                                                              |   |   |   |   |   |
|                                        | (6764,8544)                                                              |   |   |   |   |   |
|                                        | 3802.08                                                                  | II|   |   |   |   |
|                                        | 0.0021                                                                   |   |   |   |   |   |
|                                        | 0.252                                                                    |   |   |   |   |   |
|                                        | 0.256                                                                    |   |   |   |   |   |
|                                        | 0.257                                                                    |   |   |   |   |   |
| P2 (2492,356 0)                        |                                                                           |   |   |   |   |   |
|                                        | (3560,4984)                                                              |   |   |   |   |   |
|                                        | (4984,6052)                                                              |   |   |   |   |   |
|                                        | (6052,7476)                                                              |   |   |   |   |   |
|                                        | 3927.03                                                                  | II|   |   |   |   |
|                                        | 0.0002                                                                   |   |   |   |   |   |
|                                        | 0.257                                                                    |   |   |   |   |   |
|                                        | 0.257                                                                    |   |   |   |   |   |
|                                        | 0.257                                                                    |   |   |   |   |   |
| P3 (4272,747 6)                        |                                                                           |   |   |   |   |   |
|                                        | (7476,1068 0)                                                            |   |   |   |   |   |
|                                        | (10680,1388 4)                                                           |   |   |   |   |   |
|                                        | (13884,1708 8)                                                           |   |   |   |   |   |
|                                        | 11381.3                                                                  | III|   |   |   |   |
|                                        | 0.0011                                                                   |   |   |   |   |   |
|                                        | 0.245                                                                    |   |   |   |   |   |
|                                        | 0.245                                                                    |   |   |   |   |   |
|                                        | 0.345                                                                    |   |   |   |   |   |
| P4 (3916,783 2)                        |                                                                           |   |   |   |   |   |
|                                        | (7832,1174 8)                                                            |   |   |   |   |   |
|                                        | (11748,1566 4)                                                           |   |   |   |   |   |
|                                        | (15664,1958 0)                                                           |   |   |   |   |   |
|                                        | 7641.89                                                                  | I |   |   |   |   |
|                                        | 0.0001                                                                   |   |   |   |   |   |
|                                        | 0.246                                                                    |   |   |   |   |   |
|                                        | 0.246                                                                    |   |   |   |   |   |
|                                        | 0.246                                                                    |   |   |   |   |   |

Firstly, the public acceptance is divided into I difference, II medium, III good and IV excellent. Through the data obtained from the questionnaire, the thresholds of environmental values, risk perception, risk communication and system trust are calculated, and the grade of the evaluation index is determined according to the actual score. Then use the forward cloud algorithm to program the weight $\omega$ and membership $r$ of the indicator (Table 3).

Finally, the fuzzy evaluation method is used for evaluation. According to the principle of maximum membership degree, the public acceptance of the environmental risk of heavy chemical projects is medium (II) (Table 4).

Table 4. Public acceptance evaluation results based on entropy weight cloud model.

| Grade | I    | II    | III   | IV    |
|-------|------|-------|-------|-------|
|       | Public acceptance | 0.000005458 | 0.00051467 | 0.0000433 | 0.00002707 |

3.2. Comprehensive evaluation cloud model

Calculate the standard and actual cloud digital characteristics of each level of indicators (Table 5). The comprehensive evaluation cloud model diagram (Fig. 1) drawn by MATLAB 7.0 can visually find that the public acceptance of environmental risks in heavy chemical projects is at level II. Therefore, the public's acceptance of environmental risks in heavy chemical projects is at a medium level.
Table 5. Indicator cloud digital feature.

| Digital features | P1                  | P2                  | P3                  | P4                  | P        |
|------------------|---------------------|---------------------|---------------------|---------------------|----------|
| Actual           | 3802.00,2721.0      | 3927.04,2116.3      | 11381.32,5442.0     | 7719.51,6651.38     | 9113.48,3950.06 |
| Standard         | 5340.00,2721.0      | 4984.00,2116.3      | 10680.00,5442.0     | 11748.00,6651.3     | 10559.60,4256.2 |

Figure 1. Comprehensive evaluation of cloud model map.

3.3. Result analysis

Through research, it is found that the public's awareness of environmental values is strong, but it tends to be one-sided, mainly focusing on feelings that are important but not important. The awareness of environmental issues related to themselves is far greater than the concern for overall environmental protection. Therefore, the environmental values are at a medium level.

Through research, it is found that the communication channels between the public and the government and project operators are lacking, environmental risk information cannot be obtained in time, and the media does not release the project environmental risk information in time, which has a negative impact on the public acceptance of heavy chemical projects, so the risk communication is at a medium level.

Through research, it is found that the public's trust in the government and project operators is mainly concentrated on the two trust levels of trust and less trust, which is more biased than trust, and the media trust distribution is relatively average, so the system trust is at a good level.

Through research, it is found that the public believes that the pollution degree of heavy chemical waste to the environment is very serious. The environmental risk perception of heavy chemical projects is very high, causing the public to resist the heavy chemical projects, so the risk perception is at a poor level.

From the cloud model map, it can be intuitively found that the entropy and super-entropy of the cloud map are relatively small, indicating that the cloud model map has strong cohesiveness, that is, the opinions of the survey objects tend to be consistent, and the evaluation results are reliable.
4. Conclusion

According to the characteristics of heavy chemical projects, the public acceptance rating system for environmental risks of heavy chemical projects was constructed from the perspective of public acceptance. According to the results of the questionnaire survey, the public participation awareness in environmental values is mainly reflected in the attitude towards environmental issues. The disclosure of risk information in the media mainly affects the public acceptance of the project environmental risks, and the environmental trust institutions in system trust. The professional quality is the key content of public concern. The public perception of risk perception mainly focuses on whether heavy chemical projects affect the depreciation of surrounding industries.

The evaluation results of the entropy weight cloud model obtained through the cloudization process are consistent with the evaluation results of the comprehensive evaluation cloud model, that is, the public’s acceptance degree of environmental risks of heavy chemical projects is at a medium level, which indicates that the cloud model has good credibility and feasibility in the evaluation of environmental risks of heavy chemical projects.

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