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Research Article

A Study on Effectiveness Evaluation for the Physical Protection System of a High Security Prison Based on the Cloud Model

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In order to improve the effectiveness and accuracy of effectiveness evaluation for the physical protection system of a high security prison, this paper analyzed factors affecting the evaluation of such a system and, on this basis, applied the cloud theory and constructed a cloud model for evaluating the effectiveness of such a system. A case study was used to discuss the risk controllability of such a system with the evaluation method based on the cloud model. The research results show that the cloud model that we constructed for effectiveness evaluation can greatly reduce the influence of subjective factors in the risk evaluation for the physical protection system of a high security prison through the setting, calculation, and analysis of relevant parameters and we found that it is more accurate and practically useful especially when it is used in the evaluation together with the fuzziness and randomness of qualitative linguistic concepts.

1. Introduction

With the rapid development of information technology, the information technology of high security prisons has also been constantly strengthened and advocated. The integrated physical protection system is the foundation and core of building a more intelligent high security prison with more advanced information technology and which is often called a system that requires long-term construction and constant improvement. Since the comprehensive physical protection system is the center of daily operation support and management of the prison, its stability is essential to the security of the entire management system. As Fennelly, Lawrence [1] pointed out that no physical protection system is 100% defeat-proof, and if it is expected and designed to eliminate most threats, it always has its weak links. Physical barriers, alarm systems, security forces, and all the other components of a security system cannot achieve maximum security individually. Therefore, it is necessary to establish an effectiveness evaluation system for the physical protection system of a high security prison.

According to the existing literature, the researches on effectiveness evaluation for the physical protection system of a high security prison can be divided into three categories: The first category mainly puts emphasis on the intelligent analysis technology in the physical protection system, such as the research of Jie Xu [2] which analyzes how the physical protection system is constructed and applied based on the construction of the high security prison in Foshan, and further discusses the security needs and development orientation of high security prisons, especially the demand for and application of intelligent analysis technology. The second category focuses on the application of big data in physical protection, such as the Research of YunguoZuo [3] which analyzes the combined application of new technologies such as network and intelligence technologies of the physical protection system and the big data analysis technology in high security prisons and the research of Xu Xiaogang [4] which, based on the specific case in a high security prison, discusses the path and method of improving and creating innovative physical protection models in response to the change of situation in a high security prison; the third category involves the basically comprehensive researches, such as the research of WANG Hai-wei [5] which proposes a scheme to build an integrated physical protection system in response to the current situation and problems of the construction of the physical protection system. The scheme has built the dispersed physical protection subsystems into an integrated physical protection system of mutual interaction and integration. However, most of these researchers emphasized the construction of the physical protection system from a qualitative and excessively subjective point of view without making adequate quantitative analysis. Therefore, it is often difficult to promote and apply their research results in practice.

How to strengthen physical protection and improve the effectiveness of the physical protection system of a high security prison has always been an important task in the public safety management. In recent years, scholars have proposed some evaluation models to try to solve the problem of effectiveness. For example, Eric G. Lambert et al. [6] made a detailed analysis which revealed that the effects of the personal variables were conditional on staff position; that is, irrespective of position, two of seven work environment variables studied were closely related to greater perceived risk of harm from the job; Jennifer Shea and Tory Taylor [7] posit that, without explicitly incorporating the assessments at the foundation of the Evaluation-led Learning framework, developing mental evaluation's ability to affect organizational learning in productive ways will likely be haphazard and limited. Some others advocate that the Cloud Model theory can be effectively applied into the assessment [8–15]. We know that, on the basis of traditional fuzzy mathematics and probability statistics, the cloud model organically combines fuzziness and randomness to establish a quality and quantity data conversion model, which realizes the natural conversion between qualitative linguistic values and quantitative values and objectively reflects the characteristics of the evaluated indices and makes the comprehensive evaluation of system effectiveness more objective. Based on this assumption, this paper will, according to the characteristics of the cloud theory together with the individual needs of the physical protection system of a high security prison which is different from ordinary physical protection systems, establish relevant parameters and make use of certain arithmetic expressions of the weighted integrated cloud model to build an adjustable effectiveness evaluation model for the physical protection system from the perspective of qualitative and quantitative conversion.

2. Research Areas

A high security prison is actually rather a complicated system. Although there are not many sites involved, the configuration of its internal area is usually complicated; e.g., a high security prison always includes the security fence, the duty room, the sub-control center, the command center, the prison factory, the reception room, the infrastructure site, the ordinary cells, the quarantine cells, and the restaurant. Its physical protection system should be based on the specialness of its structure and the specificity of its needs. Its security level requires that its physical protection system must be able to ensure the security of its periphery, the security of guardsmen, the security inside and outside a cell, and the security of inmates when they meet with their families. In addition, it is necessary to effectively manage the prisoners' personal data and sentencing information, the prison officers' personal records and attendance records, the entry and exit records of various personnel, and the reporting of events and issuance of decision-making results when emergency occurs.

In recent years, information technology and Internet of Things technology have been widely used in various types of work in a high security prison. At present, in high security prisons of China, a three-dimensional warning system with a wall and an AB door as the main body has been developed and additionally supported by a power grid, an access control, and an alarm system and relatively built perfect systems of defense by personnel and by physical barriers. In the system of defense by technology, various subsystems are established, such as the video surveillance system, the alarm system, the periphery defense system, the vehicle bottom detection system, the AB door management system, the access control system, and the broadcast intercom system. According to the data, the total number of video surveillance stations across the country has reached 450,000. There are 20 provinces which have basically built a two-level command system between bureau of prisons and prisons, though it is obviously far from meeting the needs.

As the physical protection system is increasingly used in prison management, its role in prison security is continuously played to extremes. However, according to the data of the public security system, there are two big problems that need to be addressed and solved in the physical protection system of a high security prison: first, how to test whether the to-be-designed or existing physical protection system can achieve the effects and goals required by the security design; secondly, how to strike a balance between demand and cost in the physical protection system construction, since if so it can not only play its due role decently, but also help avoid the use of duplicate devices. Due to the important role played by the physical protection system in security management of a high security prison, a frequent and effective evaluation mechanism for such a system can improve its effectiveness and stability which will be discussed in detail as follows.

3. An Effectiveness Evaluation Model for the Physical Protection System of a High Security Prison Based on the Normal Cloud Model

3.1. An Introduction to the Normal Cloud Model. The normal cloud model is mainly expressed by expectations (Ex), entropy (En), and super entropy (He).

The normal cloud model [16] used in this study is one of cloud models. Since the distribution curves of many things in social and natural sciences are approximately expressed in the normal or semi-normal distribution, the normal cloud model can indicate more universality in application. It, evolved and developed from the probability theory and fuzzy mathematics, is a new model using linguistic values to represent uncertainty conversion between the qualitative and the quantitative [17–19]. The digital characteristics of the normal cloud model which is represented through the quantitative expressions of qualitative concepts are often expressed by expectations (Ex), entropy (En), and super entropy (He).

Cloud generation algorithms include the forward cloud generation algorithm [20] and the reverse cloud generation algorithm [21]. The forward cloud generation algorithm converts natural linguistic values to quantitative values; conversely, the reverse cloud generation algorithm converts quantitative values to natural linguistic values. So, we say that the cloud model is a new mathematical model that is developed on the basis of normal distribution and the bell-shaped membership functions. Since the model can be applied widely [22, 23], its computing concept can be divided into the following steps [24]:

(1) Generate a normal random number

$$En_i' = NORM\left(En, He^2\right) \tag{1}$$

In (1), En and He^2 represent expectation and variance, respectively.

(2) Regenerate another normal random number

$$x_i = NORM\left(\mathrm{Ex}, En_i'^2\right) \tag{2}$$

In (2), Ex and $En_i'^2$ represent expectation and variance, respectively, and NORM represents the normally distributed random function.

(3) Calculation

$$\mu_i = \exp\frac{-\left(x_i - Ex\right)^2}{2En_i'^2} \tag{3}$$

(4) (x_i, μ_i) represents any cloud drop in the number field.

(5) Repeat Steps (1) to (4) until we obtain the required number of cloud drops.

3.2. The Effectiveness Evaluation Index System for the Physical Protection System of a High Security Prison. For a high security prison, the effectiveness of its physical protection system refers to the functions of its physical protection system, namely, the extent to which its physical protection system reaches or achieves the system's intended goals in its safety management system. Since it is a type of very complicated and exploratory research to determine the effectiveness evaluation indices for its physical protection system, there is no clear unified standard for relevant researches at present. Due to the fact that the relationship is complex between any two evaluation factors in effectiveness evaluation for its physical protection system which not only involves video surveillance, periphery defense, entrance and exit control, intercom broadcast, emergency alert, electronic patrol, intelligent analysis, and electronic maps among other physical protection functions, but also has to interact with the police management system, the intelligence research and judgment system, dispatching and command system, etc, therefore, the construction of an evaluation index system for its physical protection system should be based not only on the basic evaluation model for the physical protection system, but also on the special needs of high security prisons which have special functions.

Most prison security systems have similar requirements and authorize their staff to collect and report intelligence relatively [25]: escape planning, organized gang-related activity, drug trafficking, planned assaults on staff or other prisoners, illicit communications via mobile phone and Internet, radicalization and violent extremist activity, bullying of vulnerable prisoners and risks to safety and security, and order and control of the prison.

Table 1: Effectiveness evaluation index system for the physical protection system of a high security prison.

First-Level Indices	Second-Level Indices
Information Collection, Transmission and Control	Means of Information Collection
	Quality of Information Collection
	Speed of Information Transmission
	Security of Information Transmission
	Capability of Signal Shielding
Judgment and Processing of Information	Analysis of Information Content
	Research on and Judgment of Information Content
	Information Data Sorting and Mining
	Information Interaction Ability
Detection and Monitoring	Detection Range
	Detection Sensitivity
	Monitoring Place
	Covertness of Detection Equipment
Entrance and Exit Control	Access Authorization
	Response Time
	Emergent Opening
	Vehicle Detection Capability
Prison Officers' Patrol	Management of Prison Patrollers
	Patrol Route
	Equipment of Prison Patrollers
Self-Protection Capability of the System	Anti-Destruction and Anti-Interference Capability
	Level of Operating Personnel
	Backup Management Capability
	False Positive Rate and False Negative Rate

Based on the principles of clear hierarchy, high scientific content, completeness, comparability, and data availability and operability, this paper will consider the status of the physical protection system of a high security prison in China and the availability of evaluation data and try to build an effectiveness evaluation index system for the physical protection system of a high security prison based on the author's previous research [26, 27] and others' relevant research achievements [28, 29]. The specific contents are shown in Table 1.

(1) Information collection focuses on the means of information acquisition, as well as the quality and timeliness of data information; information transmission examines the communication status and transmission efficiency of the physical protection information system of a high security prison, and information control focuses on interfering and shielding information transmission through specific channels or of specific frequencies within prison; the information

technology level of the physical protection system of a high security prison can be accurately evaluated by quantitative indices such as stable running time, failure rate, and accuracy, and therefore this method has good measurability and operability.

(2) Judgment of information mainly examines the application of the physical protection system (of a high security prison) in assistance to analyze, study, and judge data information; and the information processing focuses on the evaluation of the ability to automatically sort, identify, and integrate information so as to generate corresponding judgment results. The system's capability of processing interaction is mainly reflected in the capability of interaction between subsystems, the quick response to emergency, and the capability to work 24 hours, such as the interaction between the video surveillance system and the intrusion alarm system, the fire protection system, the entrance and exit control system, the intercom system, and the emergency alarm system, which will help identify automatically and send alarm signals.

(3) Detection and monitoring cover not only external invasion from outside to inside in periphery protection, but also emergencies that break out from inside to outside. It focuses on the coverage and sensitivity of various intrusion detectors, as well as the video surveillance index in the prison security system to assess the coverage of the video, the covertness of the front-end equipment such as the camera, and the resolution of the back-end video.

(4) The access control index is divided into two parts: the control of personnel's and vehicles' entrance and exit. It mainly examines the authority of the entrance and exit, the time duration of the entrance and exit, the emergent opening and closing of the entrance and exit, and the inspection of signs of life in and out of vehicles.

(5) The evaluation index of personnel patrolling mainly includes the management of prison patrollers, the design of patrol routes, and the personnel's equipment. The management of prison patrollers refers to the assignment of patrollers' number and the arrangement of patrol time; patrol routes are designed on the basis of the patrollers and should cover key and vital areas completely. Personnel's equipment includes emergency equipment for a single officer in the environment of a high security prison.

(6) On the one hand, the self-protection capability refers to the adaptability, fault-tolerant repair capability, and resilience of the system after being used. Physical protection equipment is the key part of the physical protection system. Failure of the physical protection equipment will result in the failure of its protection capability, which in turn will affect the protection effectiveness of the physical protection system. On the other hand, the system's self-protection capability index is more related to the system maintenance by the users to adopt the integrated management system for physical protection of a high security prison, including equipment backup, technical support, and system failure confirmation. This capability improves the survivability of the system, guarantees the benefits of the investment, and helps to play a better role in the system's advantage of physical protection.

3.3. *The Effectiveness Evaluation Model for the Physical Protection System of a High Security Prison*

3.3.1. Determination of Comments. Most of these comments are described in ambiguous language. The indices for evaluating the physical protection system are mostly qualitative indices, which cannot be directly quantified and need to be indirectly converted into quantitative indices. Therefore, we should represent comments by the one-dimensional cloud model, and we can develop a set of standard cloud models for evaluation of the index system. The following formula is used to solve the digital characteristics of the cloud model:

$$Ex_i = \begin{cases} C_i^{min} & i = 1 \\ \dfrac{C_i^{min} + C_i^{max}}{2} & 1 < i < n \\ C_i^{max} & i = n \end{cases} \quad (4)$$

$$En_i = \frac{C_i^{max} - C_i^{min}}{6} \quad (5)$$

$$He_i = K \quad (6)$$

(C^{min}, C^{max}) is the range of values for comments. In the formula, k is a constant, indicating the degree of ambiguity of certain comments, which can be determined based on historical data, or can be directly given by experts according to experience, while the value of He cannot be too large, so as to avoid the error of Ex being too large and the result being inaccurate. Based on relevant literature on risk assessment by the cloud model [20, 21, 28] and according to the effectiveness evaluation criteria for the physical protection system of a high security prison, this paper has set the ranks and corresponding scores of the comments as follows: low risk $[0, 4]$, relatively low risk $[4, 6]$, medium risk $[6, 8]$, relatively high risk $[8, 9]$, and high risk $[9, 10]$, with the value of He being 0.03. According to this definition, this paper can obtain a table of digital characteristics for standard cloud models of risk (Table 2).

Obtain the standard cloud graph with Matlab according to data in Table 2.

3.3.2. Determination of Each Index's Weight. The evaluation index system clarifies the affiliation between indices, but the importance of each index at the same level to its superior index still needs to be determined by using scientific methods. Concerning the hierarchical structure of the effectiveness evaluation index system for the physical protection system of a high security prison, it is appropriate to use the analytic hierarchy process (AHP) to calculate the weight value of each index. This paper uses the AHP to solve the problem of index weight distribution. Its main approach is as follows: Use Saaty's scaling method for priorities [30] to make a comparison between indices at the same level and score each one of them in terms of importance and then construct a corresponding judgment matrix for them according to the scores and then verify the consistency of the judgment matrix. If the matrix fails to meet the requirements

Table 2: A set of standard cloud models for evaluation.

Comments	Low Risk	Relatively Low Risk	Medium Risk	Relatively High Risk	High Risk
Standard Cloud Model	(0,0.667,0.03)	(5,0.333,0.03)	(7,0.333,0.03)	(8.5,0.1667,0.03)	(10,0.1667,0.03)

of consistency, it needs to be repeatedly reconstructed until the requirement of consistency is met. Finally, the weight of each index is obtained by hierarchical single ordering and hierarchical total ordering..

3.3.3. Determination of the Cloud Model for Each Index. According to the risk value judged by the expert group for each index, the cloud model of each level is calculated by the reverse cloud generator formula without the degree of certainty:

Firstly, the mean value of each set of data samples is obtained

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} x_i \quad (7)$$

The first absolute central moment for each set of data samples

$$\frac{1}{n}\sum_{i=1}^{n} \left| x_i - Ex \right| \quad (8)$$

Variance

$$S^2 = \frac{1}{n-1}\sum_{i=1}^{n} \left(x_i - \overline{X} \right)^2 \quad (9)$$

Expectation

$$Ex = \overline{X} \quad (10)$$

At the same time, the entropy can be obtained from the mean value

$$En = \sqrt{\frac{\pi}{2}} \times \frac{1}{n}\sum_{i=1}^{n} \left| x_i - Ex \right| \quad (11)$$

Based on variance and super entropy, we can obtain

$$He = \sqrt{S^2 - En^2} \quad (12)$$

3.3.4. Determining Evaluation Results with the Help of the Cloud Model Graph. Based on the cloud models of the second-level indices together with each index's weight, we can calculate the cloud models of the first-level indices. The calculation formula is shown in (13)-(15), where *Ex*, *En*, and *He* are the evaluation cloud models of the $(n\text{-}1)^{\text{th}}$ level indices; $\text{Ex}_1, \text{Ex}_2, \cdots \text{Ex}_n$ is the expectation of the cloud model of each index at the n^{th} level; $\text{Ex}_1, \text{Ex}_2, \cdots \text{Ex}_n$ is the entropy of the cloud model of each index at the n^{th} level; $He_1, He_2, \cdots He_n$ is the super entropy of the cloud model of each index at the n^{th} level; i is the number of indices at the n^{th} level; and $\partial_1, \partial_2, \cdots \partial_n$ is the weight of each index at the n^{th} level. We keep calculating until the integrated cloud model of the target level for evaluation is obtained.

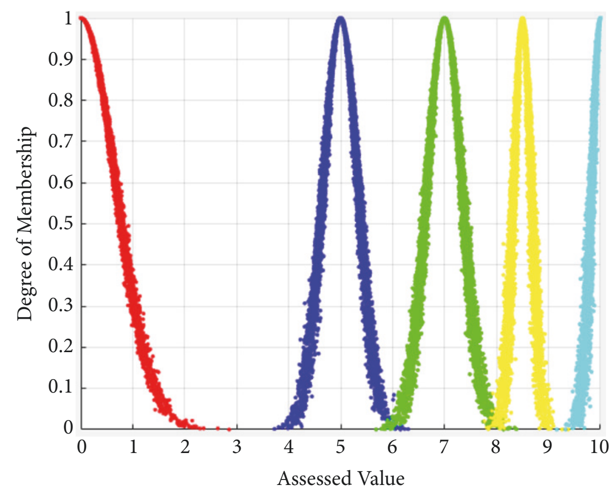

Figure 1: Standard cloud model graph for the evaluation model.

$$\text{Ex} = \frac{Ex_1 \times En_1 \times \partial_1 + Ex_2 \times En_2 \times \partial_2 + \cdots + Ex_n \times En_n \times \partial_n}{En_1 \times \partial_1 + En_2 \times \partial_2 + \cdots + En_n \times \partial_n} \quad (13)$$

$$En = En_1 \times \partial_1 + En_2 \times \partial_2 + \cdots + En_n \times \partial_n \quad (14)$$

$$\text{He} = \frac{He_1 \times En_1 \times \partial_1 + He_2 \times En_2 \times \partial_2 + \cdots + He_n \times En_n \times \partial_n}{En_1 \times \partial_1 + En_2 \times \partial_2 + \cdots + En_n \times \partial_n} \quad (15)$$

The total model obtains the cloud graph by Matlab as shown in Figure 1 and verifies the evaluation levels of the entire system.

4. Results and Analysis

This paper made a case study of the physical protection system of a high security prison which has just completed the overall reconstruction of its physical protection system and improved significantly from three aspects: defense by prison personnel, defense by physical barriers, and defense by technology. The configuration of its physical protection system is relatively representative. According to the index system, the evaluation model, and the calculation method constructed above, the following analysis and calculation were performed.

According to the effectiveness evaluation index system for the physical protection system of a high security prison constructed in the previous section, we organized an expert group to score each index item according to the scaling method of the AHP and establish a judgment matrix for each level of evaluation indices, where we have the following:

First level index set:

$$A = \{A_1, A_2 \cdots A_i\} \quad (i = 1, 2, \ldots, o) \quad (16)$$

The weight set of the first level indices:

$$\omega = \{U_1, U_2 \cdots U_i\} \quad (i = 1, 2, \ldots, o) \tag{17}$$

Second level index set:

$$A_i = \{A_{i1}, A_{i2} \cdots A_{ij}\} \quad (j = 1, 2, \ldots, p) \tag{18}$$

The weight set of the second level indices:

$$\omega_i = \{\omega_{i1}, \omega_{i2} \cdots \omega_{ij}\} \quad (j = 1, 2, \ldots, p) \tag{19}$$

T is the judgment matrix of A1, A2, and A3 (first level indices) for evaluating the effectiveness of the physical protection system; T1, T2, T3…T6 are the judgment matrices of A11, A12, A13…A66 (second level indices) for evaluating the effectiveness of the physical protection system. The judgment matrix of each level's indices is as follows:

$$T = \begin{bmatrix} 1 & \frac{1}{3} & \frac{1}{3} & \frac{1}{5} & 1 & \frac{1}{3} \\ 3 & 1 & 1 & \frac{1}{3} & 3 & 1 \\ 3 & 1 & 1 & \frac{1}{3} & 3 & 1 \\ 5 & 3 & 3 & 1 & 5 & 3 \\ 1 & \frac{1}{3} & \frac{1}{3} & \frac{1}{5} & 1 & \frac{1}{3} \\ 3 & 1 & 1 & \frac{1}{3} & 3 & 1 \end{bmatrix}$$

$$T_1 = \begin{bmatrix} 1 & \frac{1}{3} & \frac{1}{3} & \frac{1}{5} & \frac{1}{5} \\ 3 & 1 & 1 & \frac{1}{3} & \frac{1}{3} \\ 3 & 1 & 1 & \frac{1}{3} & \frac{1}{3} \\ 5 & 3 & 3 & 1 & 1 \\ 5 & 3 & 3 & 1 & 1 \end{bmatrix}$$

$$T_2 = \begin{bmatrix} 1 & \frac{1}{3} & 1 & \frac{1}{2} \\ 3 & 1 & 3 & 6 \\ 1 & \frac{1}{3} & 1 & \frac{1}{2} \\ 2 & \frac{1}{6} & 2 & 1 \end{bmatrix}$$

$$T_3 = \begin{bmatrix} 1 & \frac{1}{2} & 3 & \frac{1}{3} \\ 2 & 1 & 5 & \frac{1}{2} \\ \frac{1}{3} & \frac{1}{5} & 1 & \frac{1}{7} \\ 3 & 2 & 7 & 1 \end{bmatrix}$$

$$T_4 = \begin{bmatrix} 1 & \frac{1}{3} & \frac{1}{5} & \frac{1}{3} \\ 3 & 1 & \frac{3}{5} & 3 \\ 5 & \frac{5}{3} & 1 & \frac{5}{3} \\ 3 & \frac{1}{3} & \frac{3}{5} & 1 \end{bmatrix}$$

$$T_5 = \begin{bmatrix} 1 & \frac{1}{3} & \frac{1}{2} \\ 3 & 1 & 2 \\ 2 & \frac{1}{2} & 1 \end{bmatrix}$$

$$T_6 = \begin{bmatrix} 1 & \frac{1}{3} & 2 & \frac{1}{3} \\ 3 & 1 & 5 & 1 \\ \frac{1}{2} & \frac{1}{5} & 1 & \frac{1}{5} \\ 3 & 1 & 5 & 1 \end{bmatrix} \tag{20}$$

Table 3: Weight vector and consistency judgment.

Weight Vector	CR	Consistency Judgment
ω=(0.0597,0.1606,0.1606,0.3986,0.0597,1606)^T	0.0093	Satisfy
ω_1=(0.0557,0.1298,0.1298,0.3424,0.3424)^T	0.0125	Satisfy
ω_2=(0.1325,0.5381,0.1325,0.1968)^T	0.0938	Satisfy
ω_3=(0.1623,0.2879,0.0604,0.4894)^T	0.0071	Satisfy
ω_4=(0.806,0.325,0.4028,0.1917)^T	0.0573	Satisfy
ω_5=(0.1638,0.539,0.2973)^T	0.0079	Satisfy
ω_6=(0.1376,0.3935,0.0754,0.3935)^T	0.0015	Satisfy

The weight vector of each level's indices was calculated and the consistency was verified, as shown in Table 3.

Table 3 is the result of the hierarchical single ordering. However, in order to obtain the importance of all the indices at the same level with respect to the highest level, the hierarchical total ordering must also be conducted on the basis of the hierarchical single ordering. The weight vector of each index relative to its target level is shown in Table 4.

According to the risk criteria defined in Table 2, we asked experts to score each index and then calculated the cloud model characteristics (Ex, En, and He) from the quantitative to the qualitative using formula (7)-(12) of the reverse cloud model generation algorithm without the degree of certainty. The result is shown in Table 5.

According to the data in Table 5, the integrated cloud model for the physical protection system of this high security prison was calculated by formula (13)-(15) (4.96486, 0.2672, 0.4065), and the cloud graph Figure 2 was crafted.

From Figure 2, it can be seen that the risk value of this prison's physical protection system is consistent with the cloud graph of relatively low risk. In other words, in relatively low risk, this calculation result is consistent with the assessment results of some experts and the results from

Table 4: Weight vector of each index relative to its target level.

First Level Index	Weight Vector	Second Level Index	Weight Vector	Weight Vector in Total Ordering
A1	0.0597	A11	0.0557	0.0033
		A12	0.1298	0.0078
		A13	0.1298	0.0078
		A14	0.3424	0.0204
		A15	0.3424	0.0204
A2	0.1606	A21	0.1325	0.0213
		A22	0.5381	0.0865
		A23	0.1325	0.0213
		A24	0.1968	0.0316
A3	0.1606	A31	0.1623	0.026
		A32	0.2879	0.0462
		A33	0.0604	0.0097
		A34	0.4894	0.0786
A4	0.3986	A41	0.0806	0.0321
		A42	0.325	0.1295
		A43	0.4028	0.1606
		A44	0.1917	0.0764
A5	0.0597	A51	0.1638	0.0098
		A52	0.539	0.0322
		A53	0.2973	0.0178
A6	0.1606	A61	0.1376	0.0221
		A62	0.3935	0.0632
		A63	0.0754	0.0121
		A64	0.3935	0.0632

survey. The entropy and super entropy of the integrated cloud model for evaluation are small, which proves that the distribution of the cloud is relatively concentrated, the opinions are more in unison, and the evaluation results are more reliable. Compared with other methods such as pure analytic hierarchy process, this method can be adopted with more accurate values and then convert these values through the cloud model into a graph, which shows results more clearly.

5. Conclusion

In general, the traditional methods for evaluating the risk level of security systems focus on evaluation techniques, but rarely consider the randomness and fuzziness, the two attributes of qualitative language. This will cause defects in these methods no matter how many efforts are made in the subjective analysis, and the reliability and authenticity of the evaluation results are always in question.

In this paper, the cloud theory was applied to evaluate the effectiveness of the physical protection system of a high security system, and then a case study was adopted to discuss the controllability of risk of such a system with the evaluation

Table 5: Weight vector and cloud model of each second level index.

Second Level Index	Weight Vector in Total Ordering	Cloud Model	Evaluation Results
Means of Information Collection	0.0033	(2.1818,0.7458,0.0864)	Low Risk
Quality of Information Collection	0.0078	(3.8182,1.1601,0.1335)	Low Risk
Speed of Information Transmission	0.0078	(4.0909,1.1523,0.4516)	Relatively Low Risk
Security of Information Transmission	0.0204	(4.6364,1.1808,0.2454)	Relatively Low Risk
Capability of Signal Shielding	0.0204	(3.0909,1.2844,0.2031)	Low Risk
Analysis of Information Content	0.0213	(2.9091,0.6215,0.3235)	Low Risk
Research on and Judgment of Information Content	0.0865	(1.9091,0.6215,0.3235)	Low Risk
Information Data Sorting and Mining	0.0213	(2.5455,0.8701,0.3402)	Low Risk
Information Interaction Ability	0.0316	(5.3636,1.4087,0.2649)	Relatively Low Risk
Detection Range	0.026	(6.1818,1.1601,0.1335)	Medium Risk
Detection Sensitivity	0.0462	(3.2727,1.3465,0.4528)	Low Risk
Monitoring Place	0.0097	(3.6364,1.0979,0.2215)	Low Risk
Covertness of Detection Equipment	0.0786	(5.7273,1.1187,0.4084)	Relatively Low Risk
Access Authorization	0.0321	(4.9091,0.6215,0.3235)	Relatively Low Risk
Response Time	0.1295	(5.0909,1.0772,0.3612)	Relatively Low Risk
Emergent Opening	0.1606	(4.8182,1.4294,0.5661)	Relatively Low Risk
Vehicle Detection Capability	0.0764	(6.7273,0.8908,0.1571)	Medium Risk
Management of Prison Patrollers	0.0098	(7.9091,0.8286,0.0653)	Medium Risk
Patrol Route	0.0322	(4.1818,1.0151,0.3650)	Relatively Low Risk
Equipment of Prison Patrollers	0.0178	(4.8182,1.1601,0.1335)	Relatively Low Risk
Anti-Destruction and Anti-Interference Capability	0.0221	(5.0909,0.8494,0.4117)	Relatively Low Risk
Level of Operating Personnel	0.0632	(6.0000,1.3673,0.5750)	Medium Risk

Table 5: Continued.

Second Level Index	Weight Vector in Total Ordering	Cloud Model	Evaluation Results
Backup Management Capability	0.0121	(3.9091,1.0358,0.1343)	Low Risk
False Positive Rate and False Negative Rate	0.0632	(3.3636,0.6629,0.1229)	Low Risk

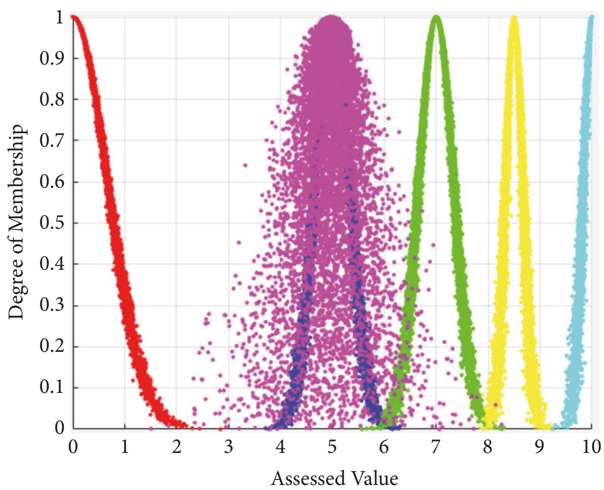

Figure 2: Cloud graph for evaluating the risk level of the physical protection system.

method based on the cloud model. The research results show that the cloud model for effectiveness evaluation we constructed can greatly reduce the influence of subjective factors in the risk evaluation for the physical protection system of a high security system through the setting, calculation, and analysis of relevant parameters and it is very accurate and practically useful especially when it is used in evaluation together with the fuzziness and randomness of qualitative linguistic concepts. To be sure, due to the limitations of the conditions, further discussion and research are needed in the comparative study on different cloud models.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The author declares that they have no conflicts of interest.

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