# Evaluation of Command Effectiveness of Anti-Terrorism Drill Based on Analytic Hierarchy Process

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Abstract: Anti-terrorism drill is an effective means to improve the anti-terrorism combat capability, and the command in the drill is its key link. In order to ensure the quality of anti-terrorism drill and improve the command efficiency, Delphi method is adopted to establish the evaluation of five core command capabilities, including intelligence mastery capability, situation analysis capability, operational control capability, combat coordination capability and organizational support capability index system. The analytic hierarchy process is introduced, combined with the scoring of the expert group.A comprehensive evaluation model is established, and the application evaluation is carried out for the anti-terrorism drill in D city. The results show that the model comprehensively considers the functionality and balance of each index, effectively tests the command effectiveness in anti-terrorism drill, and plays an obvious guiding role in the improvement of command ability.



## 1 INTRODUCTION

The anti-terrorism drill is an effective means to deal with extreme violent terrorist events. Cities in China have successively carried out large-scale anti-terrorism drills, which has improved the city's ability to respond to terrorist attacks. The effectiveness of anti-terrorism drills should be tested through scientific evaluation methods. As for the evaluation of emergency drills, scholars conducted research from different perspectives and methods.

In terms of content, Gao Xiao and other scholars conducted drills on the coordination and emergency response capabilities of road emergency commanders and rescuers for various road emergencies (Gao, 2022); Zhao kaigong and other scholars constructed a reasonable scenario for mine emergency drill (Zhao, 2022). At the method level, scholars adopt a variety of methods from the overall perspective. Ren longlong and others used BP neural network to build a high-speed railway emergency drill evaluation model (Ren, 2020). Wang lei and Chen guohua formed a quantitative drill performance evaluation method (Wang, 2008) from the use of time resources and the demonstration of emergency capacity. Li rong adopted a combination of AHP and TOPSIS (Li, 2020).

Anti-terrorism is a systematic project that requires the active cooperation of relevant industries, departments and the masses. The key for coordination is the command and deployment in emergency response (Sunnie, 2020). At present, there is still a lot of research space for the academic community to conduct a detailed evaluation from the micro level, especially the command and deployment in the drill. Therefore, this paper selects the crucial decision-making command in the anti-terrorism drill for evaluation, and tries to find a scientific and reasonable command decision-making evaluation method by using the analytic hierarchy process.

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# 2 CONSTRUCTION OF THE EVALUATION INDEX SYSTEM OF ANTI-TERRORISM DRILL COMMAND EFFECTIVENESS

## 2.1 Analysis of Key Factors

The command ability of anti-terrorism drill is the comprehensive embodiment of the quality and efficiency of the command subject's using knowledge and wisdom to solve the command problems in the anti-terrorism drill (Hu, 2022). It reflects the cognition of the command subject to the anti-terrorism operation and the level of command action. include:

Quick understanding ability: through listening to sporadic and fragmentary situations, quickly grasp the basic situation of the events (Sun, 2018).

Accurate judgment ability: judge the nature and situation of the event, and predict the possible trend (Shang, 2016).

Decisive decision-making ability: according to the judgment made on the nature and situation of the event, select an applicable plan or formulate a disposal plan on the spot (Shang, 2016).

Thorough operational research capability: deploy the disposal actions, including dividing the police forces under their jurisdiction into groups, defining their respective responsibilities and tasks, action plans, police equipment and cooperation, and determining the command position and mode (Li, 2017).

Flexible adaptability: timely adjust the police deployment and action plan according to the changing situation (Yang, 2019).

## 2.2 Selection Principle of Evaluation Indicators

Guided by practical improvement. The selection of evaluation indicators is guided by the actual combat, highlighting the actual combat standards in terms of evaluation design, evaluation content, evaluation standards, etc.

The ability test shall be taken as the standard. Because it is difficult to determine the command decision of anti-terrorism drill, we should focus on the results rather than the process when designing and selecting indicators, and take the inspection of various abilities that the command should have as the standard.

Supported by quantitative analysis. In the design and selection of indicators, we should try to rely on quantitative analysis to analyze the role of command effectiveness in anti-terrorism drills.

It is essential to be comprehensive and accurate. First of all, it is necessary to highlight the comprehensive consideration of command ability, comprehensively analyze various influencing factors, and build an integrated evaluation index. Secondly, we should respect the objective facts, and the selected indicators should objectively reflect the command ability needs. Third, ensure that the indicators are derived from first-hand information, that is, accessibility.

## 2.3 Construction Method of Evaluation Index

Considering the influencing factors of anti-terrorism simulation training and the quantifiable ability of indicators, it should be reasonable and comprehensive. The Delphi method is used to determine the evaluation indicators at all levels. The steps are as follows:

Determine the evaluation content. Prepare anti-terrorism simulation training materials and various instructions for relevant research.

Establish an expert group. Invite experts with senior research in anti-terrorism simulation training to provide experts with research contents, relevant requirements, etc.

Through relevant materials and their own cognition, experts filled in the evaluation index questionnaire of anti-terrorism simulation training command effect.

Analyze and sort out the returned questionnaires. The second expert questionnaire shall be prepared according to the experts' opinions and fed back to the experts together with the previous opinions.

Again, analyze and sort out the collected questionnaire. Repeat until the expert opinion does not change.

## 2.4 Evaluation Index of Anti-Terrorism Drill Command Effectiveness

Establish the evaluation index system of anti-terrorism drill command effectiveness, as shown in Figure 1. The indicator system has four layers: the first layer is the criterion layer, which is the general goal of anti-terrorism drill command. The second is the middle tier, which requires five core capabilities for anti-terrorism drill command. The third layer is the element layer needed to achieve core competence, which is represented by

$C_{11}C_{12}$.....$C_{52}$. As the element indicators under the control of operational capability cannot be quantified, the fourth layer of quantifiable element indicators are added to this indicator. The third layer $C_{31}C_{32}C_{33}C_{34}C_{35}$ has two indicators corresponding to the accuracy and timeliness of instructions issued under each indicator. $C_{311}C_{312}$.....$C_{351}C_{352}$ respectively.

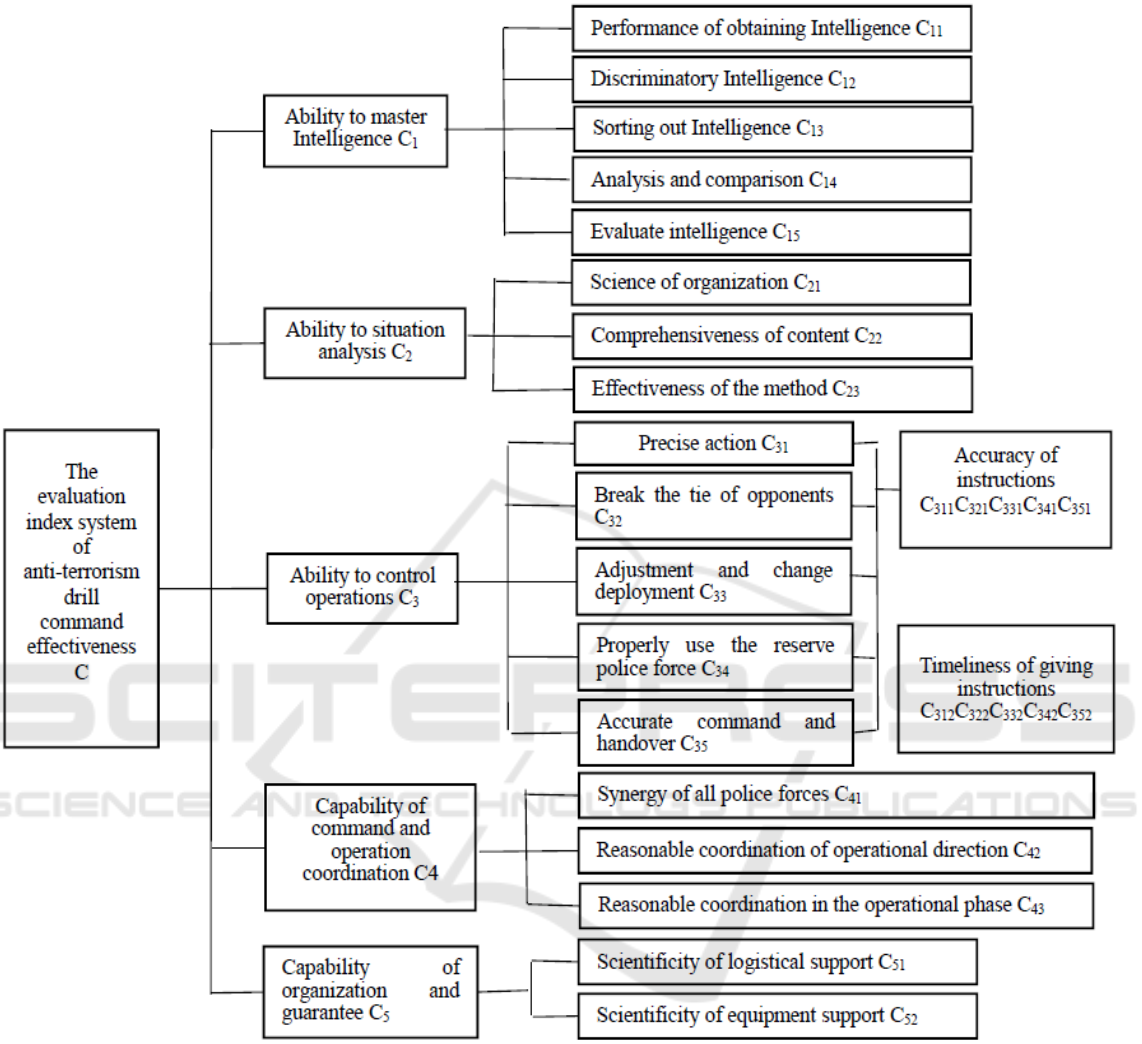


Figure 1: Anti-terrorism drill command effectiveness evaluation indicator system.

# 3 DESIGN OF EVALUATION MODEL FOR ANTI-TERRORISM DRILL

Obtaining the value of the anti-terrorism drill command effect index basically depends on the subjective judgment of the evaluation experts. When establishing the evaluation model, try to adopt the strategy of eliminating the subjective factors in the evaluation.

## 3.1 Evaluation of End Indicators

### 3.1.1 Acquisition of End Indicators

(1) Fuzzy value

The fuzzy value of expert judgment is described in the form of interval number. The value range of interval number is defined as: $Q=[a_1,a_2],0\le a_1\le a_2\le 100 \text{and} a_1,a_2\in R$ .To limit the degree of fuzziness in evaluation, the width of interval number is specified as $0\le w(Q)\le 15$.

(2) Linguistic scale
The set of language scales is generally the level of "excellent, good, medium, poor, and extremely poor". In order to minimize the fuzziness in the evaluation, each large level is subdivided into three sub levels. See Table 1 for the corresponding relationship between language scale and interval number.

Table 1: Correspondence between Language Scales and Interval Numbers.

| level | | interval number | level | | interval number | level | | interval number |
|---|---|---|---|---|---|---|---|---|
| excellent | Excellent+ | [95,100] | medium | medium+ | [65,70) | extremely poor | extremely poor+ | [20,30) |
| | Excellent | [90,95) | | medium | [60,65) | | | |
| | Excellent- | [85,90) | | medium- | [55,60) | | extremely poor | [10,20) |
| good | good+ | [80,85) | poor | poor+ | [47,55) | | | |
| | good | [75,80) | | poor | [39,47) | | extremely poor- | [0,10) |
| | good- | [70,75) | | poor- | [30,39) | | | |

### 3.1.2 Valuation Criteria of Indicator Value

The evaluation criteria are the basis for evaluation by evaluation experts and the premise to ensure the objectivity of the evaluation. See Table 2 for the evaluation criteria of anti-terrorism drill command effectiveness indicator

Each index adopts a four level scoring standard, the first level is 85-100； the second level is 70-84; The third level is 55-69; The fourth level is 0-54.

## 3.2 Calculation of Index Weight

The weight is the importance of the indicator to the system effectiveness, which reflects the evaluation experts' recognition of the importance of the indicator. The effectiveness indicators of anti-terrorism simulation training are numerous and have a complex hierarchical structure. The weight of indicators at each level is determined by using the analytic hierarchy process.

### 3.2.1 Construction of Judgment Matrix

The indicator system shown in Figure 1 is used to construct a judgment matrix by comparing the elements of each layer in pairs. Taking the criterion layer as an example, the constructed judgment matrix is as follows:

$$P=\begin{bmatrix} 1 & 3 & 1/3 & 2 & 5 \\ 1/3 & 1 & 1/5 & 1/3 & 3 \\ 3 & 5 & 1 & 4 & 7 \\ 1/2 & 3 & 1/3 & 1 & 4 \\ 1/5 & 1/3 & 1/7 & 1/4 & 1 \end{bmatrix}$$

### 3.2.2 Calculation of Relative Weight of Indicators

For the constructed judgment matrix, the relative weight of each index is calculated. Taking matrix P as an example, the relative weight of each index A= (0.234,0.0859,0.4665,0.1696,0.0441). The calculation results are shown in Table 2. The maximum characteristic root is 5.1755. According to the RI table, the corresponding RI value is 1.11, so CR=CI/RI=0.0395<0.1, passing the one-time test. Similarly, the relative weight of other indicators can be obtained:

$C_{11}$: 0.51, $C_{12}$: 0.0636, $C_{13}$: 0.0329, $C_{14}$: 0.1296, $C_{15}$: 0.2638; $C_{21}$:0 .1194, $C_{22}$: 0.1336, $C_{23}$: 0.7471; $C_{31}$: 0.4754, $C_{32}$: 0.3203, $C_{33}$: 0.1068, $C_{34}$: 0.0516, $C_{35}$: 0.0459; $C_{41}$: 0.637, $C_{42}$: 0.2583, $C_{43}$: 0.1047, $C_{51}$: 0.125, $C_{52}$: 0.875; $C_{311}$: 0.5, $C_{312}$: 0.5; $C_{321}$: 0.33, $C_{322}$: 0.67; $C_{331}$: 0.67, $C_{332}$: 0.33; $C_{341}$: 0.67, $C_{342}$: 0.33; $C_{351}$: 0.5, $C_{352}$: 0.5.

Table 2: Calculation of relative weight of indicators.

| Indicators | Feature vector | Weight value | The maximum characteristic | CI |
|---|---|---|---|---|
| $C_1$ | 1.5849 | 0.234 | 5.1755 | 0.0439 |
| $C_2$ | 0.5818 | 0.0859 | | |
| $C_3$ | 3.1598 | 0.4665 | | |
| $C_4$ | 1.1487 | 0.1696 | | |
| $C_5$ | 0.2988 | 0.0441 | | |

### 3.2.3 Calculation of Composite Weight of Indicators

Composite weight of indicators, that is, the weight of end indicators relative to the overall goal. The calculation method is: the relative weight value of the indicator multiplied by the weight value of the upper indicator. The calculation results are shown in Table 3.

Table 3: Calculation of composite weight of indicators.

| indicators | composite weight | indicators | composite weight | indicators | composite weight |
|---|---|---|---|---|---|
| $C_{11}$ | 0.11934 | $C_{12}$ | 0.01488 | $C_{13}$ | 0.07699 |
| $C_{14}$ | 0.03033 | $C_{15}$ | 0.06173 | $C_{21}$ | 0.01026 |
| $C_{22}$ | 0.01148 | $C_{23}$ | 0.06418 | $C_{311}$ | 0.11089 |
| $C_{312}$ | 0.11089 | $C_{321}$ | 0.04931 | $C_{322}$ | 0.10011 |
| $C_{331}$ | 0.03338 | $C_{332}$ | 0.01644 | $C_{341}$ | 0.01613 |
| $C_{342}$ | 0.00794 | $C_{351}$ | 0.01071 | $C_{352}$ | 0.01071 |
| $C_{41}$ | 0.10804 | $C_{42}$ | 0.04381 | $C_{43}$ | 0.01776 |
| $C_{51}$ | 0.00551 | $C_{52}$ | 0.03859 | | |

### 3.2.4 Evaluation Model

The linear weighted sum model has a greater compensation effect on smaller index values, while the geometric weighted average model can highlight the balance of each index. Comprehensively consider the functionality and balance, and use the comprehensive model to calculate, $E_{xg} = \lambda_1 \cdot \sum_{i=1}^{n} e_i^* \cdot \omega_i + \lambda_2 \cdot \prod_{i=1}^{n} (e_i^*)^{\omega_i}$where is the weight of the functional factors and balance factors in the final evaluation value, and $\lambda_1, \lambda_2 \geq 0, \lambda_1 + \lambda_2 = 1$ $e_i^*$ represents the comprehensive evaluation of the indicators $i$ by the evaluation experts, and $\omega_i$ represents the weight of the indicators $i$. The comprehensive model not only considers the functional contribution of each indicator value to the final evaluation value, but also considers the balanced contribution of the end indicators.

# 4 APPLICATION EXAMPLES OF COMMAND EFFECTIVENESS EVALUATION IN ANTI-TERRORISM DRILLS

## 4.1 Data Acquisition

The evaluation object is a anti-terrorism drills command led by the Anti Terrorism Office in 2021 in City D. A total of 10 experts from the Anti Terrorism Office of City D, the Anti Terrorism Detachment of the Municipal Public Security Bureau and the anti-terrorism training tactical command and training experts were invited to score the indicators by using two methods: fuzzy value and language scale according to the evaluation criteria.

## 4.2 Data Processing

10 experts score independently, and take the average value as the expert score value. The results of linear weighting and geometric weighting are shown in Table 4. The final evaluation value is 82.6039 when the comprehensive model is used to calculate $\lambda_1 = 0.6$ $\lambda_2 = 0.4$ , taking into account the functionality and balance.

Table 4: Evaluation data of anti-terrorism drill command effectiveness.

| Evaluation indicator | index weight | Expert score | Linear weighted score | Geometrically weighted score | Evaluation indicator | index weight | Expert score | Linear weighted score | Geometrically weighted score |
|---|---|---|---|---|---|---|---|---|---|
| C11 | 0.11934 | 75 | 8.9505 | 1.674055342 | C331 | 0.03338 | 75 | 2.5035 | 1.155020108 |
| C12 | 0.01488 | 67 | 0.99696 | 1.064564533 | C332 | 0.01644 | 60 | 0.9864 | 1.069628107 |
| C13 | 0.07699 | 86 | 6.62114 | 1.409084494 | C341 | 0.01613 | 30 | 0.4839 | 1.056394097 |
| C14 | 0.03033 | 71 | 2.15343 | 1.13801678 | C342 | 0.00794 | 70 | 0.5558 | 1.034308464 |
| C15 | 0.06173 | 65 | 4.01245 | 1.293931071 | C351 | 0.01071 | 76 | 0.81396 | 1.047474631 |
| C21 | 0.01026 | 85 | 0.8721 | 1.046636409 | C352 | 0.01071 | 82 | 0.87822 | 1.048327422 |
| C22 | 0.01148 | 70 | 0.8036 | 1.049981689 | C41 | 0.10804 | 70 | 7.5628 | 1.582502454 |
| C23 | 0.06418 | 65 | 4.1717 | 1.307232327 | C42 | 0.04381 | 76 | 3.32956 | 1.208922452 |
| C311 | 0.11089 | 77 | 8.53853 | 1.618799108 | C43 | 0.01776 | 75 | 1.332 | 1.079694995 |
| C312 | 0.11089 | 75 | 8.31675 | 1.614081811 | C51 | 0.00551 | 80 | 0.4408 | 1.024438817 |
| C321 | 0.04931 | 68 | 3.35308 | 1.231291877 | C52 | 0.03859 | 70 | 2.7013 | 1.178154736 |
| C322 | 0.10011 | 50 | 5.0055 | 1.479394116 | | | | | |

### 4.3 Result Analysis

Based on the above results, the expert group's evaluation on the command effectiveness of the anti-terrorism drill in City D is good+, and is satisfied with the overall command of the anti-terrorism drill. However, there is still room for improvement in individual indicators, such as the timeliness of correct use of reserve police force instructions. In the future training, we should focus on strengthening the training of weak indicators and high weight indicators.

## 5 CONCLUSION

As an emergency preparedness link, anti-terrorism drill is an effective response to extreme violent terrorist events and a powerful means to deter terrorist acts. Emergency command and decision-making is the key link in anti-terrorism drill. This study adopts the Delphi method, takes the actual combat improvement as the guidance, the ability test as the standard, the quantitative analysis as the support, and takes the comprehensive and accurate as the basis, and relies on these indicator systems to establish principles. The evaluation index system of five core command capabilities, including intelligence mastery capability, situation analysis capability, operational control capability, combat coordination capability and organizational support capability, has been constructed. The indicator system includes four levels of indicators, namely, criterion level, intermediate level and element level. At the same time, the comprehensive evaluation model is established by using the analytic hierarchy process combined with the expert group scoring. Conduct application evaluation for anti-terrorism drill in D city. The comprehensive model not only considers that the linear weighted average model has a greater compensation effect on the smaller index value, but also considers that the geometric weighted average model is more prominent in the balance of each index. Therefore, the model can effectively test the command effectiveness in the anti-terrorism drill, and has a targeted guiding role in improving the command ability.

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