Prediction of Terrorist Attack based on Advanced Terror Black Box Model and Grey System Theory

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Abstract: Regular demand for understanding "the three forces" terrorist attacks, the "Advanced Terrorism Black Box Model (ATB) "was established, analyzed the terrorism resource flow input and the terrorism product flow output stationarity , pointed out the rule of terrorist attack time follow regular impulse,which use grey theory to predict, and the time response sequence of the terrorism event occurred in a certain region of China from 2013 to 2015 is obtained.The two breaking times after the "3•01 terrorist attacks"of kunming railway station in 2014 were predicted, the prediction error with real terrorist attacks time is 3 to 10 days, that showed ATB effectivity and availability of the model and method,and the anti-terrorist actions before 2014 failed to destroy the terrorist foundation,indicated that society may suffer a larger scale of terrorist attacks after a period of security illusion.

1. Introduction

Under the background of globalization of terrorism [1], domestic violent terrorism, religious extremism and "three forces" of national separatism are highly integrated. Domestic and foreign "three forces" collude with each other and respond internally and externally, forming a linkage in financial, human, material and intellectual support (terrorist technology, etc.), which leads to the high incidence of violent terrorism in some areas of Western China, and to our country and ourselves. Social stability, economic development and national unity pose a great threat [2-4]. " East Turkistan Islamic" even declared its allegiance to the "Islamic State (IS)", and IS also declared that Xinjiang Uygur Autonomous Region in China would be divided into its own sphere of influence.

The current anti-terrorism research is basically divided into three areas, generally limited to the basic theory of anti-terrorism on the law, the causes of terrorist activities, classification and Countermeasures [5-7]. The research focuses on macro-analysis, and the enlightenment countermeasures given are more general and vague, more qualitative and less quantitative, so it is difficult to transform and apply.

In the field of anti-terrorism research, the prediction of terrorist incidents is still blank. The commonly used methods of prediction are usually divided into qualitative analysis and quantitative analysis. By forecasting and studying the violent incidents launched by the "three forces" in China, we can accurately grasp the characteristics and regularities of the violent incidents caused by the "three forces", improve the pertinence of the preparation for the anti-violent incidents, thereby reducing the probability of violent incidents, minimizing the loss of people's lives and property, and maintaining social security and stability in the border areas.

Based on the recognition of the occurrence mechanism of terrorist incidents, this paper establishes an advanced terrorism black box model (ATB) based on the stationary process inference of terrorist resources. The input and output signals of the model are analyzed. The ATB model points out that the occurrence of terrorist incidents is regular impulses.By using the grey system theory, this paper predicts the occurrence time of the violent terrorist incidents in the western region

of China in the early period of 2014, obtains the time sequence of the violent terrorist incidents caused by the "three forces", and evaluates the effect of the anti-terrorist struggle before 2014 by comparing the time sequence with the actual events. It provides theoretical exploration for systematic research on the prediction of Terrorist attack.

2. An Advanced Black Box Model of Terror Based on the Background of the Fusion of Three Forces

The system attributes of substances determine that the object of study is a system composed of several elements. The system realizes information processing and system control through the exchange of internal and external information.

2.1. Black box principle

"Black box" refers to a system that will be destroyed if it is not opened or that the current knowledge cannot be opened[8-10].

Terrorist system is a complex giant system with black box characteristics. The black box system is isolated from the outside. The external anti-terrorism forces can not know the internal structure and mechanism of the black box system. The black-box method can be used to comprehensively investigate the input and output of terrorist system from the perspective of understanding the whole terrorist system, so as to infer the functions and characteristics of terrorist system and achieve the purpose of anti-terrorism.

2.2. ATB Model Based on Anti-terrorism Perspective

There are two types of input signals outside the ATB. The first type consists of terrorist signals, including various human, material, intellectual, and resources supported by terrorist groups. This kind of resource signal is actually existed but the anti-terrorist forces cannot know,it's black signal; the second category is the security defense information generated by the anti-terrorist forces, the combat strength, policies and regulations, and other input signals. These signals are the anti-terror white signals input to the ATB.In the ATB, the "three forces black box" generates a terrorist black signal stream by accepting the black and white signals. The terrorist black signal stream enters the terrorist pool to buffer and accumulate. It is controlled by the terrorist strategy valve to generate a certain intensity of terrorist attack white signal in the form of siphon. The ATB system is shown in Figure 1.
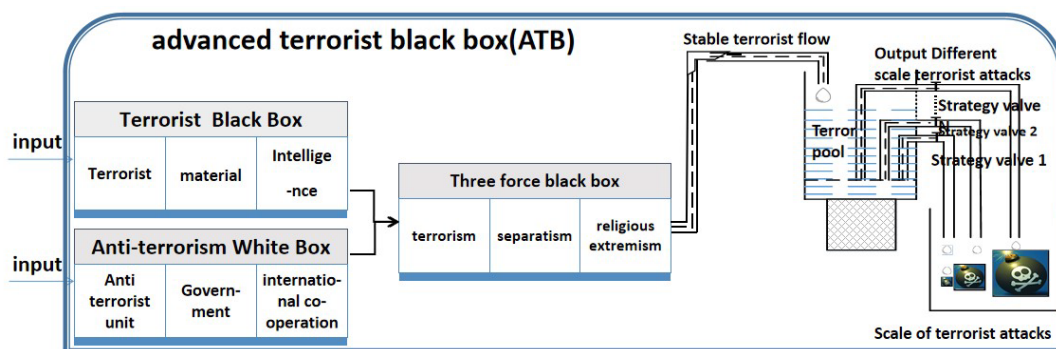

Figure 1. The advance terrorist black box system.

ATB system has two characteristics. First, the local input consists of human, material and intelligence, and the local signal may come from abroad, but the type of signal is white; second, although the internal mechanism of ATB system is not clear, but in the absence of social unrest, the terror-anti-terrorism system is a stable system, and the two sides of terror-anti-terrorism maintain the system balance through game.

Therefore, the input black and white signals of ATB system are stable, that is, the statistical law of black and white signals of "three forces black box" is constant, and there is no huge fluctuation. Terrorist black box can output stable terrorist product flow by processing stable input signals and by

means of mechanical production. Terrorist product flow eventually accumulates into terrorist attacks. Therefore, ATB system can be understood as a mechanical production system for producing terrorist products.

Therefore, the ATB system fully conforms to the characteristics of the black box principle, But ATB system is an advance black box system with black input.

3. Prediction of Terrorist Pulse Occurrence Time Based on Grey System Theory

Quantitative analysis of terrorist attacks is difficult, vulnerable to interference from international and domestic factors, and it is difficult to obtain relevant information for reasons of confidentiality. Terrorist attack prediction needs a method that can find the law through data mining under the condition of small sample, poor information and uncertainty. Grey system theory can process and mine data in the case of poor information.

ATB model points out that the output signal of the "three forces black box" is an unobservable flow of black terrorism products. The flow of terrorist products buffers through the terrorist pool to form an observable pulse of terrorist incidents. Using the available observation data and the grey system theory, the impulse law of terrorist incidents can be excavated, and the internal operation mechanism of advance terrorist black box system can be inferred, and the breaking time rule of terrorist attack impulse can be obtained.

3.1. Black box principle

Grey system theory is a new method to study the problems of minority data, poor information and uncertainty [11-14].The grey system prediction theory establishes a GM model of approximate differential equation [15-18], which has the properties of differential, differential and exponential compatibility. It regards the system as a function changing with time. Modeling can achieve better prediction effect [19-20], and achieve higher fitting and prediction accuracy without the support of a large number of data and the need for data to obey the typical probability distribution.

3.2. Time Prediction of Terrorist Attacks Based on Grey System Theory

Since 2011, there has been a high incidence of violent terrorist incidents in China. According to the National Security Research Report of China (2014), there were 10 violent terrorist incidents in China in 2013. This paper uses the data to model.Because the new information is more enlightening to the research. Therefore, this paper focuses on the analysis of the terrorist incidents since the second half of 2011. The earliest data is the attack on the Nabar police station in Hetian, Xinjiang, China, on July 18, 2011.

Table 1. Summary of terrorist attacks in the first half of 2013-2014

Numble	1	2	3	4	5	6	7	8	9
date	04.23	06.26	08.20	10.28	12.15	12.30	03.01	04.30	05.22
place	Bachu	Shanshan	Kashgar	Beijing	Shache	Shache	Kunming	Urumqi	Urumqi
Interval (day)	0	64	55	67	48	62	60	60	82
Statistics (month)	21.3	23.4	25.3	27·5	29.1	31.1	33.1	35.1	35.8
year	2013	2013	2013	2013	2013	2013	2014	2014	2014

Note: For the convenience of statistics, the monthly rate is 30 days.

Data citation thought: First, based on the background of the integration of three forces, the above incidents are launched by "three forces black box", which faction is unknown; Second, based on ATB model, the occurrence of terrorist attacks is usually a regular impulse, but under the condition of full terrorist pool, based on the disturbance of specific political factors or other related incentives, terrorist groups may adopt terrorist strategies to adjust. Terrorist attacks break away from the law of ATB model, which leads to the continuous occurrence of terrorist attacks at the same time or place. Therefore, this kind of terrorist attacks in the same area with political factors or other similar inducements are regarded as the step-by-step implementation of the same terrorist attack.Under this

principle, the time interval between two unrelated incidents is taken as the data revision standard. The two terrorist attacks that occurred in Shache County in succession within 15 days of December 2013 are regarded as a step-by-step implementation of an incident. The time interval between the previous incident and the last one is calculated from the Tiananmen terrorist attack, and the time interval between the latter one and the second Shache incident is calculated from the second Shache incident. Similarly, the events that took place in Urumqi on April 30 and May 22, 2014 during the President visits to Xinjiang, are regarded as a step-by-step implementation of an incident. The interval between the incident and the last terrorist attack is calculated from the terrorist attack at Kunming Railway Station. The revised data are shown in Table 2.

Table 2. Revised data sheet for terrorist attacks in the first half of 2013-2014

Numble	1	2	3	4	5	6	7	8	9
date	04.23	06.26	08.20	10.28	12.15	12.30	03.01	04.30	05.22
place	Bachu	Shanshan	Kashgar	Beijing	Shache	Shache	Kunming	Urumqi	Urumqi
Interval (day)	0	64	55	67	48	62	60	60	82
Statistics (month)	21.3	23.4	25.3	27·5	29.1	31.1	33.1	35.1	35.8
Revised data	21.3	23.4	25.3	27.5	29.1	Relevant	31.1	33.1	Relevant
year	2013	2013	2013	2013	2013	2013	2014	2014	2014

Note: For the convenience of statistics, the monthly rate is 30 days.

3.3. Prediction Model of Terrorist Attacks Occurring Time

Grey system theory GM (1,1) model is used to predict the time response sequence of $x^{(0)}(k) + az^{(1)}(k) = b$. If $X^{(0)} = (x^{(0)}(1), x^{(0)}(2), ..., x^{(0)}(n))$ is the time interval of terrorist attack, the time of terrorist attack accords with the grey system theory prediction condition. $X^{(0)} = (x^{(0)}(1), x^{(0)}(2), ..., x^{(0)}(n))$ is taken as the revised data, and the first six items are taken. the events of Bachu on April 23 and Kunming Railway Station on on March 1, respectively.

$$X^{(0)} = (x^{(0)}(1), x^{(0)}(2), ..., x^{(0)}(n)) = (21.3, 23.4, 25.3, 27.5, 29.1, 31.1) \quad (1)$$

$X^{(1)}$ is the cumulative generating sequence of $X^{(0)}$, Using GM (1,1) model prediction method of Grey system theory prediction , we can get the regular function of terrorist attacks in China from 2014 to 2015 as follow

$$\widehat{x}^{(0)}(k+1) = \widehat{x}^{(0)}(k+1) - \widehat{x}^{(1)}(k) = (1 - e^a)(x^{(0)}(1) - \frac{b}{a})e^{-ak}, k = 1, 2, \cdots n \quad (2)$$

reduction $X^{(0)}$, get the conclusion

$$\widehat{x}^{(0)}(k) = (21.300\,0, 23.582\,6, 25.296\,4, 27.134\,6, 29.106\,5, 31.221\,6), k = 1, 2, \cdots 6 \quad (3)$$

Table 3. Error Checklist

Numble	Actual data	Simulation data	residual	relative error
	$x^{(0)}(k)$	$\hat{x}^{(0)}(k)$		$\Delta_k = \frac{\varepsilon(k)}{x^{(0)}(k)}$ $\varepsilon(k = x^{(0)}(k) - \hat{x}^{(0)}(k))$
2	23.4	23.582 6	-0.182 6	0.07%
3	25.3	25.296 4	0.003 6	0.01%
4	27.5	27.134 6	0.365 4	1.32%
5	29.1	29.106 5	0.006 5	0.02%
6	31.1	31.221 6	0.121 6	0.39%

Sum of squares of residuals $s = \varepsilon^T \varepsilon = 0.181\,7$, So there's $\Delta = \frac{1}{5} \sum_{k=2}^{5} \Delta_k = 0.062\,9$

3.4. Prediction of the Occurrence Time of Terrorist Attacks

Prediction of the Occurrence Time of Two Terrorist Attacks after March 1, 2014 Based on Time Response Sequence $\widehat{x}^{(0)}(7) = 33.49$ and $\widehat{x}^{(0)}(8) = 35.92$, The prediction conclusion is reduced to the actual time, that is:

$$\widehat{x}^{(0)}(7) - \widehat{x}^{(0)}(6) = 33.49 - 31.1 = 2.39 \qquad (4)$$

The grey theory predicts that there will be a terrorist attack 2.39 months after the last incident (the terrorist attack at Kunming Railway Station on March 1, 2014) (May 12, 2014). History proves that two serious terrorist attacks occurred in Urumqi on April 30 and May 22, 2014. The prediction time is 10 days away from the actual time.

$$\text{Similarly} \qquad \widehat{x}^{(0)}(8) - \widehat{x}^{(0)}(7) = 35.92 - 33.49 = 2.43 \qquad (5)$$

The second terrorist attack occurred 2.43 months (25 July 2014) after the last predicted result (12 May 2014) in Kunming Railway Station. Facts have proved that a serious terrorist attack took place in Shache County on July 28, 2014. The actual occurrence time is 3 days away from the forecast time.

3.5. Analysis of Prediction Results of Terrorist Attacks Occurring Time Based on Grey System Theory

The pre-relative error of 0.0629 indicates that there is a high degree of integration among the "three forces" and that there is a correlation between the terrorist attacks launched by their branches. Therefore, in combating violent terrorist forces, we must focus on the overall development trend of the "three forces", take overall precautions and strike comprehensively.

The accurate prediction of the two terrorist attacks after March 31, 2014 shows that a series of anti-terrorist operations before May 2014 failed to fundamentally destroy the structure of the "three forces", nor to reverse the situation of the resumption of the terrorist capability of the "three forces", which still have the ability to launch violent terrorist attacks according to their own wishes and plans after being attacked. It is pointed out that in view of the situation at that time, we should make Enough troops, intensify our efforts to combat them, and reverse the trend of recovery of the ability of the "three forces" as soon as possible.

The terrorist pool model of ATB model reflects that the "three forces" will pursue the maximization of terrorist benefits by using different game strategies. Therefore, in the context of failing to defeat the terrorist forces before 2014, if a longer period of peace appears in the society in late 2014, it shows that the performance of the "three forces" is caused by the use of latent strategies, and its latent accumulated strength will be in the future. I guard against weaker time nodes and regions, and release them in the form of larger-scale terrorist attacks.

4. Conclusion

Based on ATB model and grey system theory, the prediction results of terrorist attack occurrence time are highly matched with the actual data, which shows the availability and validity of ATB model and the regularity of terrorist attack occurrence.

Acknowledgments

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