

Research on the construction of social stability early warning model based on TOPSIS and entropy weight method

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Abstract: This paper selects the data of 20 developing countries and developed countries from 2012 to 2021 as samples, and constructs a social stability early warning model based on TOPSIS and entropy weight method. The evaluation results of the social stability early warning model are divided into five grades from high to low: no police, light police, middle police, heavy police and huge police. Choose belarus as a case, the use of social stability early warning model determine belarus belongs to the police countries, combined with the model through political, economic, social and other factors four aspects points out the cause of the color revolution failure, and judge in addition to the future social stability from the police to heavy police trend, based on this to belarus from political, economic, social and other aspects. This paper has some reference significance for preventing color revolution and promoting social stability.

Keywords: TOPSIS, Entropy Weight Method, Early Warning Model of Social Stability, Color Revolution

1. Introduction

"Color revolution" mainly refers to a series of regime change events named by peaceful and non-violent means in the central Asia of the former Soviet Union at the beginning of the 21st century. In fact, the word "revolution" here no longer has the connotation of "violence" and "armed struggle" in the traditional sense, but has more specific symbolic significance.[1] Such peaceful and non-violent crisis events make it more difficult to identify crisis early warning. In recent years, social unrest and the complex international situation have left many countries to face domestic troubles and foreign invasion. Since modern times, the research on social stability indicators has gradually emerged, and the attention is increasing. The recent attack of COVID-19 has hit the economic development of more than half of the countries, aggravating the economic situation of some countries with slow or even poor economic foundations. The political intervention and sanctions of the political outside countries, the organization disputes within the country, and the political instability also affect the social stability. Under the continuous development of human society, the increasingly fierce competition, economic, political, cultural and other aspects of social factors change each other and influence each other, but once a factor appeared larger fluctuations, the interaction between factors will affect more or less affect the other factors in society, to shake the social stability, lead to social unrest or collapse. Therefore, whether it can have a social early warning system to measure social stability and judge social risks is a major social problem, and it is also the first important thing for the rulers. Therefore, how to build a more accurate and sustainable social early warning system is a fundamental problem that all countries need to reflect on and face.

As mentioned above, in a period of increasingly complex international situation, countries urgently need to establish an early warning system for social stability. How to build a set of appropriate models to accurately evaluate and predict the social stability of a country is a problem we need to face. First of all, we need to evaluate the key indicators of social stability in each country through qualitative and quantitative analysis. The threshold value of each index is obtained through the calculation of the index, and the index system of evaluating the social stability early warning is constructed. After that, we will

further select the countries or regions where the color revolution failed and led to regime change, infer the reasons for their failure or success, and judge the future trend of social stability. Finally, put forward relevant suggestions for the world to prevent color revolution and maintain social stability. Of course, the effectiveness of policies and the actual effect and impact of policy changes on various countries need to be further evaluated.

2. Study design

2.1 Hypothesis

- (1). Suppose that there is no influence such as political intervention among countries.
- (2). Suppose that there is no economic crisis.
- (3). Suppose that there is no systemic risk.
- (4). Suppose that there is no large-scale emergency.
- (5). Suppose that changes in individual factors have a limited impact on other factors.
- (6). Suppose that there are no influencing factors that cannot be quantified.
- (7). Suppose that the data we collect are all accurate.
- (8). Assuming that the weight is not influenced by subjective factors.
- (9). Suppose an index data is lower than the weight value, there must be an index data higher than the corresponding weight value.

2.2 Symbol definition

The symbols are as defined in Table 1.

Table 1: Description of the symbol setting

SYMBOL	EXPLAIN
X	Forward forward the processed matrix
Y	The normalized matrix
D	The distance (size) of any number to the largest or smallest value of the column
S	Scores before the social indicators were not normalized
V	Social indicators early warning level set
W	Scores after normalization of the social indicators
I,J	Matrix of column j in row i
M,N	And $m < i, n < j$, the number describing row i j
A,B,C,D,E	Five warning levels

2.3 Sample data

We collected the developed countries including Britain, the United States, Switzerland, Israel, Japan, South Korea, France, Australia, Canada, developing countries including China, Indonesia, India, Syria, Ukraine, Malaysia, kyrgyzstan, Georgia, Russia, Brazil, Ethiopia, a total of 20 countries. These data include GDP, GDP per capita, GDP growth rate, unemployment rate, inflation rate, total population, population growth rate, immigration number, population aging, organization, military, a total of 12 indicators of political influence. The data comes from the United Nations database, World Bank, CEIC Global Economic Database, Forelooking database, World Economic Database, Bing and Kuai Yi data.

3. Early-warning indicator system for social stability

3.1 Target system

Only a good index system can build a good model. Therefore, this paper needs to build a social stability index system to select qualitative and quantitative representative indicators that can fully reflect all aspects of social stability, and analyze the correlation and causality of each index.

In order to find out the representative indicators, combined with the studies of Yang [2], Hou [3] et al., we looked for the index system that may reflect the social stability from several large aspects. Finally, we decided to find a suitable index system from several major aspects, including economy, politics and humanities. We used some common sense and searched for materials and read them. Under the qualitative analysis of a large number of literature, we adopted a series of indicators to build a system, as shown in Table 2.

Table 2: Index system of social stability early warning model

Level 2 indicators	Level 3 indicators
economy	GDP(a hundred million)
	Real GDP percapita(yuan)
	GDP growth rate(%)
	rate of unemployment(%)
	Inflation(%)
society	Total population(a hundred million)
	population growth(%)
	Immigrate(people)
	ageing of population(Proportion of the elderly aged 65 and above)(%)
politics	Political influence(individual)
	Army(ten thousand people)
	Political influence

3.2 Index analysis

	GDP	GDP Per Capita	GDP Growth Rate	Jobless Rate	Inflation	Total Population	Population Growth Rate	Number of Immigrants	Population Ageing
GDP	1	-0.085	0.032*	-.552**	-0.065	.942**	.739**	.504**	-.796**
GDP Per Capita		1	-0.128	-.476**	-.398*	-.366*	.452**	-0.151	.577**
GDP Growth Rate			1	-0.072	-.343*	.360*	0.259	0.27	-.410**
Jobless Rate				1	0.032	-.384*	-.655**	-0.255	0.097
Inflation					1	0.064	-0.274	-0.015	-0.097
Total Population						1	.602**	.540**	-.940**
Population Growth Rate							1	.403**	-.439**
Number of Immigrants								1	-.528**
Population Ageing									1

Figure 1: Index correlation heat map

As can be seen from the figure 1, GDP shows a weak positive correlation with GDP per capita. Per capita GDP showed a weak positive correlation with the total population. GDP, per capita GDP and total population are in a weak negative correlation. The total number of population was positively correlated with the population growth rate and the number of immigrants. Political influence has a strong negative correlation with most indicators. From the correlation analysis, we can see the correlation between the indicators and the actual compliance, which proves that the setting of the indicators has a certain rationality.

4. Establishment of the early-warning model for social stability

Using the evaluation method of TOPISTS, the data is first forward, and then the data is normalized by our model. After normalization, the entropy weight method is used to find the weight of each index, that is, the proportion of the influence degree of each index. At the same time, we use the normalized data to unsystematically establish the hierarchical boundaries of social stability.

4.1 Model building

- (1) First, find the mean value of each index of each country as the index data of that country;
- (2) The number of immigrants is replaced by the immigration rate, and the number of immigrants

divided by the total number of immigrants is worth the immigration rate;

(3) The number of troops is replaced by the rate of troops, and the number of troops divided by the total number of troops is worth the rate.

In the early warning model of social stability, the TOPISTS comprehensive evaluation method is selected, so the premise of our model is the number of indicators and enough objects to compare, that is, our data should be large enough.

First, the basic score calculation formula is established by using the forward data:

$$\frac{x_i - \min(x_i)}{\max(x_i) - \min(x_i)} \tag{1}$$

The score calculation formula is to subtract the minimum value of an index divided by the maximum value of the index and the minimum value of the index. In a single index, it can be understood as a distance from a value to the minimum value divided by the distance from the maximum value to the minimum value, that is:

$$\frac{\text{The distance of } x \text{ from the minimum value}}{\text{The distance between the maximum and minimum values}} \tag{2}$$

Thus, the score of the value in the index is obtained, and in order to reflect the weight of the score more directly in the whole index system, the normalization is realized. This method represents the principle of using TOPISTS comprehensive evaluation, and when the number of indicators is large, we also change on its underlying model.

After obtaining a forward matrix of row i and column j , namely a forward matrix composed of i evaluation objects and j data indicators:

$$x = \begin{bmatrix} x_{11} & \cdots & x_{1j} \\ \vdots & \ddots & \vdots \\ x_{i1} & \cdots & x_{ij} \end{bmatrix} \tag{3}$$

In order to remove the influence of the class, we standardized the data of this matrix as follows:

$$y = \frac{x_{nm}}{\sqrt{\sum_{n=1}^i x_{nm}^2}} \tag{4}$$

Y is the standardization treatment value, so the standardization matrix can be obtained:

$$y = \begin{bmatrix} y_{11} & \cdots & y_{1j} \\ \vdots & \ddots & \vdots \\ y_{i1} & \cdots & y_{ij} \end{bmatrix} \tag{5}$$

After the standardization process, we used the same method above to solve the score of the evaluation object. Due to the matricization of the data, our scoring formula also changed. First, we had to find the maximum and minimum values of each column, namely:

$$\text{Maximum metric value } y^+ = (y_1^+, y_2^+, y_3^+, \dots \dots y_j^+) \tag{6}$$

$$\text{Minimum metric value } y^- = (y_1^-, y_2^-, y_3^-, \dots \dots y_j^-) \tag{7}$$

To obtain a distance formula for any evaluation object to the minimum and maximum objects:

$$d_m^+ = \sqrt{\sum_{n=1}^j (y_n^+ - y_{mn})^2} \tag{8}$$

$$d_m^- = \sqrt{\sum_{n=1}^j (y_n^- - y_{mn})^2} \tag{9}$$

So we can get the unnormalized score formula for the calculated object:

$$s_m = \frac{d_m^-}{d_m^+ - d_m^-} \tag{10}$$

Finally, the relevant early warning rating set v_h is formulated according to the normalized score data.

4.2 Solution of the model

Then, the data are standardized according to the above method of building the model. Finally, the above model is used to obtain the normalized values, which are illustrated as shown in the figure 2 and Table 3 below:

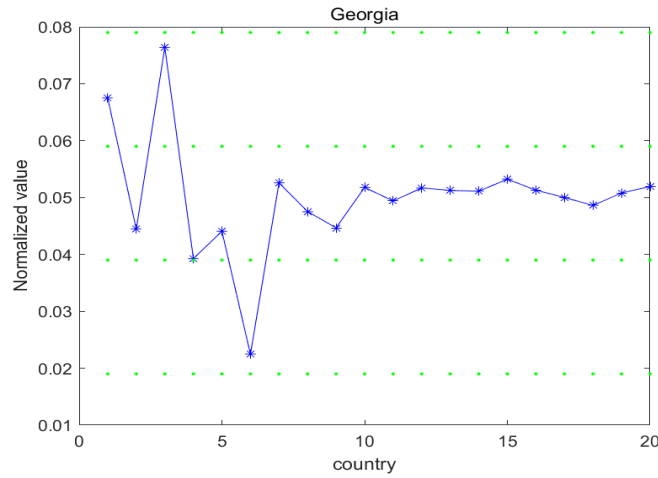


Figure 2: Statistical plots of the normalized numerical fold lines

According to the normalized data we obtained, we divided the warning level into five levels, namely $h = (A, B, C, D, E)$ [4]

Table 3: Early warning level classification table

$h(h=A,B,C,D,E)$	Normalized scores for social stability indicators
A:No	[0.08-0.10]
B:Light	[0.06-0.79]
C:Middle	[0.04-0.59]
D:Heavy	[0.02-0.39]
E:Giant	(0.00-0.19]

5. Early warning analysis of Belarus society

5.1 Social stability early warning assessment and analysis

We took Belarus as the research object, and used the social stability warning model to evaluate its social stability, and finally got its $w=0.042621$, which corresponds to our warning level, which is the middle police and close to the heavy police, as shown in Figure 3.

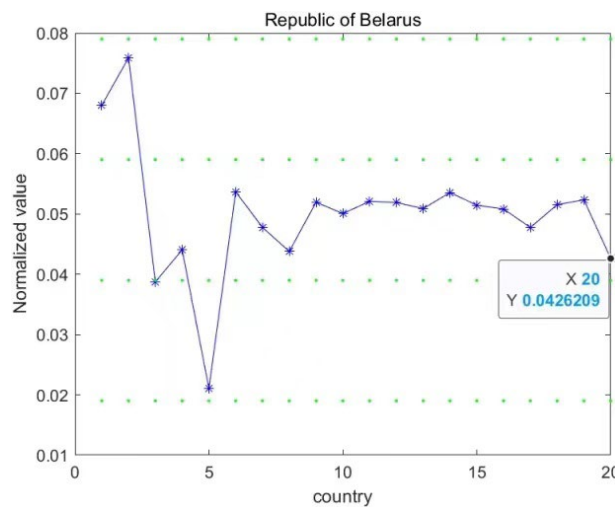


Figure 3: Normalized model after addition of Belarusian data

In order to directly reflect the indicators on the main cause of the social instability, we will bring the belarus data, using our model and entropy weight method, find the weight after join belarus data, because our index after positive, the higher the better, but with the weight compared with the weight can be found before some indicators of the weight is significantly smaller. The following are our subtracted line charts and the data, as shown in Figure 4 and Table 4:

Table 4: Subtracted weight data

index	The original weight	The difference in weight
GDP(a hundred million)	0.3882	0.0134
Real GDP percapita(yuan)	0.2285	0.0027
GDP growth rate(%)	0.0338	-0.0018
rate of unemployment(%)	0.0648	-0.0045
Inflation(%)	0.0274	-0.0002
population growth(%)	0.0281	-0.0019
Immigrate(people)	0.0246	-0.0016
ageing of population(Proportion of the elderly aged 65 and above)(%)	0.0272	-0.0018
Parties (individual)	0.033	-0.0022
Military rate	0.0423	-0.0029
Political influence	0.1022	0.0007

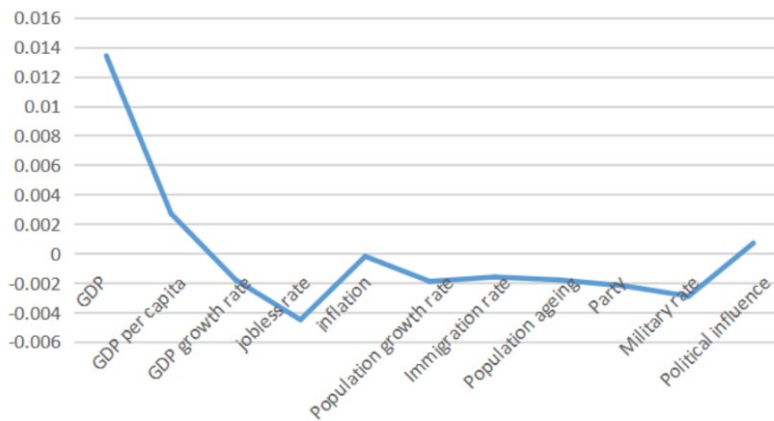


Figure 4: Line plot of the difference between the Belarusian weight value and the new weight value and the weight value

Through the analysis of the weight we found that the GDP growth rate, unemployment rate, inflation rate, population growth, inflation, population growth, population aging, organization, immigration rate of these index weight are dropped, but because we are positive after the data, so these indicators are rising, and the rise of these indicators, also can see from the data intuitive these are the cause of color revolution. At the same time, the indicators of political influence have also declined, so Belarus's society is very unstable.

5.2 The main reason for the failure of the color revolution

(1) Economic aspect

Belarus has enjoyed good economic development and its people's living standards are high. Belarus is a country that rapidly drives economic growth through the oil processing industry. In addition, the Belarusian government authorities have implemented high welfare social policies, and the people are highly satisfied with life.

(2) Political aspects

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(3) Social management

During the period of the outbreak of color revolution in various countries, Belarus put forward timely measures to strictly prevent "color revolution", and introduced a series of laws and regulations to prevent "color revolution", such as cracking down on non-governmental organizations in China and severely punishing those who encouraged social riots, with a strong sense of prevention. In addition, Belarus has implemented a new Internet management method, paying close attention to the development of information and limiting the riot activities of the opposition, so as to stop all activities that hinder the general election in time.

(4) Other aspects

The vast majority of Belarus people advocate peace and stability and are unwilling to have a civil war. Although Belarus is also a multi-ethnic country, there is no ethnic opposition and division in Belarus. Most of the ethnic groups share the same origin, and there is no sharp cultural conflicts and contradictions. In addition, Belarus is also very stable outside, with the support of Russia and the CIS countries, with good diplomacy.

5.3 The future trend of social stability

In the future, Belarus is bound to face intense pressure from both the EU and Russia, neither of which will give up on the fight for Belarus. Political external pressure has also affected people's confidence in the Belarusian president, and their approval ratings have begun to fall. In terms of economy, the development of Belarus in economy and people's livelihood has begun to go backwards, which has made the people tired of the Belarusian government, and the public support rate has been declining. At the same time, as the impact of COVID-19 has intensified public dissatisfaction, the economy and people's livelihood in the country need to be improved as soon as possible in the post-epidemic period. However, the existing problems in Belarus are all long-term problems, which are difficult to be solved in a short time. According to the collected data, economic development and people's livelihood employment have shown an obvious downward trend in recent years. With global oil prices falling, the oil industry, on which Belarus is supported, has also been hit. In addition, there is also a serious problem of gender discrimination in Belarus. To sum up, the development of Belarus is still difficult in the future, and the social stability index will decline.

5.4 Suggestions for early warning in the Belarusian society

First, focus on solving the economic problems in the post-epidemic period. At the beginning of the COVID-19 outbreak, the Belarusian president of Belarus failed to take any blockade measures, but for the sake of economic development and employment promotion, leading to the severity of the COVID-19 epidemic in Belarus, the economy did not advance or retreat, causing the people's dissatisfaction with the government. Therefore, Belarus needs to spend more time on economic issues, stimulating employment and promoting economic development. Instead of unilaterally relying on industry and oil, new economic support policies should be added to mitigate the impact of the epidemic.

Second, political aspect: the main trigger of the "color revolution" is foreign intervention in politics and the cultivation of opposition at home to find the right time to carry out anti-government activities. Therefore, on the one hand, Belarus should always remain vigilant against the political intervention of external countries and limit the activities of Western NGOs. On the other hand, we should raise the people's information to the government and public support, think more about people's livelihood and fight corruption and build integrity. Actively weaken the strength of the opposition, and promptly curb the development of small riots into mass protest violence. At the same time, Belarus needs to choose the right diplomacy to avoid putting itself in a dilemma and becoming a second Ukraine.

Third, social management: In the era of information diversification, Belarus has strengthened the management of information, adopted some intelligent innovative programs to prevent and respond to potential threats, strengthened the construction of infrastructure, guaranteed urban security, and improved social welfare security.

Fourth, other aspects: On the one hand, many long-term problems in Belarus still need to be solved. The Belarusian government should pay attention to the issue of gender discrimination, timely adjust relevant policies, and avoid the rise of the gender issue as a political problem, which becomes one of the reasons for the political instability. On the other hand, strengthen the political education of the new generation of Belarus, realize the change of the people's ideas, and timely adjust the policies of the authorities based on this change.

6. Suggestions on maintaining social stability

We combine the interrelationship of the various index systems, the established social stability index system and the literature, and give suggestions from the political, economic, social and other four aspects.

6.1 Political aspects

(1) Identify the critical political period and be alert to domestic and foreign political issues. Governments of all countries should adhere to the overall national security concept, recognize the nature of color revolution, identify the political critical period, legislate to restrict the activities of NGOs in their own countries, and be alert to political problems at home and abroad.

(2) Improve the governance ability and ensure political stability. Political stability is conducive to promoting the sustainable development of the economy and society, and improving the public support rate and satisfaction rate. Therefore, the ruling parties of all countries should improve their governing ability and constantly promote the modernization of national governance, rather than copying the development experience of other countries, adhere to the national status, find a development path suitable for their own countries, seek benefits for the people, and ensure political stability.

(3) Properly handle relations with the opposition. Treat the opposition accordingly according to the situation of your own country. Strict measures should be taken to crack down on the excessive behavior of the opposition parties, and even strictly restrict the activities of the opposition, and implement a strict registration system and activity approval system for the opposition and organizations.

(4) Strengthen the control of the military, police and other departments. Presidents should have effective control over the military as a guarantee of national peace and stability and prevent inaction or even support for the opposition when a rebellion occurs. Strictly enforce military discipline, strengthen control, raise requirements, and prevent corruption within the military, police and other forces.

6.2 Economic aspects

(1) Economy is the foundation, and vigorously develop the economy is the fundamental essence. Although on the surface, the beginning of the color revolution is all political factors, but politics and economy are inseparable. The economy is strong enough, the politics is stable enough, and it is even more difficult to be influenced by the color revolution.

(2) Key economic resources should be in the hands of the state. Clarify the strategic position of state-owned enterprises, grasp the core position in the basic and pillar industries, improve the system construction of state-owned enterprises in [5], and improve the ability of international business management. Looking for a more sustainable and long-term economic development model, rather than just relying on the past, a single economic model to develop.

6.3 Social aspects

(1) Focus on the development of the population and timely adjustment. Too much or too little population relative to national resources will cause economic problems. The rapid growth of population is not adapted to the level of economic and social development, and the country's development is slow, but the less population is not the better. Talent is also one of the resources of national development, and the low population cannot provide sufficient follow-up labor force for the sustainable development of domestic economy and society. Improve the education level and narrow the gap between urban and rural areas.

(2) Education is an important foundation for a country's development, and people's livelihood is an important aspect of improving the quality of people's lives. On the one hand, improving the level of education is conducive to the cultivation of talents and the national economic construction. On the other hand, it is conducive to improving citizens' political literacy and providing help for the work of the government. The gap between urban and rural areas has always been a long-standing problem in many countries. With the mismatch of resources and the large population gap, education is a good breakthrough. Narrow the gap between urban and rural areas, can better improve economic benefits and stabilize the society.

(3) To stimulate employment and reduce poverty. Poverty is the most social problem of all the social problems. The increasing number of unemployed people is also a major problem plaguing the social

development of the CIS countries. There are various factors contributing to the growth of unemployment: large-scale privatization, economic recession, business collapse, free population migration and the imperfect labor security system. At present, there are still many imperfect places in the labor employment and unemployment security system, and the imperfect system also has a negative impact on the employment and wage structure of workers. Therefore, all countries should pay attention to employment and reduce poverty.

6.4 Other aspects

(1) Grasp the domestic media, guard the public opinion position. Since the 21st century, the Internet, as a tool to promote the "change of dynasties", has played a more and more prominent role as an "incubator" and "booster" in the "color revolution". In particular, the Internet penetration rate and the number of young Internet users are increasing, and the huge political propaganda and political mobilization function of the network have been repeatedly confirmed by the practice of "color revolution". There is no substitute for the role of the media in regime change [6]. For the ruling organization, the release of public opinion means the beginning of the loss of power. Therefore, countries should firmly grasp their own media to prevent public opinion from getting out of control.

(2) We should properly handle ethnic and regional contradictions and achieve consistent external relations. There have always been complex ethnic and regional contradictions, which are not properly solved for a long time, and will become an important problem restricting the development of the country. We should correctly handle policies and measures among the people, clearly distinguish the nature of contradictions, grasp the boundary between ethnic and non-ethnic issues, strengthen the construction of ethnic legal systems and laws and regulations, and establish an effective mechanism for dealing with emergencies. Problems within the nation are solved internally, preventing other countries from intervening, and being externally when the country is generally threatened by foreign countries.

7. Model evaluation and further discussion

The main advantages of this model are as follows: (1) using the TOPISTS comprehensive evaluation method, The index system is obvious, Operations for small datasets, We can quickly process the data set; (2) The TOPISTS method does not have many limitations on the size of the data set, Strong placibility, Data processing is more regular; (3) The entropy weight method fails to consider the horizontal relationship between the indicators, But we addressed this deficit using Pearson's correlation analysis, Intuitively reflects the horizontal relationship between indicators. (4) For the weight evaluation of each index of the evaluation index system, we adopt the entropy weight method. Directly reflects the weight of each index, Can intuitively reflect the influence degree of each index. However, there are also some deficiencies. Subsequent research can be improved. (1) The data of each index required by the TOPISTS method, and the data collected of these indicators and the amount of data collected will affect the results; (2) we use the entropy weight method to establish the weight of each index, but ignore the importance of the index itself, which will produce certain errors.

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