Problem Chosen	2023HSB MCM/ICM Summary Sheet	Team Control Number
B		MI01297

Stable or not, that's a Question!

Summary

Stability is a prerequisite for development; however, in recent years, due to global epidemics and color revolutions, how to ensure social stability and provide early warning before sudden changes in stability has become a focus of attention in various countries. Therefore, this paper establishes a set of indicators that can measure the degree of social stability, based on which a social early warning model is built. At the same time, we summarize and make suggestions based on the use of the model.

In order to measure the degree of social stability, we first used **McKinsey logic tree** analysis to identify all necessary indicators, and then combined the advantages of **Analytic Hierarchy Process** and **Entropy Weighting Method** to calculate the combined weights, so as to quantitatively determine the impact of changes in indicators. Since everything is connected, we calculated the **Spearman correlation coefficients** between the indicators and plotted the coefficients, from which we found that most of the indicators in the subsystem have a strong relationship with each other.

After that, the social stability early warning model **(SREAM)** is developed based on Task 1. Since different indicators have different scales, we use the transformation methods such as **Polar Difference Transformation** to forward them and thus derive the indicator score intervals. Secondly, the formula for calculating the social stability index (SSI) is constructed by using the weighted summation method. Finally, the index scores and index weights are used to classify the warning levels.

Next, we first assessed the social stability of Belarus using SREAM and concluded that the overall stability of Belarusian society is high, and combined with the indicator mixture chart this concluded that social control is the main reason for its social stability, and the important reasons for the **aborted color revolution** are its emphasis on economic development and people's welfare, anti-corruption, unity of internal ethnic groups and friendly and active diplomacy; after that, we used the **Grey Model** to obtain its continued positive future social stability and make three related recommendations.

We then used SREAM on Ukraine to explore the reasons for its regime iteration, and we found that its SE had a great impact on the overall social stability, concluding that the main reasons for its regime iteration were **internal government government inaction**, party rivalry and other problems that seriously affected the trust of the people and the development of the economy, while external hegemonic forces pushed the envelope.

Based on the above four issues, we propose specific prevention suggestions for the causes of color revolutions in four areas: **economic development, ideological leadership, government action, and ethnicity and religion.**

Keywords: EWN ;Grey Model; Color Revolution; Social Stability

Contents

1 Introduction

1.1 Problem Background

What is social stability? According to Parsons' theory of social action, social stability refers to the coordination or coupling between the subsystems of a social system.[1] The social system consists of economy, polity, community and value system, and each subsystem of the social system performs its own functions - adaptation, goal acquisition, integration, pattern maintenance and tension management.

Why is it necessary to discuss and study this issue at the time when peace is the theme of the era? The reason is simple: for a better development. Although the current international situation remains generally peaceful and stable, the localized wars, turmoil and tensions have increased.

At the beginning of this century, color revolutions were constantly got on the stage of history to achieve their own goals by striking the weakest link of social stability, inciting and creating an atmosphere of uneasiness.At present, the international and regional situation is undergoing profound and complex changes, the evolution of the world's unprecedented changes in a century has accelerated, and the instability and uncertainty of the international situation has increased significantly. In the past year, regional local conflicts continue, hot war smoke, the crisis in Ukraine stings the global geopolitical nerve; the game of major powers intensifies, cold war thinking, some countries around the gang, threatening regional peace and prosperity. The culprit that overthrows a country is instability, and only under the premise of social stability can we focus on solving various discordant problems in economic and social development.

Therefore, it is of realistic urgency and practical significance to establish a reliable indicator system to measure social stability, to study the connection between indicators, and on this basis to provide early warning of sudden changes in social stability by establishing a social early warning model.

1.2 Restatement of the Problem

Considering the background information and restricted conditions identified in the problem statement, we need to solve the following problems:

- **Task 1:** Since a social stability indicator system is an important prerequisite and foundation for social early warning, this paper first needs to select representative indicators and establish an indicator system that can influence social stability from both qualitative and quantitative aspects.
- **Task 2:** Based on Task 1, a social stability early warning model is developed and the synergistic operations, constraining effects and other interactions within the indicators are discussed.
- **Task 3:** Assess the social stability of a country or region where a color revolution has failed by using the model developed in Task 2 and determine its future trends.
- **Task 4:** Analyze a country or region where a color revolution succeeded by using

the model built in Task 2 and summarize the main reasons for its regime change。

- **Task 5:** Based on the four tasks above, summarize and make recommendations to prevent color revolutions.

1.3 Literature Review

The system of social stability evaluation indicators has emerged in the United States since the 1960s, and the research of foreign scholars has been divided into three stages: the stage of "economic indicators dominated", the stage of integration and systematization of indicators, and the stage of empirical warning of national crises. The main representative theories of each stage are the "Harvard Prosperity Index" and the "Advance Index" calculated by the U.S. Department of Commerce, the "Flanders Index" proposed by Hanher, the "National Crisis Level Index" proposed by Z. Brzezinski in 1989, etc.[2] The design of the index system has been gradually systematized and comprehensive, and more emphasis has been placed on empirical analysis.

Although the relevant domestic research is later than the foreign development, it is also emerging with the development and transformation of the society. Based on the national situation and foreign scholars' research, the following three research results have been obtained, including the mechanism research of social early warning system, the establishment of social stability index system and the construction of early warning model. The representative theories and achievements include Yan Yaojun's "Social Stability Physical Model" and the corresponding social stability indicator system, Song Linfei's "Social Risk Early Warning System" (SREWS) in 1989, and Niu Wenyuan's "In 1989, Linfei Song proposed the Social Risk Early Warning System (SREWS) and Wenyuan Niu proposed the Social Burning Theory and its social stability early warning system.

Despite the fruitful research at home and abroad, there are still problems such as the linkage between indicators from various disciplines needs to be further linked, the subjectivity of indicator selection and system establishment, and data availability. These are the directions that academics need to continue to explore and study in depth.

1.4 Our Work

With the above elaboration of the problem context, the problem statement of understanding and the summary of the existing literature, we need to go through the following tasks：

1. First, the selection of indicators was based on the review of a large amount of literature and the reasons for the occurrence of color revolutions.Secondly, the calculation of the weights of the first-level indicators was performed using **Analytic Hierarchy Process**, and for the evaluation of the weights of the second-level indicators, the **Entropy Weight Method** was used. Finally, **Kendall's correlation coefficient** and **Spearman's correlation coefficient** were used to study and explore the correlation and causality between the indicators.
2. To build an early warning model of social stability, we use **structural equation modeling** to conduct the study. At first, the model is constructed based on the theory,

based on which the research hypothesis is proposed and the operational definition of variables is performed.Then, the model is tested for credibility after collecting sample data.What's more, the model fitness is then tested using Amos and the model is revised and iterated.Eventually, the path coefficients are analyzed and the hypotheses are tested based on the results of the analysis.

3. Use the established early warning model to evaluate the social stability of the selected countries and regions, draw relevant conclusions and predict the future development trend.
4. Based on the above study, propose feasible suggestions for preventing color revolutions.

For convenience, we draw a flow chart (**Figure 1**) to represent our work.

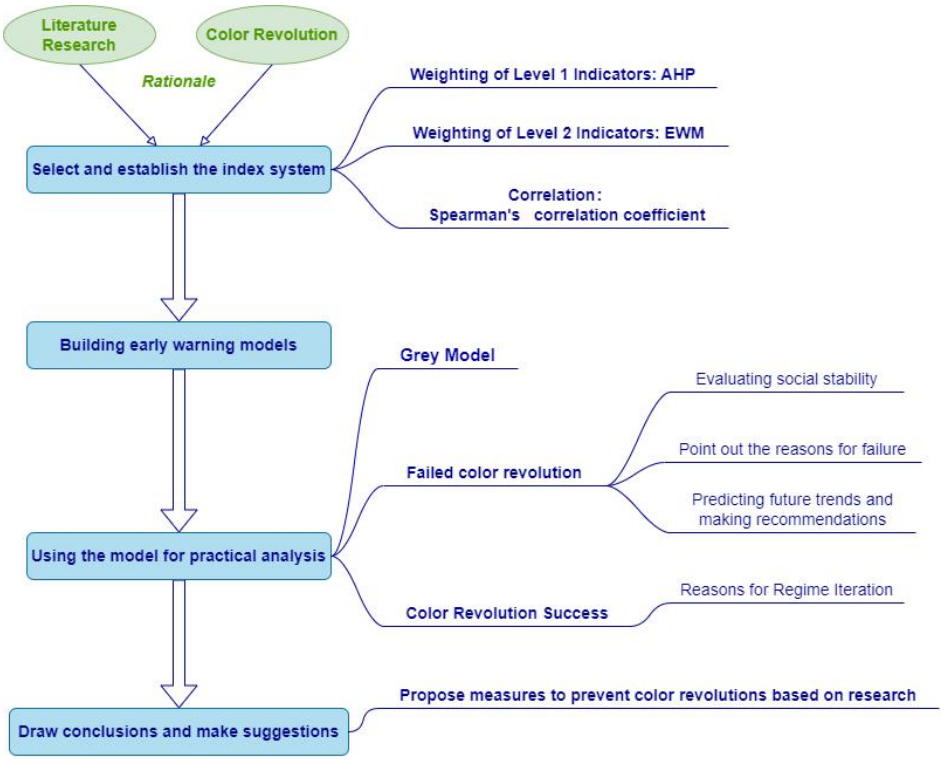

Figure 1: Flow chart of our work

2 Assumptions and Justifications

To simplify the problem, we make the following assumptions, each of which is properly justified:

- **Assumption : When establishing the early warning model to measure the level of social stability, indicators that are relatively unimportant are neglected.**
  - ✧ **Justification:** According to the Pareto principle, for many outcomes, about 80% of the results come from 20% of the causes. To assess social stability, we concentrate on the key components of causes and use key performance indicators to assess the level of stability.
- **Assumption : Our data sources are reliable and accurate.**
  - ✧ **Justification:** Since our data comes from international data sites, we assume

that the data is reliable. On this basis, objective and accurate results can be obtained by applying the data to the establishment of our model.

- **Assumption: Expert scoring does not distinguish between the professional level of experts.**
  - ✧ **Justification:** In AHP, there will be several experts to score, whose professionality is assumed to be identical.

3 Notations

The key mathematical notations used in this paper are listed in Table 1.

Table 1: Notations used in this paper

Symbol	Description
x	indicator data
e	information entropy of the indicator
ω	weight of the indicator
V	indicator score value
SSI	social secure index

4 Social Stability Index System

4.1 Indicator Selection

A review of a large body of literature yielded six major domains that affect the stability of a society: ***Subsistence Security, Economic Support, Social Distribution, Social Control, Social Psychological , and External Environment***. Within these six domains, each of the primary indicators is subdivided into many subfactors and indicators. In our model, we use McKinsey logic tree analysis to select several important indicators to estimate the degree of stability and risk in a society. The selected indicators are shown in Figure 2.

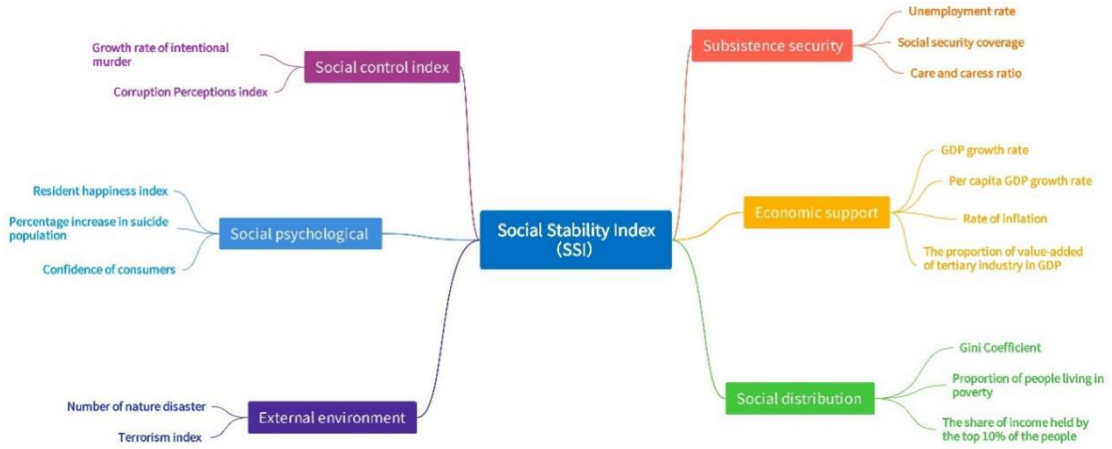

Figure 2: Indicators selected by McKinsey logic tree analysis

- **Subsistence Security**

Social security is the most basic of the six systems. Human society is a social system of survival that must meet and guarantee the conditions of survival in order for society to

maintain its stability. Under this area, we have mainly chosen unemployment rate, dependency ratio and social security coverage for our main analysis.

The unemployment rate reflects the employment situation and the security of individual survival conditions in a period of time. A too high indicator means that on the one hand the number of people with insecure income is increasing and on the other hand it means that the number of people with nothing to do is increasing, all of which will be harmful to social stability.

Contribution ratio is the ratio of the number of contributors to the number of recipients, which mainly reflects the degree of burden on contributors, and we tend to think that the smaller this index is the more burdened the whole society is and the stability is challenged.

The higher the index, the more people are covered, and the more stable the society.

- **Economic Support**

Economic support is the first area of study in this field, which not only provides the material basis for human existence, but also plays a decisive role in the superstructure. In this field, we have chosen four main indicators: GDP growth index, GDP per capita growth index, inflation rate and the share of tertiary sector value added in GDP.

The GDP growth index reflects the change in the overall economy of a country or region from one year to another. A positive index indicates that the economy is expanding and a negative index indicates that the economy is in recession.

The GDP per capita is a measure of the living standard of the people in each country, and when the living standard of the people increases, the society tends to be stable.

Inflation rate reflects the general level of prices, which affects people's purchasing power and thus their normal life, and has a negative impact on both production and economic aspects, so the index is not good if it is too high or too low, which will have a negative impact on social stability.

The great change in the proportion of GDP accounted for by the tertiary sector indicates that the economic structure will take place and the society will enter a stage of transformation, thus having a certain impact on social stability.

- **Social Distribution**

The most prominent and sensitive in the operation of social stability, and the most difficult to deal with, is the issue of social distribution. To show that most of the colors, among the reasons for the occurrence of revolutions are the problem of social distribution inequity. We have chosen the Gini coefficient, the proportion of poor people, and the share of income owned by the richest 10% for our main study.

The Gini coefficient reflects the class gap and measures the unfairness of income distribution in a region or a country, with values ranging from 0 to 1.

The higher this index is, the more backward the country's development is, the more difficult it is for residents to maintain basic survival, and the less stable the society will be.

The share of income held by the top 10% of the wealthiest people reflects the concentration of wealth and income inequality. Within a certain range, we expect this index to converge to a stable and reasonable value.

- **Social Control**

The Social Control Index reflects the ability to regulate and coordinate the stable functioning of society. The growth rate of intentional homicide reflects the stability of a society, the security of social services and the credibility of the police, and the lower the index, the more equal the society is, the smaller the gap between rich and poor, and the more stable the society is. A high integrity index is conducive to the prevention of political corruption and contributes to social stability, and is positively related to social stability.

- **Social Psy-chological**

Now after entering the multipolar stage, no nation or country can seek social stability in a closed country, and both nature and external domains can play a disturbing role in the degree of social stability. We have mainly chosen infiltration in the form of terrorism and armed intervention forces as the main factors of study. With reflecting the degree of control of society over unexpected situations and the degree of social vigilance, the indicator we expect to be in a balanced and stable state.

- **External Environment**

People as social animals and social psychological conditions depend on the actual social life and affect the social climate, positive psychological conditions are conducive to promote social stability, and vice versa, social stability regression. We have selected two main pairs of opposite indicators, one is the happiness index and the other is the suicide rate. The happiness index is a barometer of the psychological condition of the society, which can reflect the people's satisfaction with their lives and the development and stability of the society. The salad, on the other hand, reflects the stressful situation of people's lives as well as the availability of culture and education and medical coverage, and we hope that the lower the index is, the better.

4.2 Weight Determination

4.2.1 Determine the weight of the first-level indicators by AHP

First, according to the literature reading and topic background screening to obtain the first-level indicators, reference is made to Yan Yaojun[1] on all levels of indicators for the construction of the judgment matrix, before formally using the judgment matrix for weighting, we use the formula for its consistency test:

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{1}$$

Find the corresponding average random consistency index RI=1.26, The consistency ratio CR =0.0729<0.1 is calculated, and the consistency of the judgment matrix is considered to be acceptable. The maximum eigenvalues of the consistent matrix and its corresponding eigenvectors are found, and the eigenvectors are normalized:

$$(\lambda E - A)\omega_o = 0 \tag{2}$$

The weights of the indicators can be obtained in the following order:

$$\omega_i = [0.28580586\ 0.1720696\ 0.1345696\ 0.1345696\ 0.13841575\ 0.1345696] \tag{3}$$

4.2.2 Determine the weight of the second-level indicators by EWN

Entropy weight method is an objective assignment method, and its calculated weight has

the information entropy of the index to determine, that is, the expectation value of the amount of information, the greater the information entropy, the more significant it is in the evaluation. Therefore, in calculating the SSI, we use EWN to determine the secondary indicator weights.

Since our data come from several databases, including the World Macroeconomic Database, the World Economic Development Database and the World Major Economies Database, there are missing values and some outliers in the data. Therefore, we first identified the dirty data in the massive data and performed a series of data cleaning processes such as removing, filling, and correcting.

Based on the accuracy and volume of data, we obtained data indicators from 174 countries and regions for the last 20 years, which can be divided into positive and negative indicators. The increase of positive indicators represents a positive effect on social stability, while the negative indicators are negative.

A matrix was obtained by forwarding the 8 evaluation indicators for these 84 objects as follows:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \tag{1}$$

Normalization of this matrix is performed by applying Eq2.

$$z_{ij} = \frac{x_{ij} - \min\{x_{1j}, x_{2j}, \cdots, x_{nj}\}}{\max\{x_{1j}, x_{2j}, \cdots, x_{nj}\} - \min\{x_{1j}, x_{2j}, \cdots, x_{nj}\}} \tag{2}$$

After obtaining the non-negative matrix the calculation of the probability matrix P is carried out and the formula for each element in P is as follows:

$$p_{ij} = \frac{z_{ij}}{\sum_{i=1}^{n} z_{ij}} \tag{3}$$

Easy to verify : $\sum_{i=1}^{n} p_{ij} = 1$, that is, the probability sum corresponding to each indicator is guaranteed to be 1. Then,the information entropy can be obtained from Eq.7:

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^{n} p_{ij} \ln(p_{ij}) \ (j = 1,2,\cdots,m) \tag{4}$$

If pij = 0, plug Eq.8 into Eq.7:

$$\lim_{p_{ij} \to 0} p_{ij} \ln p_{ij} = 0 \tag{5}$$

Based on the information entropy e_j, the weight of each indicator could be calculated by Eq.9 to Eq.10

$$d_j = 1 - e_j \tag{6}$$

$$W_j = d_j / \sum_{j=1}^{m} d_j (j = 1,2,\cdots,m) \tag{7}$$

4.2.3 Calculation of the Comprehensive Weights and Composite Score

The SSI model is used to measure the social stability of a country or region, and we multiply the above weights with the following formula to obtain the combined weight of a particular indicator:

$$\omega_{ij} = \omega_i \omega_{j|i, i=1,2,3,4, j=1,2,\cdots,n_i} \tag{1}$$

- ✧ $\omega_{j|i}$stands for second-level indicator given the weight of first-level indicator.
- ✧ ω_{ij}stands for weight of the second-level indicator given the weight of SSI.
- ✧ n_i stands for the number of second-level indicators in the ith first-level indicator.

We assign weights to each indicator based on the discussion above, and the final result calculated by the two methods is shown in the following **Figure 3**:

	Indicators(I)	Weights（ω_i）	Indicators(II)	Weights($\omega_{j\|i}$)	Weights（ω_{ij}）
Social Stability Index（SSI）	Subsistence security	0.2858	Unemployment rate	0.0793	0.0227
			Social security coverage	0.7104	0.2030
			Care and caress ratio	0.2103	0.0601
	Economic support	0.1721	GDP growth rate	0.0556	0.0096
			Per capita GDP growth rate	0.0448	0.0077
			Rate of inflation	0.8775	0.1510
			The proportion of value-added of tertiary industry in GDP	0.0220	0.0038
	Social distribution	0.1346	Gini Coefficient	0.2984	0.0402
			Proportion of people living in poverty	0.1042	0.0140
			The share of income held by the top 10% of the people	0.5974	0.0804
	Social control index	0.1346	Crime rate of intentional murder	0.1402	0.0189
			Corruption Perceptions index	0.8598	0.1157
	Social psychological	0.1384	Resident happiness index	0.5067	0.0682
			Confidence of consumers	0.2999	0.0260
			Percentage increase in suicide population	0.1934	0.0404
	External environment	0.1346	Number of nature disaster	0.1531	0.0212
			Terrorism index	0.8469	0.1172

Figure 3: Index and its Weight

4.3 Correlation Discussion

Everything in the world is universally connected, and the different parts and elements within anything are interrelated, so is the system (SSI) we have established. The following will explore the correlation using China as an example, We obtained its correlation coefficient plot by calculating the Spearman correlation coefficient as follows:

	UR	SSC	CCR	GPR	PGR	TIP	GNC	PIP	I10	IMR	RHI	COC	SPP	NND	TI
UR	1.000						0.680			0.682			0.726		
SSC		1.000	-0.838	0.901	0.884	0.806	0.752	0.906	0.617	0.865		-0.818	0.861	0.778	
CCR			1.000	-0.779	-0.771	-0.636	-0.703	-1.000	-0.814	-0.615		0.714	-0.667	-1.000	
GPR				1.000	0.996	0.925	0.830	0.991	0.991	0.962		-0.846	0.940	0.976	
PGR					1.000	0.918	0.841	0.973	0.856	0.951		-0.829	0.929	0.929	
IR									0.633						
TIP						1.000	0.728	0.818		0.879		-0.754	0.842	0.881	
GNC							1.000	0.735	0.830	0.901		-0.628	0.927		
PIP								1.000			-0.618				
I10									1.000		-0.823				
IMR										1.000					-0.626
NND														1.000	0.833

Figure 4: Correlation Coefficient Graph

Survival security is the most basic system, on the one hand, it is the vane to measure the living standard of the people, improve the quality of workers and promote social reproduction on the basis of ensuring people's food and clothing; on the other hand, the system also needs to obtain energy from the outside world, for example, it needs material support from the economic system and is bound by the psychosocial and other systems, while receiving protection from the social control system in times of crisis.[3]

Economic support system is the cornerstone of the stable operation of society. Only on the basis of economic development is it possible to truly achieve social stability. The economic foundation determines the superstructure, and the economy provides material energy for the whole social system, which has a profound impact on the social distribution system and the social psychological system. At the same time, it is also constrained by other systems, such as the institutional constraints of the social control system and the support of the survival security system, etc.

Social distribution is the bridge between economic support and survival security. The mode of production of economic society determines the object and mode of social distribution, without economic output, there is no way to talk about distribution; and the form in which members of society participate in the distribution of economic products depends on what kind of social form they participate in production. The social distribution system has a counteraction to other systems through the social psychological system - a fair and reasonable social distribution produces a positive function, and vice versa a negative function.

Social control system is the "traffic policeman" who maintains the healthy functioning of society. It provides organizational energy and spiritual motivation for all systems, including the economic support system. He promotes the coordination and balance among all systems of society through hard and soft means. However, the economic support system is needed to provide material energy, and it needs to fit with the psycho-social system, and it must function in cooperation with other systems.

Psycho-social system is a mirror, and its condition is completely determined by other systems, and this reflected "mirror image" will also be reflected in other systems. On the one hand, the operation of all systems will be reflected in the social psychology to varying degrees, for example, in times of economic depression, the social psychology is generally negative; on the other hand, what has been rooted in people's psychological level will also have a great influence on the operation of other systems through spiritual, emotional and ideological activities, for example, during the war against Japan, the patriotic spirit will promote social development in the direction of stability.

External environmental system is an external disturbance that changes the internal system composed of the above-mentioned systems, and it acts as a magnifying and reducing glass for the variables of the internal system of social stability. External factors with malicious intent act as a trigger and blower to turn bad factors, such as negative social opinion, into bigger problems, while good factors are suppressed and erased; well-intentioned external factors do the opposite.

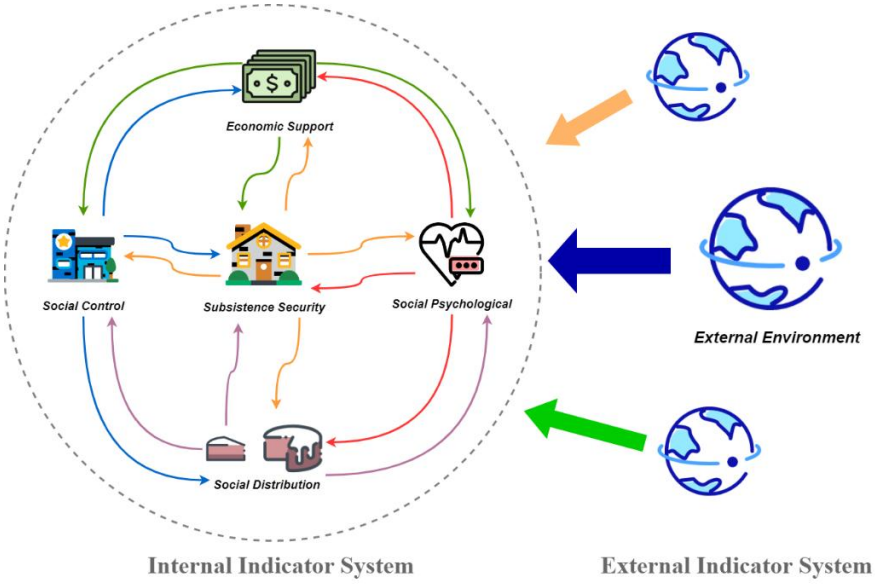

Figure 5: Correlation Diagram

5 Social Risk Early Alert Model

1. Early Alert Indicator System SSI and Indicator Weights

"Stability" is a vague and unclear term, so specific indicators are needed to measure it. The indicator system constructed in this paper consists of 6 major sections, as described in Part 4, and for the sake of conciseness and clarity of the article, only charts are shown as follows:

	Indicators(T)		Indicators(TI)	
Social Stability Index (SSI)	SS	Subsistence security	UR	Unemployment rate
			SSC	Social security coverage
			CCR	Care and caress ratio
	ES	Economic support	GPR	GDP growth rate
			PGR	Per capita GDP growth rate
			IR	Inflation Rate
			TIP	The proportion of value-added of tertiary industry in GDP
	SD	Social distribution	GNC	Gini Coefficient
			PIP	Proportion of people living in poverty
			I10	The share of income held by the top 10% of the people
	SC	Social control index	IMR	Crime rate of intentional murder
			CPI	Corruption Perceptions index
	SP	Social psychological	RHI	Resident happiness index
			COC	Confidence of consumers
			SPP	Percentage increase in suicide population
	SE	External environment	NND	Number of nature disaster
			TI	Terrorism index

Figure 6: Index Indicator System

2、Indicator score values

Since different indexes have different scales, and some indexes tend to be larger and smaller, so if we do not do any processing to score of the indexes, there will be great errors in the calculation, so we use the Extreme Difference Transformation formula to process the smaller the better indexes(hereinafter referred to as SB) and the larger the better indexes((hereinafter referred to as SB)), and for a certain point optimal index data(hereinafter referred to as MB) we use the forward equation.The processes are as followed:

- For the LB indicator data, we use Eq.9:

$$V_{ij} = \frac{x_{ij} - \min\{x_{1j}, x_{2j}, \cdots, x_{nj}\}}{\max\{x_{1j}, x_{2j}, \cdots, x_{nj}\} - \min\{x_{1j}, x_{2j}, \cdots, x_{nj}\}} \tag{1}$$

the more the value obtained after processing converges to 1, the better the indicator, about converges to 0, the worse the indicator (i.e., the maximum value of the indicator is 1, the minimum value is 0)

- For the SB indicator data, we use Eq.9:

$$V_{ij} = \frac{x_{ij} - \max\{x_{1j}, x_{2j}, \cdots, x_{nj}\}}{\min\{x_{1j}, x_{2j}, \cdots, x_{nj}\} - \max\{x_{1j}, x_{2j}, \cdots, x_{nj}\}} \tag{2}$$

the value obtained after processing converges to 1 the better the indicator is, and approximately converges to 0 the worse the indicator is (i.e. the minimum value of the indicator is 1 and the maximum value is 0)

- For the MB indicator data, the better the data (i.e., the indicator with neither small nor large data), we use the Eq.9:

$$V_{ij} = 1 - \frac{|x_{ij} - a|}{\max(|x_{ij} - a|)} \tag{3}$$

  - ✧ a is the optimum value or mean value of the optimal range of values

and the more the value obtained after processing converges to 1, the better the indicator, and about converges to 0, the worse the indicator (i.e., the optimal value of the indicator is 1, and the worst value is 0).

3、Calculating the degree of stability

Using the combined weights obtained above, a composite score for the degree of social stability can be calculated for each region. Its calculation formula is as:

$$SSI = \sum_{i=1}^{6} \sum_{j=1}^{n_i} V_{ij}\omega_{ij} \tag{4}$$

4、Warning level

Since the indicator weights and indicator scores are between 0 and 1, and with reference to international alert levels, we divide the social stability early warning level into 5 levels (each level is left continuous).

- **Level Ⅰ (Maximum):** SSI = 0-0.2(not including0.2), poor social stability , the indicator color is blood red.
- **Level Ⅱ (Severe):** SSI = 0.20-0.4 (not including 0.4), fair social stability , the indicator color is orange-red color.

- **Level Ⅲ (Moderate):** SSI = 0.40-0.6 (not including 0.6), average social stability , the indicator color is goose yellow.
- **Level Ⅳ (Light):** SSI = 0.6-0.8 (not including 0.8), good social stability , the indicator color is light green.
- **Level Ⅴ (Normal):** SSI = 0.8-1.0(including 1.0), excellent social stability , the indication color of military green.

The early warning level division table is as follows(Figure):

Warning level	Criterion	State	Stability	Color Range
I	$0 \leq SSI < 0.2$	Maximum Warning	Poor	
II	$0.2 \leq SSI < 0.4$	Severe Warning	Fair	
III	$0.4 \leq SSI < 0.6$	Moderate Warning	Average	
IV	$0.6 \leq SSI < 0.8$	Light Warning	Good	
V	$0.8 \leq SSI \leq 1.0$	Normal	Excellent	

Figure 7: Warning Level Chart

6 Model Applications

Through literature reading, we learned that countries that have had color revolutions are currently occurring mainly in countries of the Commonwealth of Independent States and Central Asia. For the purpose of Task 3 and Task 4, we divided the countries that have had color revolutions into two main categories, those that have had successful color revolutions and those that have successfully prevented color revolutions. As shown in the Figure:

Countries where Color Revolutions Took	
Failed	**Realized**
Iran	**Georgia**
	Ukraine
	Iraq
Belarus	**Lebanon**
	Kyrgyzstan
Kazakhstan	**Tunisia**
	Myanmar

Figure 8: Countries where color revolutions took place

6.1 Solution to Question 3

We chose Belarus, a typical country that has successfully prevented color revolutions, as the object of analysis and assessment for Task 3. Using the SREAM model described above, we first preprocessed the data related to social stability in Belarus for the last decade, after which we derived the following graph of social stability for the last 10 years using the model approach:

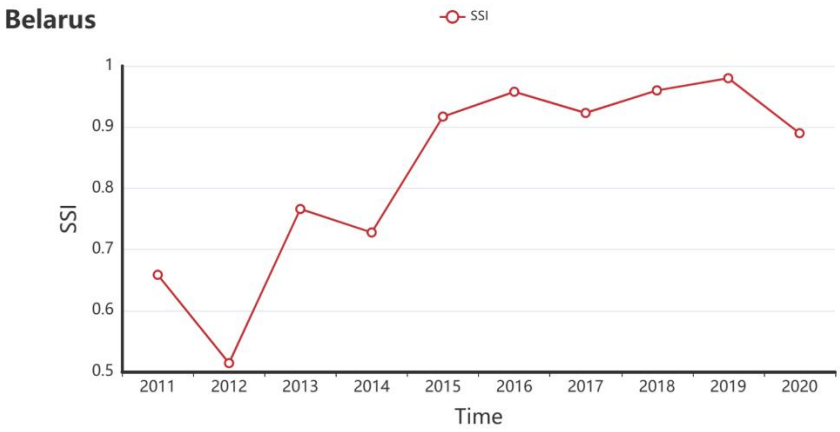

Figure 9: SSI of Belarus

It can be seen that the overall value of the SSI in Belarus is above 0.5 and shows an increasing trend from year to year, which is consistent with the historical facts that the society is stable and developing in a good direction in comparison with the table of early warning indicators.

In order to investigate more clearly the reasons for its resistance to color revolutions, we have also drawn the following mixed graphs. The SS is in the normal and good region, which plays a great role in maintaining social stability, the ES shows a year-on-year increase and stabilization, which indicates that Belarus is well driven by the oil economy, which supports the SS and makes the society more stable, and the SP rises with the SS and ES, which indicates that the high welfare policy implemented by the Belarusian government has been able to make most people satisfied with their lives. SE and SC are growing in the same direction, which is mainly due to Lukashenko's positive measures in social governance and external prevention. sD had a big fluctuation in 2014, which had a certain impact on social stability, but the negative effect of this indicator was offset by the rise of other indicators.[4]

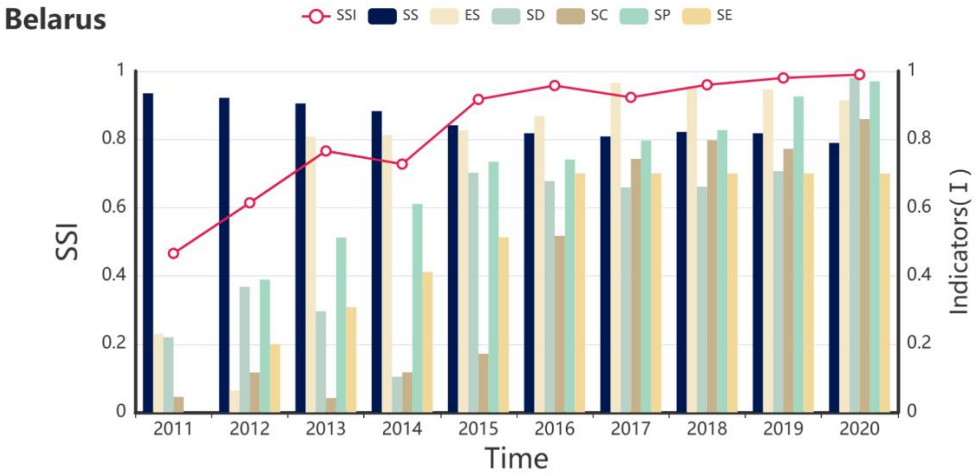

Figure 10: Mixed graph of index relationships

Next we use a gray forecasting model to forecast future social stability trends in Belarus, and before building the Gray Rorecasting model GM(1,1), we perform a cascade test on the pairwise time series to obtain the following table.

Table 2: Grade Ratio Test Results

Index item	Original value	Stage ratio	Translation sequence value after conversion	Panning conversion rear stage ratio
1	0.658	-	1.658	-
2	0.514	1.281	1.514	1.095
3	0.766	0.671	1.766	0.857
4	0.728	1.053	1.728	1.022
5	0.917	0.793	1.917	0.901
6	0.958	0.958	1.958	0.979
7	0.923	1.037	1.923	1.018
8	0.96	0.962	1.96	0.981
9	0.98	0.98	1.98	0.99
10	0.89	1.101	1.89	1.048

The above table shows the sequence values and the level ratio values. Since not all the level ratio values lie within the interval $(e^{(-2/(n+1))}, e^{(2/n+1)})$, all the level ratio values of the sequences after our translation transformation lie within the interval (0.834, 1.199), indicating that the translation-transformed sequences are suitable for the construction of the gray prediction model.

To check whether the model can be used for prediction, we calculated the posterior test difference ratio value of 0.351, and the model accuracy was qualified; the average relative error of the model was calculated to be 8.978%, implying that the model fit was good. Finally, we obtained the prediction graph as Figure 3.

In order to ensure that Belarusian society will continue to be stable, we propose the following recommendations based on the above analysis: continue to maintain a certain level of social control and the dynamic role of the government; adhere to the modernization of state governance and eliminate "Western superstitions"; in addition, the government needs to continue to improve the social distribution system compared to other indicators with relatively low SD, so that people can better enjoy the benefits of social production.

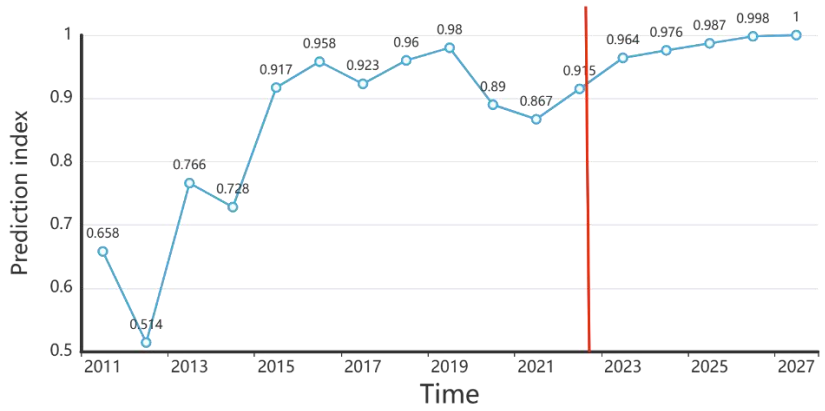

Figure 11: Future Trend Forecast

6.2 Solution to Question 4

Ukraine is a neighbor of Belarus, but the color revolution has "reaped a lot" in this land. Again, we selected data from the last 10 years to assess and analyze its new social stability and obtained the following data trends:

Figure 12: SSI of Ukraine

It can be seen that the Ukrainian society as a whole is in a relatively turbulent state, and in 2014-2015 there was a big slide from 2014 to 2015, when the color revolution took place. This is the time when the United States initiated the "Square Revolution" in Ukraine, and the opposition forces were supported and social stability was threatened.

The following mixed plot, on the other hand, facilitates our exploration of the causes of the fluctuations of the Social Stability Index in Ukraine. A closer look reveals that SSI is significantly correlated with SC, which is also consistent with the relationship shown by the correlation coefficients we conducted in Section 2, while the SS and external support SE boosted by ES can mitigate the decline in social stability due to the absence of SC when SC is weak.

In addition, we find that for Ukraine, the external environment has a huge impact, which is closely related to its geographical location and historical reasons. As part of the former Soviet Union, Russia has a profound influence on the development of Ukraine, while the US-Soviet war has plunged Ukraine into a deeper crisis.

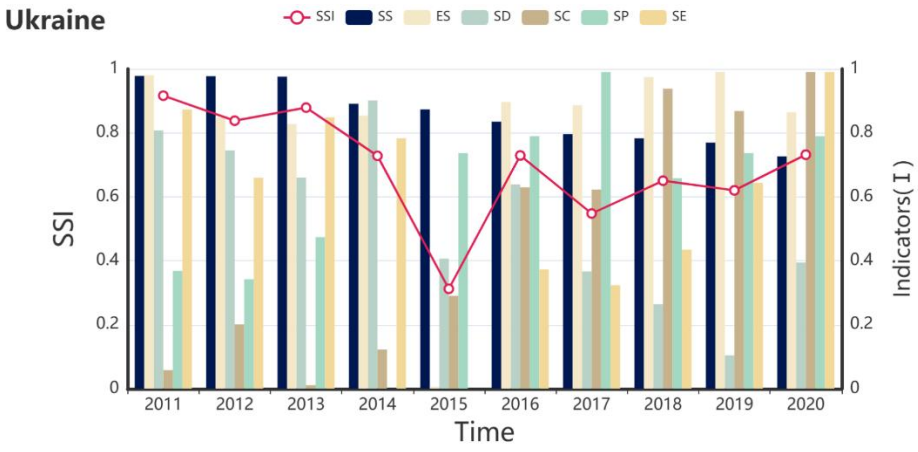

Figure 13: Mixed graph of index relationships

Based on the above-mentioned research, we conclude that there are two main internal and external reasons for the frequent regime change in Ukraine due to the "color revolutions".

First, the government's "shock therapy" has led to the stagnation of economic development and the inability of the people to secure even the most basic livelihood; in addition, there is serious partisanship, and the leaders of the parties in the country blindly

implement and copy the external forms of the Western multi-party system, the separation of powers and the parliamentary system without taking into account the actual development of their own societies. As a result, corruption and enrichment of officials frequently occur, leading to a decline in public confidence in the government and an increase in the number of demonstrations and petitions; furthermore, the economic downturn has led to an increase in unemployment, a widening gap in social distribution, and a soaring crime rate, resulting in social unrest. Finally, because party leaders come from different ethnic groups, there are often conflicts in religious beliefs, doctrines and interests, leading to ethnic rivalry and social unrest.

From the outside of the country, hegemonic states export their systems to maintain their status, support terrorist armed forces against the national government through capital, create a dark atmosphere of social unrest, and finally use the news media and the Internet to seize public opinion, vilify the image of the government, spread discontent and incite riots.

7 Sensitivity Analysis

Sensitivity analysis is a method for studying and analyzing the sensitivity of changes in the state or output of a system (or model) to changes in system parameters or surrounding conditions. Changes in other metrics data are observed by changing one of the model's parameters.

To verify that our model is stable when data slightly vary,we introduce Gauss noise to change the data we collected,and calculate the weight of indexs again along with relative error,and the result is as follows:

	unemploymen trate	social security coverage	careand caress ratio	GDP growth rate	Per capita GDP growth rate	Rate of inflation
original	0.0793	0.7164	0.2103	0.0556	0.0448	0.8775
changed	0.07962856	0.7094121	0.21095939	0.05565537	0.0451738	0.8768775
relative err	0.004143253	0.0097543	0.003135473	0.000995863	0.0083429	0.0007094
	the increase rate of value added of tertiary industry	Gini Coeffcient	Proportion of people living inpoverty	The share of income held by the top of the population	Crime rate of intentional murder	Corruption Perceptions Index
original	0.022	0.2984	0.1042	0.5974	0.1402	0.8598
changed	0.02229336	0.2989807	0.10424622	0.59677312	0.1403043	0.8596957
relative err	0.013334545	0.0019459	0.00044357	0.001049347	0.0007442	0.0001214
	number of nature disaster	Terrorism index	Resident happiness index	Percentage of suicidepopulation	Confidence of consumers	
original	0.1531	0.8469	0.5067	0.1934	0.2999	
changed	0.14599808	0.8540019	0.50783319	0.19312717	0.29903964	
relative err	0.046387459	0.0083858	0.002236412	0.001410703	0.002868823	

Figure 14: Sensitivity Analysis

The raletive error is generally within 1%,so our model is stable.

8 Conclusion and Suggestions

1. Rely on economic development and strive to improve the level of people's livelihood development

The most fundamental way to deal with the "color revolution" is to develop the economy, improve people's lives, and enhance its own governing performance. The key to resist the invasion of Western democracy is to improve the domestic economy, develop the productive forces, improve people's living standards, and enhance the cohesion and centripetal force of the people in socialist countries. Only by speeding up development can we effectively reduce poverty and narrow the gap between regions and the rich and the poor; create more employment opportunities so that the people can live and work happily; establish and improve various social security mechanisms; and continuously improve the country's comprehensive national power to resist economic threats from Western countries.

2. Maintain ideological security and solidify the ideological foundation

Explore the path of democratic development in line with national conditions, promote progressive reforms and oppose radical reforms through news media reports and network communications, and advocate the principle of national stability first. Strengthen the space of online media to make the cyberspace clean and full of positive energy, and on this basis eliminate the absolute boundaries between different ideologies and treat other pluralistic ideologies and their values with an open attitude to interpret them positively and effectively.

3. Strengthen anti-corruption campaigns and improve the credibility of the government

It is necessary to establish and improve the system of punishment and prevention of corruption, adhere to both the symptoms and the root causes, comprehensive treatment, punishment and prevention, and focus on prevention. At the same time, promulgate relevant laws and regulations, use fair and effective means to restrain the riotous movement against the government, establish and improve the democratic petition system, make democracy real and reachable, and improve the credibility of the government.

4.Promote the harmonious coexistence of various ethnic groups and reduce religious conflicts

Respect and tolerance of the unique cultural customs of all ethnic groups, exchanges and intermingling of all ethnic groups, and promote the formation of a consensus, common, shared and shared spiritual and cultural system is a realistic requirement and a direct and effective channel to build a common spiritual home for all ethnic groups. Restraining and cracking down on anti-social and anti-human bad beliefs, encouraging and developing beliefs that promote peaceful human development and national unity are conducive to the formation of a good social climate, thus promoting social stability and reducing social risks.

9 Model Evaluation and Further Discussion

9.1 Strengths

- The indicators selected in the indicator system model are scientific and reasonable. In determining these indicators, we considered more than 20 sets of data from 204

countries. These indicators are six aspects that include social stability and make the later model building more reliable.

- We combine the advantages of entropy and hierarchical analysis to achieve diversity while avoiding the influence of personal subjective factors on the accuracy and objectivity of the model.
- When making predictions, we use a gray prediction model, which solves the problems of little historical data, completeness of the series and low reliability, and is able to generate the irregular raw data to get a more regular generating series, which makes a more reliable prediction of the social stability of Belarus.

9.2 Weaknesses

- Despite our best efforts to obtain relevant indicator data, several types of data are still missing for some countries and regions due to database limitations, which have a negative impact on the accuracy of indicator weights.
- The more hierarchical relationships between the indicators require more complex mathematical methods of calculation, which were not explored and discussed further due to time and capacity constraints.

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