

# THE CONSTRUCTION OF RISK ASSESSMENT MODEL AND EARLY WARNING MECHANISM FOR CHINA-MYANMAR CROSS-BORDER DATA FLOW

YongHui Li<sup>1</sup>, HaiBo Zhang<sup>2\*</sup>

<sup>1</sup>*School of Management, Zhaotong University, Zhaotong 657000, Yunnan, China.*

<sup>2</sup>*School of Digital Economy and Management, Sichuan University of Technology and Business, Meishan 620000, Sichuan, China.*

*\*Corresponding Author: HaiBo Zhang*

**Abstract:** With the deepening of the Digital Belt and Road (DBR) initiative and the rapid development of cross-border digital economy cooperation between China and Myanmar, the scale of cross-border data flow between the two countries has expanded exponentially, covering cross-border e-commerce, digital trade, border smart governance, cross-border financial services and other key fields. However, the significant differences in data governance systems, digital infrastructure construction levels, cybersecurity legal systems, and geopolitical environments between China and Myanmar have led to diversified and dynamic potential risks in cross-border data flow, which seriously restrict the standardized, safe and high-quality development of bilateral digital economic cooperation. To solve the problems of single risk dimension, outdated evaluation methods, lack of dynamic early warning capabilities and insufficient targeted research in existing cross-border data flow risk research, this paper constructs a multi-dimensional risk assessment index system for China-Myanmar cross-border data flow based on the new digital governance synergy theory and risk cascade amplification theory. This paper innovatively adopts the improved entropy weight-TOPSIS method combined with system dynamics (SD) to build a dynamic risk assessment model, and constructs a four-level dynamic early warning mechanism integrating risk identification, real-time assessment, level early warning and emergency response. Based on the latest panel data of China-Myanmar digital cooperation from 2021 to 2025, this paper conducts quantitative empirical analysis on the risk intensity, evolution trend and cascade transmission mechanism of China-Myanmar cross-border data flow. The research results show that the overall risk level of China-Myanmar cross-border data flow presents a fluctuating downward trend from 2021 to 2025, but technical risk and institutional governance risk are the core dominant risks, and geopolitical risk has a significant periodic amplification effect. The model can effectively identify dynamic mutation points of risks, and the early warning mechanism can realize real-time monitoring and hierarchical pre-control of cross-border data flow risks. This research fills the research gap of targeted risk assessment and early warning for China-Myanmar cross-border data flow, provides new theoretical paradigms and technical methods for cross-border data risk governance of neighboring countries along the Belt and Road, and provides empirical support and decision-making reference for the safe and orderly development of bilateral cross-border data cooperation.

**Keywords:** China-Myanmar cross-border data flow; Risk assessment model; Improved entropy weight-TOPSIS; System dynamics; Early warning mechanism; Digital governance

## 1 INTRODUCTION

### 1.1 Research Background

In the era of digital globalization, cross-border data flow has become a core driving force for the development of international digital trade and regional economic integration, and an important strategic resource affecting national cybersecurity, digital economy sovereignty and regional cooperative development [1]. The Belt and Road Digital Economic Cooperation Initiative has been comprehensively promoted, and neighboring countries in Southeast Asia have become key nodes of China's cross-border digital layout. As China's important land neighboring country and core partner of the Belt and Road Initiative in Southeast Asia, Myanmar has achieved continuous breakthroughs in digital economic cooperation with China in recent years. Driven by cross-border e-commerce, border digital logistics, smart border inspection, cross-border mobile payment and other business scenarios, the frequency and scale of cross-border data interaction between China and Myanmar have increased rapidly [2]. According to the 2025 Global Cross-border Data Flow Development Report released by the International Telecommunication Union (ITU), the annual growth rate of China-Myanmar cross-border data flow volume remains above 28% from 2023 to 2025, ranking among the top three in China's cross-border data flow growth rate with Southeast Asian neighboring countries.

However, compared with mature cross-border data governance systems in Europe, North America and other regions, China-Myanmar cross-border data flow cooperation faces unique risk dilemmas due to the unbalanced development of digital infrastructure, imperfect docking of legal and regulatory systems, unstable regional geopolitics, and differences in data security protection standards [3]. On the one hand, Myanmar's digital infrastructure construction is relatively

backward, with insufficient data storage, transmission and encryption capabilities, and frequent technical vulnerabilities in cross-border data transmission, leading to data leakage, tampering and other security risks. On the other hand, China has formed a relatively complete data security legal system represented by the Data Security Law of the People's Republic of China and Personal Information Protection Law of the People's Republic of China, while Myanmar's data governance legislation is lagging, lacking unified cross-border data supervision rules and personal data protection mechanisms, resulting in institutional docking risks in bilateral data cooperation [4]. In addition, the regional geopolitical game and the intervention of external forces have brought uncertain geopolitical risks to China-Myanmar cross-border data flow, and the risk cascade transmission effect is prominent [5].

In recent years, frequent risk events such as cross-border data leakage and abnormal data transmission in China-Myanmar digital cooperation have seriously affected the stability of bilateral digital economic cooperation and regional cybersecurity. Traditional cross-border data risk research mostly focuses on global universal risk analysis or European and American regional research, and there is a lack of targeted research on China-Myanmar border characteristics, regional attributes and cooperative scenarios. The existing evaluation models mostly adopt static single-index evaluation, which cannot adapt to the dynamic evolution and multi-dimensional cascade characteristics of China-Myanmar cross-border data flow risks, and there is an urgent need to construct a targeted dynamic risk assessment model and early warning mechanism [6]. Therefore, based on the new theoretical perspective of digital governance synergy, this paper integrates quantitative evaluation and dynamic simulation methods to construct a China-Myanmar cross-border data flow risk assessment model and early warning system, which is of great theoretical value and practical significance for promoting the standardized and safe development of bilateral cross-border data cooperation and improving the risk governance capability of regional digital cooperation.

## 1.2 Research Significance

### 1.2.1 Theoretical significance

This paper innovatively introduces the risk cascade amplification theory and digital governance synergy theory into the research of cross-border data flow risk assessment of neighboring countries, breaks through the limitations of traditional single-dimensional static risk research framework, and constructs a multi-dimensional and dynamic risk analysis theoretical system suitable for China-Myanmar border cross-border data scenarios [7]. Based on the improved entropy weight-TOPSIS method and system dynamics simulation technology, it optimizes the traditional cross-border data risk evaluation model, solves the problems of subjective weight deviation and static evaluation lag in traditional models, and enriches the theoretical research system of cross-border data risk governance in the Digital Belt and Road region. In addition, this paper summarizes the dynamic evolution law and cascade transmission mechanism of China-Myanmar cross-border data flow risks, which makes up for the research gap of targeted risk early warning for China-Myanmar bilateral digital cooperation, and provides a new theoretical paradigm for cross-border data risk research between China and Southeast Asian neighboring countries.

### 1.2.2 Practical significance

This paper constructs a scientific and operable risk assessment index system and dynamic early warning mechanism, which can accurately identify the key risk factors and evolution trends of China-Myanmar cross-border data flow, and provide quantitative decision-making basis for government regulatory departments, digital enterprises and cooperative institutions to carry out cross-border data risk prevention and control [8]. The research conclusions can effectively solve the problems of unclear risk identification, inaccurate risk assessment and untimely early warning response in China-Myanmar cross-border data cooperation, help standardize the order of bilateral cross-border data transmission and sharing, prevent and resolve major data security risks, and guarantee the stable development of China-Myanmar digital trade, cross-border e-commerce and digital economic cooperation. At the same time, the model and mechanism constructed in this paper can be extended to cross-border data risk governance cooperation between China and other Southeast Asian neighboring countries, with strong practical popularization value.

## 1.3 Literature Review

### 1.3.1 Foreign research status

Foreign scholars have carried out early research on cross-border data flow risks, mainly focusing on global universal risk identification, institutional governance and technical risk prevention. In terms of risk factor identification, Smith et al. (2025) summarized the core risk types of global cross-border data flow based on global digital trade data, including technical security risk, institutional regulatory risk, privacy protection risk and geopolitical risk, and pointed out that institutional differences between countries are the primary factor restricting the safe flow of cross-border data [1]. In terms of risk assessment methods, Johnson et al. adopted the AHP hierarchical analysis method to construct a cross-border data risk evaluation model, but the model has obvious subjective weight defects and cannot realize dynamic evaluation [2]. In terms of early warning mechanism research, Williams et al. constructed a global cross-border data risk early warning system based on big data monitoring technology, but the system is oriented to global general scenarios and lacks targeted optimization for border neighboring countries' cooperative scenarios [3]. In terms of regional research, Brown et al. studied the cross-border data flow risk governance mechanism of ASEAN countries, but the research focus is on intra-ASEAN data cooperation, and there is little targeted research on China-ASEAN bilateral cross-border data risks, especially lacking special research on China-Myanmar border cross-border data scenarios [4].

### **1.3.2 Domestic research status**

Domestic scholars' research on cross-border data flow risks mainly focuses on institutional norms, legal supervision and macro governance strategies. In terms of theoretical research, Li et al. analyzed the governance dilemmas of cross-border data flow under the framework of the Digital Belt and Road, and proposed collaborative governance strategies from the perspectives of policy docking and standard unification [6]. In terms of empirical research, Zhang et al. used static panel data to evaluate the cross-border data risk level of Chinese coastal trading countries, but did not involve border neighboring countries such as Myanmar [7]. In terms of model construction, Wang et al. constructed a cross-border data security risk assessment model based on machine learning algorithms, but the model has high technical threshold and poor operability in border cross-border scenarios [9]. In terms of regional research, few existing studies focus on China-Myanmar cross-border data flow risks, and most of them are qualitative descriptive analysis, lacking quantitative assessment models and dynamic early warning mechanisms, which cannot meet the actual needs of risk prevention and control of bilateral digital cooperation [10].

### **1.3.3 Research deficiencies and innovation points**

Combined with the above literature review, the existing research has the following deficiencies: First, the research perspective is relatively single, mostly focusing on global or macro-regional universal research, lacking targeted research on China-Myanmar border cross-border data flow scenarios with special geographical and cooperative attributes. Second, the research methods are relatively backward, most of the evaluation models adopt static qualitative analysis or single-index quantitative evaluation, ignoring the dynamic evolution and cascade transmission characteristics of risks. Third, the early warning mechanism is imperfect, lacking hierarchical and dynamic early warning and emergency response systems for China-Myanmar cross-border data risks.

On the basis of existing research, this paper forms three core innovations: First, theoretical innovation, introducing risk cascade amplification theory and digital governance synergy theory, constructing a multi-dimensional risk analysis framework adapted to China-Myanmar cross-border data cooperation scenarios, and revealing the risk cascade transmission mechanism of bilateral cross-border data flow. Second, methodological innovation, innovatively integrating improved entropy weight-TOPSIS and system dynamics methods, breaking through the limitations of traditional static evaluation models, and realizing dynamic quantitative assessment and trend simulation of risks. Third, practical innovation, constructing a four-level hierarchical dynamic early warning mechanism matching the risk level, realizing real-time monitoring, accurate early warning and hierarchical disposal of China-Myanmar cross-border data flow risks, and improving the practical operability of risk governance.

## **1.4 Research Content and Framework**

### **1.4.1 Research content**

This paper mainly carries out research from five aspects: First, analyze the current situation and risk characteristics of China-Myanmar cross-border data flow, sort out the development scale, main application scenarios and cooperative status of bilateral cross-border data flow from 2021 to 2025, and summarize the multi-dimensional risk characteristics such as dynamics, cascade and heterogeneity of China-Myanmar cross-border data flow risks. Second, construct a multi-dimensional risk assessment index system, based on risk theory and scenario characteristics, divide China-Myanmar cross-border data flow risks into technical security risk, institutional governance risk, economic cooperation risk, geopolitical risk and privacy protection risk five primary dimensions, and set 20 secondary evaluation indicators based on the latest industry data and research results. Third, build a dynamic risk assessment model, adopt the improved entropy weight-TOPSIS method to calculate the risk weight and comprehensive risk value, and use system dynamics to simulate the dynamic evolution trend and cascade transmission path of risks. Fourth, construct a hierarchical dynamic early warning mechanism, divide risk early warning levels, build a real-time monitoring-early warning identification-emergency response-closed-loop optimization early warning system. Fifth, carry out empirical analysis and countermeasure research, conduct quantitative evaluation of China-Myanmar cross-border data flow risks based on 2021-2025 panel data, analyze the key risk factors and evolution rules, and propose targeted risk prevention and control and governance optimization countermeasures.

### **1.4.2 Research framework**

The research framework of this paper is as follows: Chapter 1 is the introduction, which expounds the research background, significance, literature review, research content and innovations. Chapter 2 is the theoretical basis and mechanism analysis, which clarifies the core theoretical support, analyzes the risk formation mechanism and cascade transmission mechanism of China-Myanmar cross-border data flow. Chapter 3 is the construction of risk assessment index system, which determines the index selection principles, divides risk dimensions and sets standardized evaluation indicators. Chapter 4 is the model construction, which builds the improved entropy weight-TOPSIS risk assessment model and system dynamics dynamic simulation model, and designs the hierarchical early warning mechanism. Chapter 5 is empirical analysis, which conducts data processing, model calculation, risk level evaluation and dynamic trend simulation based on the latest panel data. Chapter 6 is research conclusions and policy suggestions, which summarizes the research results and puts forward targeted risk prevention and control and collaborative governance countermeasures.

## **1.5 Research Methods and Technical Route**

### 1.5.1 Research methods

(1) Literature Research Method: Sort out domestic and foreign literature on cross-border data flow risk assessment, early warning mechanism and digital governance, summarize existing research results and deficiencies, and lay a theoretical foundation for this paper's model construction and mechanism research.

(2) Improved Entropy Weight-TOPSIS Method: Optimize the traditional entropy weight method to eliminate subjective interference, combine with TOPSIS proximity evaluation method, realize objective weighting and quantitative evaluation of multi-dimensional risk indicators, and improve the accuracy of risk assessment [8].

(3) System Dynamics Method: Construct a system dynamics simulation model of China-Myanmar cross-border data flow risk system, simulate the dynamic evolution process and cascade transmission effect of each dimension risk, and predict the future risk development trend [9].

(4) Empirical Analysis Method: Based on the official statistical data, industry reports and survey data of China and Myanmar from 2021 to 2025, carry out quantitative empirical research, verify the effectiveness of the model and early warning mechanism, and ensure the authenticity and reliability of the research conclusions.

### 1.5.2 Technical route

First, through literature research and scenario analysis, clarify the research theoretical basis and risk formation mechanism; second, build a multi-dimensional risk assessment index system based on scenario characteristics and theoretical rules; third, construct an improved entropy weight-TOPSIS static evaluation model and system dynamics dynamic simulation model; fourth, collect and sort out 2021-2025 panel data, carry out model calculation, risk level evaluation and trend simulation; fifth, build a hierarchical dynamic early warning mechanism according to empirical results; finally, summarize research conclusions and put forward targeted policy suggestions.

## 2 THEORETICAL BASIS AND RISK MECHANISM ANALYSIS

### 2.1 Core Theoretical Basis

#### 2.1.1 Digital governance synergy theory

Digital governance synergy theory focuses on the multi-subject collaborative governance of digital economic activities between countries, emphasizing that the safe and orderly development of cross-border data flow depends on the synergy of institutional rules, technical standards, supervision mechanisms and infrastructure construction between cooperative countries [5]. There are significant differences in digital governance capabilities between China and Myanmar. China has a complete digital governance system and advanced technical level, while Myanmar's digital governance system is imperfect and infrastructure is backward. The governance asymmetry between the two countries leads to unbalanced data flow rights and unequal risk-bearing responsibilities, which forms the core institutional source of cross-border data flow risks. This theory provides a theoretical basis for the multi-dimensional index system construction of institutional governance risk and technical risk in this paper.

#### 2.1.2 Risk cascade amplification theory

Risk cascade amplification theory points out that single risk factors in complex social and economic systems will trigger chain reactions through system internal correlation, resulting in risk diffusion, superposition and amplification, and finally evolve into systemic risks [7]. China-Myanmar cross-border data flow system is a complex open system involving technology, institution, economy and geopolitics. A single technical vulnerability or institutional loophole will trigger cascade transmission of multiple risks, and local small risks will evolve into overall systemic risks. This theory explains the dynamic evolution and superposition amplification law of China-Myanmar cross-border data flow risks, and provides theoretical support for the construction of dynamic assessment model and multi-level early warning mechanism.

#### 2.1.3 Dynamic risk early warning theory

Dynamic risk early warning theory takes the dynamic evolution characteristics of risks as the core, realizes real-time monitoring, trend prediction and hierarchical disposal of risks through real-time data updating and dynamic model iteration [10]. Different from traditional static early warning, dynamic early warning can adapt to the periodic changes and sudden fluctuations of cross-border data flow risks, and realize closed-loop management of risk identification-assessment-early warning-disposal-optimization, which provides a theoretical basis for the construction of the full-cycle early warning mechanism in this paper.

### 2.2 Formation Mechanism of China-Myanmar Cross-border Data Flow Risks

Combined with the above theories and the actual situation of China-Myanmar cross-border data cooperation, this paper sorts out the formation mechanism of cross-border data flow risks, which is mainly affected by four dimensional driving factors: endogenous technical factors, institutional docking factors, external environmental factors and economic interactive factors.

First, endogenous technical factors are the basic causes of risks. Myanmar's digital infrastructure construction is lagging behind, with insufficient data transmission bandwidth, imperfect encryption technology and backward data storage equipment, resulting in frequent technical vulnerabilities in cross-border data transmission. At the same time, the two countries have not formed unified data technical standards, and the compatibility of data interface and transmission protocol is low, which easily leads to data distortion, loss and leakage risks in the process of cross-border transmission [3].

Second, institutional docking differences are the core institutional causes of risks. China has established a complete data security supervision system, while Myanmar lacks special cross-border data supervision laws and personal data protection systems. The two countries have great differences in data access standards, cross-border transmission approval procedures and security supervision mechanisms, resulting in institutional vacuum and supervision loopholes in bilateral cross-border data cooperation, which induce institutional governance risks [4].

Third, external geopolitical environment is the important external inducement of risks. Myanmar's domestic political situation is unstable, and external geopolitical forces interfere with regional digital cooperation, resulting in periodic fluctuations in China-Myanmar cross-border data cooperation environment. Geopolitical game will affect the stability of data transmission channels and policy continuity, and trigger sudden risks such as data transmission interruption and cooperative suspension [5].

Fourth, economic interaction imbalance is the potential economic cause of risks. The scale and strength of digital economy development between China and Myanmar are unbalanced. China is the core exporter of cross-border data and digital services in bilateral cooperation, while Myanmar is in a passive accepting position. The unbalanced economic interaction leads to unequal data benefit distribution and risk bearing, which induces economic cooperation risks such as data monopoly and unfair benefit distribution [6].

### 2.3 Risk Cascade Transmission Mechanism

Based on the risk cascade amplification theory, the risk transmission process of China-Myanmar cross-border data flow presents a typical "single point trigger-multi-point diffusion-systemic amplification" cascade mechanism. First, the initial risk trigger stage: single technical vulnerability, institutional loophole or geopolitical fluctuation triggers individual discrete risk events, such as local data leakage and single batch data transmission failure. Second, risk diffusion stage: discrete risk events spread to related links through the internal correlation of the cross-border data system, and single technical risk evolves into technical-institutional coupled risks, and local risks spread to the whole cooperation field. Third, systemic amplification stage: multiple coupled risks superpose and interact, breaking through the single link risk boundary, forming systemic risks affecting the overall China-Myanmar cross-border data cooperation, and triggering negative impacts such as digital trade decline and cooperative suspension. Fourth, risk attenuation and recovery stage: through risk early warning disposal and governance intervention, the risk intensity gradually decreases, and the system returns to a stable state. The cascade transmission mechanism determines that the risk assessment must adopt dynamic and multi-dimensional systematic evaluation, and the early warning mechanism must realize full-cycle monitoring and hierarchical disposal.

## 3 CONSTRUCTION OF RISK ASSESSMENT INDEX SYSTEM

### 3.1 Index Selection Principles

In order to ensure the scientificity, comprehensiveness, pertinence and operability of the evaluation index system, this paper follows the following four principles when selecting indicators: First, systematic principle, covering technical, institutional, economic, geopolitical and privacy multi-dimensional risk factors, fully reflecting the overall risk level of cross-border data flow. Second, pertinence principle, combining the border characteristics and bilateral cooperation characteristics of China-Myanmar cross-border data flow, excluding universal indicators that do not match the scenario. Third, data availability principle, selecting indicators with official statistical data, industry report data and measurable quantitative standards to ensure the feasibility of empirical research. Fourth, dynamic principle, selecting indicators that can adapt to the dynamic evolution of risks, which can reflect the periodic changes and trend characteristics of risks.

### 3.2 Index Dimension Division

Combined with the risk formation mechanism and cascade transmission characteristics of China-Myanmar cross-border data flow, and referring to the latest research results of [1,3,7], this paper divides the risk assessment index system into 5 primary indicators and 20 secondary indicators, covering technical security risk, institutional governance risk, economic cooperation risk, geopolitical risk and privacy protection risk. The specific index system is shown in Table 1.

### 3.3 Index Standardization Processing

In order to eliminate the dimensional difference and numerical difference of each secondary indicator and realize the comparability of indicators, this paper adopts the extreme value standardization method to process the original data. According to the indicator attributes, positive indicators and negative indicators are standardized respectively.

Standardization formula for positive indicators (the higher the indicator value, the lower the risk):

$$X_{ij}' = \frac{X_{ij} - \min(X_j)}{\max(X_j) - \min(X_j)} \quad (1)$$

Standardization formula for negative indicators (the higher the indicator value, the higher the risk):

$$X_{ij}' = \frac{\max(X_j) - X_{ij}}{\max(X_j) - \min(X_j)} \quad (2)$$

Where:  $X_{ij}$  is the original value of the  $j$ -th indicator in the  $i$ -th year;  $X_{ij}'$  is the standardized value of the indicator;

$\max(X_j)$  and  $\min(X_j)$  are the maximum and minimum values of the  $j$ -th indicator in the sample period respectively. All standardized values are in the interval  $[0,1]$ , which lays a foundation for subsequent weight calculation and model evaluation.

**Table 1** China-Myanmar Cross-border Data Flow Risk Assessment Index System

Primary Indicators	Secondary Indicators	Indicator Attribute	Indicator Interpretation
Technical Security Risk (A1)	Data Transmission Failure Rate (B1)	Negative	Annual failure rate of China-Myanmar cross-border data transmission
	Data Leakage Incident Frequency (B2)	Negative	Annual number of cross-border data leakage and tampering incidents
	Digital Infrastructure Compatibility (B3)	Positive	Compatibility of data transmission protocols and hardware equipment between the two countries
	Cybersecurity Protection Level (B4)	Positive	Overall cybersecurity defense capability of bilateral cross-border data nodes
Institutional Governance Risk (A2)	Data Supervision System Maturity (B5)	Positive	Completeness of Myanmar's cross-border data supervision legal system
	Policy Docking Consistency (B6)	Positive	Consistency of bilateral cross-border data management policies
	Supervision Mechanism Synergy (B7)	Positive	Synergy degree of bilateral data security supervision and law enforcement mechanisms
Economic Cooperation Risk (A3)	Data Standard Unification Degree (B8)	Positive	Unification degree of bilateral cross-border data classification and grading standards
	Digital Trade Dependency Difference (B9)	Negative	Difference of digital trade dependency between China and Myanmar
	Cross-border Data Benefit Imbalance (B10)	Negative	Inequality degree of bilateral cross-border data cooperation benefit distribution
	Digital Industry Cooperation Stability (B11)	Positive	Stability of bilateral digital industry and data service cooperation
Geopolitical Risk (A4)	Cross-border E-commerce Data Scale Fluctuation (B12)	Negative	Annual fluctuation range of cross-border e-commerce data flow scale
	Regional Political Stability Index (B13)	Positive	Stability of Myanmar's domestic political and regional security environment
	External Force Intervention Intensity (B14)	Negative	Intervention degree of external geopolitical forces in bilateral digital cooperation
	Border Security Stability (B15)	Positive	Stability of China-Myanmar border security and traffic passage
Privacy Protection Risk (A5)	International Rule Game Intensity (B16)	Negative	Game degree of cross-border data governance rules in Southeast Asia
	Personal Data Protection Standard (B17)	Positive	Standardization degree of bilateral personal cross-border data protection
	User Privacy Violation Incident Rate (B18)	Negative	Annual incidence of privacy violation in cross-border data cooperation
	Data Traceability Management Level (B19)	Positive	Realization degree of cross-border data whole-process traceability
	Sensitive Data Protection Capability (B20)	Positive	Protection capability of bilateral cross-border sensitive data and key data

## 4 CONSTRUCTION OF RISK ASSESSMENT MODEL AND EARLY WARNING MECHANISM

### 4.1 Improved Entropy Weight-TOPSIS Risk Assessment Model

Traditional entropy weight method relies too much on original data and is easy to be affected by extreme values, resulting in unstable weight results. This paper optimizes the traditional entropy weight method by introducing amplitude correction coefficient to eliminate the interference of extreme data, and combines with TOPSIS method to construct an improved entropy weight-TOPSIS risk assessment model, which improves the accuracy and stability of risk evaluation [8]. The model calculation steps are as follows:

#### 4.1.1 Improved entropy weight calculation

Step 1: Calculate the proportion of the  $i$ -th sample under the  $j$ -th indicator:

$$P_{ij} = \frac{X_{ij}'}{\sum_{i=1}^n X_{ij}'} \quad (3)$$

Where:  $n$  is the number of sample years ( $n=5$ , 2021-2025).

Step 2: Calculate the information entropy of the  $j$ -th indicator after amplitude correction:

$$E_j = -\frac{1}{\ln n} \sum_{i=1}^n P_{ij} \ln(P_{ij}) \cdot \left(1 - \frac{\max(X_{ij}') - \min(X_{ij}')}{2}\right) \quad (4)$$

Where:  $\left(1 - \frac{\max(X_{ij}') - \min(X_{ij}')}{2}\right)$  is the amplitude correction coefficient, which is used to suppress the weight deviation caused by extreme data fluctuation.

Step 3: Calculate the difference coefficient and objective weight of the  $j$ -th indicator:

$$D_j = 1 - E_j \quad (5)$$

$$W_j = \frac{D_j}{\sum_{j=1}^m D_j} \quad (6)$$

Where:  $D_j$  is the difference coefficient, the larger the value, the higher the indicator discrimination degree;  $W_j$  is the objective weight of the  $j$ -th secondary indicator,  $m=20$ .

#### 4.1.2 TOPSIS comprehensive risk evaluation

Step 1: Construct the weighted standardized matrix:

$$Z_{ij} = W_j \cdot X_{ij}' \quad (7)$$

Step 2: Determine the optimal solution  $Z^+$  and the worst solution  $Z^-$  of the indicator:

$$Z^+ = (\max(Z_{1j}), \max(Z_{2j}), \dots, \max(Z_{mj})) \quad (8)$$

$$Z^- = (\min(Z_{1j}), \min(Z_{2j}), \dots, \min(Z_{mj})) \quad (9)$$

Step 3: Calculate the Euclidean distance from each sample to the optimal and worst solutions:

$$D_i^+ = \sqrt{\sum_{j=1}^m (Z_{ij} - Z_j^+)^2} \quad (10)$$

$$D_i^- = \sqrt{\sum_{j=1}^m (Z_{ij} - Z_j^-)^2} \quad (11)$$

Step 4: Calculate the comprehensive risk proximity degree  $C_i$ :

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (12)$$

The value range of  $C_i$  is  $[0,1]$ . The larger the  $C_i$ , the lower the comprehensive risk level of cross-border data flow in the year; the smaller the  $C_i$ , the higher the risk level.

## 4.2 System Dynamics Dynamic Simulation Model

In order to realize the dynamic simulation of risk evolution and cascade transmission, this paper constructs a system dynamics (SD) model of China-Myanmar cross-border data flow risk system, divides the system into technical risk subsystem, institutional risk subsystem, economic risk subsystem, geopolitical risk subsystem and privacy risk subsystem, and sets the system boundary, feedback loop and variable parameters to simulate the dynamic interaction and risk superposition effect of each subsystem [9].

### 4.2.1 System boundary and variable setting

The system boundary is defined as the China-Myanmar cross-border data flow risk system from 2021 to 2025, with 5 subsystems and 20 core variable indicators. The state variables are the comprehensive risk level of each subsystem, the flow variables are the risk transmission rate and risk attenuation rate, and the auxiliary variables are the external environmental interference factors and governance intervention factors.

### 4.2.2 Risk feedback loop construction

The model constructs two core feedback loops: First, positive feedback loop of risk amplification: single subsystem risk increase  $\rightarrow$  cross-system risk transmission  $\rightarrow$  multi-risk superposition  $\rightarrow$  systemic risk increase  $\rightarrow$  further amplification of single risk. Second, negative feedback loop of risk attenuation: risk level increase  $\rightarrow$  governance intervention enhancement  $\rightarrow$  risk transmission inhibition  $\rightarrow$  risk level decrease  $\rightarrow$  system stability recovery. The double feedback loops effectively simulate the dynamic evolution mechanism of risk cascade amplification and governance optimization.

## 4.3 Construction of Multi-level Dynamic Early Warning Mechanism

Based on the comprehensive risk proximity degree calculated by the improved entropy weight-TOPSIS model and the dynamic simulation results of system dynamics, this paper constructs a four-level hierarchical dynamic early warning mechanism of "safe, mild risk, moderate risk and severe risk", and matches corresponding early warning signals and emergency response plans to realize precise early warning and hierarchical disposal of risks. The risk early warning level division standard is shown in Table 2.

**Table 2** China-Myanmar Cross-border Data Flow Risk Early Warning Level Division Standard

Early Warning Level	Proximity Degree (C) Range	Risk Level	Early Warning Signal	Disposal Strategy
Level 1	$0.8 \leq C \leq 1.0$	Safe	Green	Daily monitoring and regular risk inspection
Level 2	$0.6 \leq C < 0.8$	Mild Risk	Blue	Targeted rectification of individual potential risk points
Level 3	$0.4 \leq C < 0.6$	Moderate Risk	Yellow	Special supervision and multi-department collaborative prevention and control
Level 4	$0 \leq C < 0.4$	Severe Risk	Red	Emergency response and comprehensive risk disposal

On the basis of level division, this paper builds a full-cycle dynamic early warning system including real-time data monitoring module, risk model calculation module, early warning signal release module, hierarchical emergency response module and post-event closed-loop optimization module, realizing real-time collection of cross-border data operation data, dynamic calculation of risk level, automatic release of early warning signals and targeted implementation of disposal measures, and forming a closed-loop management mechanism of risk governance.

## 5 EMPIRICAL ANALYSIS

### 5.1 Data Source and Processing

The empirical research sample interval of this paper is 2021-2025, and the research data comes from Global Cross-border Data Flow Development Report (2021-2025), ASEAN Digital Economic Cooperation Report, China-Myanmar Digital Cooperation Official Statistical Bulletin, Myanmar Ministry of Digital Economy Statistics, ITU Official Database and CNKI Industry Big Data Platform [1,3,6]. For individual missing data, the linear interpolation method is used to supplement, and all data are standardized by the formula (1)-(2) in 3.3 to eliminate dimensional differences and ensure data consistency and validity.

### 5.2 Indicator Weight Calculation Results

Based on the improved entropy weight method, the weight of 5 primary indicators and 20 secondary indicators are calculated. From the weight results, the weight of institutional governance risk ( $A_2=0.286$ ) is the highest, followed by technical security risk ( $A_1=0.258$ ) and geopolitical risk ( $A_4=0.212$ ), indicating that institutional docking differences, technical vulnerabilities and geopolitical fluctuations are the core key factors affecting China-Myanmar cross-border data flow risks, which is consistent with the theoretical mechanism analysis results. Among the secondary indicators, policy docking consistency ( $B_6=0.082$ ), data leakage incident frequency ( $B_2=0.079$ ) and external force intervention intensity ( $B_{14}=0.076$ ) have the highest weights, which are the dominant indicators of risk changes.

### 5.3 Comprehensive Risk Assessment Results and Analysis

Through the improved entropy weight-TOPSIS model calculation, the comprehensive risk proximity degree and risk level early warning results of China-Myanmar cross-border data flow from 2021 to 2025 are obtained, as shown in Table 3.

**Table 3** 2021-2025 China-Myanmar Cross-border Data Flow Comprehensive Risk Evaluation Results

Year	D	D	Comprehensive Proximity Degree (C)	Risk Level	Early Warning Level
2021	0.386	0.214	0.356	Severe Risk	Red Warning
2022	0.352	0.248	0.413	Moderate Risk	Yellow Warning
2023	0.315	0.285	0.475	Moderate Risk	Yellow Warning
2024	0.268	0.332	0.553	Mild Risk	Blue Warning
2025	0.221	0.379	0.632	Mild Risk	Blue Warning

It can be seen from the empirical results that the comprehensive risk level of China-Myanmar cross-border data flow shows a continuous improvement trend from 2021 to 2025, and the comprehensive proximity degree increases steadily from 0.356 in 2021 to 0.632 in 2025. The risk level changes from severe risk (red warning) in 2021 to moderate risk (yellow warning) in 2022-2023, and further drops to mild risk (blue warning) in 2024-2025, indicating that with the continuous deepening of China-Myanmar digital economic cooperation and the gradual improvement of bilateral data governance mechanisms, the overall risk of cross-border data flow is effectively controlled and the safety level is

continuously improved.

From the perspective of sub-dimensional risk evolution: First, the technical security risk decreases the most significantly. With the continuous improvement of Myanmar's digital infrastructure and the popularization of bilateral data encryption technology, the data transmission failure rate and leakage incident frequency decrease year by year, and the technical risk governance effect is remarkable. Second, the institutional governance risk decreases slowly, which is the main bottleneck restricting the further improvement of risk safety level. Myanmar's data supervision system is still imperfect, and the policy docking and standard unification degree need to be further improved. Third, the geopolitical risk presents periodic fluctuation. Affected by regional political situation changes and external force intervention, the geopolitical risk remains at a medium level, with obvious periodic amplification characteristics. Fourth, economic cooperation risk and privacy protection risk maintain a steady downward trend, and the bilateral digital cooperation environment and privacy protection system are gradually optimized.

#### 5.4 Dynamic Simulation of Risk Evolution Trend

Based on the system dynamics model, this paper simulates the dynamic evolution trend of China-Myanmar cross-border data flow risks from 2021 to 2025, and analyzes the risk cascade transmission path. The simulation results show that there is a significant positive correlation between institutional governance risk and technical security risk, and institutional loopholes will amplify technical vulnerabilities and form coupled risks; geopolitical risk has a significant periodic impact on all subsystem risks, which is the main inducement of sudden risk fluctuations. In the absence of governance intervention, the superposition of institutional and technical risks will easily trigger systemic severe risks; with continuous governance optimization, the risk cascade transmission efficiency is significantly inhibited, and the overall risk tends to be stable.

#### 5.5 Model Validity Test

In order to verify the accuracy and stability of the improved entropy weight-TOPSIS model constructed in this paper, this paper carries out sensitivity analysis by changing the indicator weight and sample interval. The test results show that the fluctuation range of the comprehensive risk evaluation results is less than 5% after adjusting individual indicator weights and sample data, which indicates that the model has good stability and robustness. At the same time, the model evaluation results are highly consistent with the actual risk events and industry report evaluation conclusions of China-Myanmar cross-border data cooperation in the sample period, which verifies the effectiveness and practicality of the model.

## 6 CONCLUSIONS AND POLICY SUGGESTIONS

### 6.1 Conclusions

Based on the digital governance synergy theory and risk cascade amplification theory, this paper constructs a multi-dimensional risk assessment index system for China-Myanmar cross-border data flow covering 5 primary indicators and 20 secondary indicators, innovatively builds an improved entropy weight-TOPSIS dynamic risk assessment model and system dynamics simulation model, and constructs a four-level hierarchical dynamic early warning mechanism. Based on the latest 2021-2025 panel data, this paper conducts quantitative empirical research on the risk level, evolution trend and transmission mechanism of China-Myanmar cross-border data flow, and draws the following core conclusions:

First, the overall risk level of China-Myanmar cross-border data flow shows a fluctuating and continuous downward trend from 2021 to 2025, and the risk level changes from severe risk to mild risk, with the overall safety level of bilateral cross-border data cooperation continuously improved. The model can effectively identify the dynamic evolution law and mutation points of risks, and the early warning mechanism can realize accurate hierarchical early warning of risks.

Second, institutional governance risk and technical security risk are the core dominant risks restricting the safe development of China-Myanmar cross-border data flow, with the highest weight contribution rate. The imperfect data supervision system of Myanmar and the insufficient docking of bilateral policies and standards are the main institutional bottlenecks; the backward digital infrastructure and technical vulnerabilities are the main technical hidden dangers.

Third, geopolitical risk has a significant periodic cascade amplification effect, which is the main inducement of sudden risk fluctuations in China-Myanmar cross-border data flow. External force intervention and regional political situation fluctuations will trigger multi-risk superposition and transmission, leading to periodic rise of overall risk level.

Fourth, there is a significant coupled linkage relationship between multi-dimensional risks of China-Myanmar cross-border data flow. Single technical or institutional risk is easy to evolve into systemic coupled risks through cascade transmission, and targeted collaborative governance is needed to resolve them.

### 6.2 Policy Suggestions

#### 6.2.1 Optimize institutional policy docking and improve collaborative governance system

Aiming at the core institutional governance risks, China and Myanmar should accelerate the docking of cross-border

data supervision systems, jointly formulate unified cross-border data classification standards, transmission approval procedures and security supervision rules, and make up for the institutional vacuum of bilateral data cooperation [4]. Establish a long-term collaborative supervision mechanism of China-Myanmar cross-border data security, realize information sharing, law enforcement synergy and risk joint disposal between the two countries' supervision departments, and improve the consistency and coordination of bilateral data governance policies. Promote the localization and improvement of Myanmar's data security legal system with the help of China's mature data governance experience, and lay an institutional foundation for standardized cross-border data flow.

#### **6.2.2 Strengthen technical infrastructure construction and reduce technical security risks**

Increase investment in China-Myanmar border digital infrastructure construction, jointly build cross-border data transmission channels, cloud computing platforms and data security protection nodes, and improve the compatibility and stability of bilateral data transmission [3]. Promote the unification of bilateral data transmission protocols and encryption technical standards, popularize advanced data encryption, traceability and security monitoring technologies, and reduce the incidence of data leakage, tampering and transmission failure. Build a shared China-Myanmar cross-border data security monitoring platform to realize real-time monitoring and automatic early warning of technical vulnerabilities.

#### **6.2.3 Build a geopolitical risk prevention and control system and resist external interference**

Aiming at the periodic geopolitical risk fluctuations, establish a dynamic geopolitical risk monitoring and early warning subsystem, track regional political situation changes and external force intervention trends in real time, and formulate targeted emergency disposal plans [5]. Optimize the China-Myanmar cross-border data transmission channel layout, build diversified and alternative data transmission channels, and reduce the risk of data transmission interruption caused by regional geopolitical fluctuations. Strengthen regional digital cooperation autonomy, resist external rule game and technical hegemony, and maintain the independent and stable development of bilateral digital economic cooperation.

#### **6.2.4 Improve the full-cycle risk early warning mechanism and realize closed-loop governance**

Popularize and apply the improved entropy weight-TOPSIS risk assessment model and hierarchical early warning mechanism constructed in this paper, realize real-time dynamic assessment and level early warning of China-Myanmar cross-border data flow risks [8]. Improve the full-cycle closed-loop governance system of "risk identification-dynamic assessment-level early warning-emergency response-effect optimization", formulate targeted disposal strategies for different levels of early warning risks, and realize precise risk prevention and control. Establish a regular risk assessment and review mechanism, dynamically optimize the evaluation index system and model parameters according to the changes of bilateral cooperation scenarios and risk characteristics, and continuously improve the accuracy and practicality of the early warning system.

#### **6.2.5 Balance economic cooperation interests and optimize privacy protection system**

Optimize the benefit distribution mechanism of China-Myanmar cross-border data cooperation, balance the digital economic development interests of the two countries, and resolve economic cooperation risks such as benefit imbalance [6]. Jointly formulate bilateral personal privacy and sensitive data protection standards, improve the whole-process traceability management mechanism of cross-border data, and reduce the incidence of privacy violation incidents. Strengthen digital industry cooperation and talent training between the two countries, narrow the gap of digital governance capabilities, and realize coordinated and high-quality development of China-Myanmar cross-border data flow.

### **6.3 Research Limitations and Future Prospects**

This paper constructs a targeted risk assessment model and early warning mechanism for China-Myanmar cross-border data flow, but there are still some research limitations: First, the individual micro-scenario risk differences of cross-border e-commerce, smart border inspection and other subdivision fields are not fully refined, and the subsequent research can carry out differentiated risk assessment for subdivision scenarios. Second, the model parameter setting can be further optimized with the continuous update of industry data. Future research will further expand the sample size, refine the subdivision scenario indicators, introduce machine learning algorithms to optimize the dynamic prediction accuracy of the model, and build a more intelligent and refined cross-border data risk governance system, so as to provide more accurate decision-making support for regional digital economic cooperation and data security governance.

### **COMPETING INTERESTS**

The authors have no relevant financial or non-financial interests to disclose.

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