Risk Path Identification and Research of Digital Trade Enterprises Based on the DEMATEL-ISM-MICMAC Model

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Abstract: As the world’s largest trading country, it is very important to ensure the stable operation of digital trading enterprises in the digital economy. Therefore, it is necessary to study the identification and influence path of risk factors. Based on the literature analysis method and expert interview method, this paper determines 18 risk factors of digital trade enterprises, and then divides the risk into two dimensions of internal and external factors to form the risk path identification index system of digital trade enterprises. The DEMATEL (Decision Making Trial and Evaluation Laboratory) -ISM (Interpretative Structure Method-Cross-Impact) -MICMAC (Matrix Multiplication Applied to Classification) method was used to quantitatively reveal the comprehensive influence degree of each influencing factor. And the reason degree and centrality of its impact on the risk of China’s digital trade enterprises are divided into strong (weak) driving type according to the value of reason degree greater than zero (less than zero). Further analysis of the hierarchical structure and overall influence relationship of the risk factors of China’s digital trade enterprises, the causes of the seven levels of China’s digital trade enterprise risk are obtained. Then, combined with the dependence of each key risk factor and the size of the driving force, the risk factors are divided into four quadrants, and the interaction between the risk factors is revealed. The results show that the key factors affecting enterprises are financial risk, decline of digital trade, increase of trade barriers, aggravation of digital financial risk spillover and aggravation of supply chain crisis. Based on the algorithm, this study identifies the risk factors and ways that affect Chinese digital trade enterprises. The research results can provide theoretical risk path guidance for the risk management of enterprise risks, and provide scientific decision-making basis for enterprises when facing risks.

Keywords: Digital trade; risk; path; DEMATEL; ISM; MICMAC.

1. Introduction

At present, China is in an important stage of digital transformation and traditional industry empowerment. The development momentum of digital trade is strong. Through the continuous promotion of the "four-in-one" industrial chain, the digital trading platform will accelerate the reconstruction of the traditional trade industrial chain and solve the key problems such as supply and demand mismatch and insufficient coordination ability of the industrial chain. It will expand the space of digital trading market for agriculture, steel, plastic, wholesale and cross-border industries, promote the two-way promotion of digital trading platform, promote the continuous deepening of industry upgrading and business segmentation, accelerate the upgrading to the ecological industry platform, and promote the high-quality development of China’s supply side and demand side. China’s position in the field of digital trade was clarified in the "Digital Trade Leading Trade Innovation and Development" at the 2022 Service Trade Forum. The construction of digital trade in the ancient Silk Road Economic Belt represented by the "Belt and Road" not only promotes the economic development of countries along the route, but also greatly promotes the development of cross-border e-commerce in China. Digital trade has become an important starting point for global trade recovery in the epidemic and post-epidemic eras. It has greatly alleviated the global economic downturn under the impact of the epidemic and the prevalence of Western hegemonism, which has provided an internal impetus for the steady recovery of China’s economy and will further deepen cooperation with countries around the world in various fields. Domestic and foreign scholars have carried out more research on the construction and development of digital trade. In terms of the construction of the "Belt and Road" digital economy, Gaojiang [2] proposed the main direction of promoting the development of China’s digital trade along the "Belt and Road" from the heterogeneity of the economies along the "Belt and Road," the digital transformation of service trade and goods trade, and the integration of the network...
security industry chain. Looking forward to the post-epidemic era, Zhao Qi [3] suggested that China should strengthen co-construction and sharing, build a network data security system, build a digital economic community, and promote the construction of digital ‘Belt and Road’. From the current situation of digital trade, Ren Xiaoxia [4], from the impact of digital trade on the reconstruction of global value chain, and the lack of China’s digital trade module, the core provisions of digital trade rules and China’s demands are discussed, which shows the acceleration of the reconstruction process of China’s digital industry value chain and the challenges faced by the game of international digital trade rules.

Based on the algorithm level: Ma Huilian et al. [5], through descriptive analysis, correlation analysis and regression analysis, the influencing factors affecting the competitiveness of China’s digital trade are screened out by 10 influencing factors. It is concluded that the level of science and technology investment, the development of the secondary industry, the openness of digital trade and policies have a significant positive impact on China’s digital trade competitiveness. In the current domestic and foreign literature, it is common to use DEMATEL, ISM and MICMAC alone or in combination. There are few studies using the three methods, and the ISM-MICMAC model is often used by articles in the medical field. At present, Xiang Yuran et al. [6] combined three models for mechanism analysis in scaffold accidents. Zhang Yuqing et al. [7] combined three models to analyze the fishery field for the first time, and analyzed the differences and complementarities of the combined models.

In summary, digital trade risk research has accumulated rich research results. However, there is a lack of systematic path analysis, causal relationship between risks and correlation between risks. Most of the current research stays in the analysis of the risk of a single digital trade enterprise, and lacks the discussion of the path and connection of risk. This paper obtains 18 risk factors based on literature analysis and expert interviews. In order to facilitate statistics, the factors are divided into internal and external parts, and then the correlation between risk factors is systematically analyzed by combining DEMATEL, ISM and MICMAC.

2. The construction of digital trade enterprise risk index system

2.1 External

Network security is related to whether the internal information of the enterprise is safe. If the internal information is leaked, it will lead to the decline of the enterprise’s own reputation and credit. In severe cases, it will also make the enterprise lose the leading technology, the decline of market reputation and the loss of high-quality customer groups. Export inhibition and increased trade barriers will lead to blocked exports, decreased product export sales, and lack of customer groups, sales channels and demand in the domestic market, which will lead to a double decline in production and income. Supply chain is an important guarantee for enterprise production and sales. If there are unfavorable factors such as the collapse of upstream and downstream enterprises, it will lead to large-scale bad debts and shortage of raw materials, and it is necessary to reopen downstream sales channels; the decline in digital trade means that speculators and consumers in the macro economy have poor expectations for the future, resulting in lower demand, lower consumption, surging corporate inventories and increased debt; although the frequency of force majeure is low, once it occurs, it will have a greater impact on the upstream and downstream of the industrial chain. The "deficit" of digital trade governance refers to the shortage of public goods such as global digital trade governance. The lag and vacuum of supervision will increase speculation and illegal behavior, and increase the trade risk of enterprises. Countries around the world attach great importance to tax source management, which is the starting point and basis of tax collection and management. Tax source risk affects the pricing of products by enterprises and the demand of consumers for products. Strategic decision-making mistakes usually do not have an immediate negative impact, but the impact on the entire economy is far-reaching. The reasons for the spillover of external factors into systemic financial risks are stock market fluctuations and investors’ sentiment towards financial markets, while digital trading companies are affected by exchange rate fluctuations and consumers’ willingness to buy. (as shown in Table 1)

2.2 Internal

Financial risk spillover is conducted by banks. Due to the leverage effect and risk contagion of financial institutions, a large number of financial institutions default, which in turn leads to corporate default and bankruptcy; industry competition intensifies, in order to seize the market, the enterprise’s own profits become low, or even no profit or loss for a long time; the decline of credit rating directly affects the decline of investors’ earnings expectations of stocks and bonds of enterprises, and affects the ability of companies to raise funds; in terms of digital trade and service trade, Chinese enterprises enjoy more preferential policies. If the enterprises are in the incubation and startup stage when the dividend disappears, the financial pressure will directly affect the survival of the enterprises. In the process of industrial transformation and upgrading, enterprises raise funds or use free funds by issuing foreign debt. If the digital transformation is not good, the operation of enterprises will be hindered and chaos will occur within enterprises. The cross-border flow of R & D elements will be limited, which will adversely affect the production and sales of enterprises. The digital service trade barrier has a significant effect on shortening the length of the value chain, especially the positive value chain length of the downstream industry and the reverse value chain length of the downstream industry, which is not conducive to the extension of the enterprise value chain; digital service trade barriers are mainly reflected in restricting the entry of service elements and increasing costs, because the trade rules formulated by the leaders of the United States, Japan and Europe will be more
3. Research methods

Through the analysis of existing research, the main research factors of digital trade risk are extracted. The DEMATEL method calculates the causal relationship and influence degree between factors through matrix operations on the basis of expert scoring, and obtains the causal relationship of visual factors. Combined with expert experience, the key influencing factors and degree of influence of complex issues are digitally presented. The ISM-MICMAC rules analyze the relationships between the subsystems (factors or elements) that make up the system. Based on Boolean algebra operations, the complex system is decomposed, and a multi-level ladder directed topological graph is constructed, and then the driving force and dependence of the impact are obtained by MICMAC to share the risk factors fairly, so as to clarify each influencing factor position and role in the system. Therefore, by combining the three, not only can the key elements of the system and the degree of influence be identified, but also a hierarchical structure diagram of the system elements can be constructed, and the driving forces and dependencies among risk factors can also be known. The steps of DEMATEL-ISM-MICMAC method to identify the risk path of China's digital trade are as follows \[34\]:

1) According to the analysis results, a directed graph is constructed, and the risk factor set is defined as \( Z = \{ Z_1, Z_2, \ldots, Z_n \} \). Based on directed graph, expert scoring method is adopted. Experts rate the 18 indicators based on their own experience and expertise. Scoring criteria: 0 (no effect), 1 (weak effect), 2 (moderate effect), 3 (strong effect), 4 (super strong effect). Comparing \( y_{ij} \) and \( y_{ji} \) (\( i = 1,2,\ldots,18; j = 1,2,\ldots,18 \)) (i is the X axis, j is the Y axis). Since the factor has no effect compared with itself, if \( i = j \), then \( y_{ij} = 0 \) is the diagonal value of the direct influence matrix is 0. Get the direct influence matrix between the factors \( Y = (y_{ij})_{n \times n}, i, j = 1,2,\ldots,n \). The direct influence matrix Y is normalized, and the normalized indirect influence matrix X is obtained by:

\[
X = \frac{Y}{B}, \quad B = \max_{1 \leq i < n} \left( \sum_{j=1}^{n} y_{ij} \right)
\]

2) The direct influence matrix \( Y \) is normalized, and the normalized indirect influence matrix X is obtained by:

\[
T = \lim_{k \to +\infty} (X + X^2 + \cdots X^k) = X(1 - \lambda)^{-1}
\]

Where \( I \) is the unit matrix, \( t_{ij} \) denotes the direct and indirect influence of \( Z_i \) factor on factor \( Z_j \). Calculate the influence degree, influence degree, centrality and cause degree. Formula (3-6) is shown. The row and Q of the comprehensive influence matrix T are the influence degree, and the column and D are the affected degree.

\[
Q_i = \sum_{j=1}^{n} t_{ij}, \quad i = 1, 2, \ldots n
\]

\[
D_j = \sum_{i=1}^{n} t_{ij}, \quad j = 1, 2, \ldots n
\]

Where \((Q + D)\) is the centrality and \((Q - D)\) is the cause, the centrality:

\[
p_i = Q_i + D_j = \sum_{j=1}^{n} t_{ij} + \sum_{i=1}^{n} t_{ji}, \quad i = 1, 2, \ldots n
\]

the cause:

\[
q_j = Q_i - D_j = \sum_{j=1}^{n} t_{ij} - \sum_{i=1}^{n} t_{ji}, \quad j = 1, 2, \ldots n
\]

Centrality represents the location of a factor in the evaluation system and the size of its impact, indicating the degree of contact between the various factors in the system. The position of the cause degree determining factor in the system. The difference between the cause factor and the result factor is judged according to the positive and negative degree of cause, greater than 0 is the
cause factor, and less than 0 is the result factor. Draw a causal diagram. Taking the centrality $p_i$ as the abscissa and the cause $q_j$ as the ordinate, the causality diagram is drawn to simplify the causality. Determine the overall impact matrix. Formula (7) is shown

$$H = T + I = [h_{ij}]_{n \times n}$$

I is the unit matrix, and $h_{ij}$ is the direct and indirect influence of factor i on factor j. Determine the reachability matrix M, let $M = [m_{ij}]_{n \times n}$ $i = 1, 2, ..., n$ where $m_{ij}$ represents whether subsystem i has an impact on subsystem j under a given threshold $\lambda$. If $h_{ij} \geq \lambda$, there is an impact. $m_{ij} = 1$; if $h_{ij} < \lambda$ represents no effect, $m_{ij} = 0$. Formula (8) is shown

$$m_{ij} = \begin{cases} 1, & h_{ij} \geq \lambda \ (i, \ j = 1, 2, ..., n) \\ 0, & h_{ij} < \lambda \ (i, \ j = 1, 2, ..., n) \end{cases}$$

9) Construct the ISM model.

Through the reachability matrix and MICMAC method, the rows and columns of the reachability matrix M are summed [(9) (10)], and all indicators can be divided into five regions: I (autonomous factors), II (dependent factors), III (associated factors), IV (driving factors), V (adjustment factors).

$$E_j = \sum_{i=1}^{18} k_{ij}, \ j = 1, 2, ..., 18$$

$$F_j = \sum_{j=1}^{18} k_{ij}, \ j = 1, 2, ..., 18$$

Where $E_j$ is the dependence, $F_j$ is the driving force, and $F_{ij}$ is the constituent element of the reachable matrix K. The quadrant diagram is drawn by the dependence and driving force calculation results. Then the status and role of the influencing factors are analyzed, the various characteristics of each influencing factor are clarified, and suggestions or measures are proposed. According to the above steps, the implementation flow chart based on the DEMATEL-ISM-MICMAC model used in the article is shown in Figure 1:

After extensive consultation with relevant practitioners and scholars of digital trade and international economy and trade, and group discussions, a direct impact matrix $Y$ was obtained. The establishment rule is: if $y_{ij}$ has no effect on $y_j$, it is 0; if it has an impact, it is scored in 1-4 levels. The results are as shown in Table 3:

According to formulas (1) and (2), the comprehensive influence matrix T can be obtained, and according to formula (3) ~ (6), Table 2 can be obtained. Table 2 shows the correlation value between the indexes obtained by the DEMATEL method, which analyses the correlation and importance between factors. The role and importance of each factor can be seen intuitively in Fig.2. The size of the centrality represents the degree of correlation with other factors and their importance in the system. The higher the centrality ranks in Table 4, the closer it is to the distribution of vulnerability indicators, the stronger the correlation, and the more it is distributed to the right in Figure 2.

<table>
<thead>
<tr>
<th>Factor</th>
<th>$Q_i$</th>
<th>$D_i$</th>
<th>$p_i$</th>
<th>$q_i$</th>
<th>Sorting of $p_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>z1</td>
<td>0.056</td>
<td>0.169</td>
<td>0.225</td>
<td>-0.112</td>
<td>18</td>
</tr>
<tr>
<td>z2</td>
<td>0.252</td>
<td>0.685</td>
<td>0.937</td>
<td>-0.434</td>
<td>6</td>
</tr>
<tr>
<td>z3</td>
<td>0.045</td>
<td>1.372</td>
<td>1.417</td>
<td>-1.327</td>
<td>3</td>
</tr>
<tr>
<td>z4</td>
<td>0.566</td>
<td>0.397</td>
<td>0.963</td>
<td>0.169</td>
<td>5</td>
</tr>
<tr>
<td>z5</td>
<td>0.738</td>
<td>0.791</td>
<td>1.529</td>
<td>-0.052</td>
<td>2</td>
</tr>
<tr>
<td>z6</td>
<td>0.000</td>
<td>0.433</td>
<td>0.433</td>
<td>-0.433</td>
<td>11</td>
</tr>
<tr>
<td>z7</td>
<td>0.406</td>
<td>0.047</td>
<td>0.452</td>
<td>0.359</td>
<td>10</td>
</tr>
<tr>
<td>z8</td>
<td>0.231</td>
<td>0.167</td>
<td>0.398</td>
<td>0.063</td>
<td>13</td>
</tr>
<tr>
<td>z9</td>
<td>0.120</td>
<td>0.448</td>
<td>0.568</td>
<td>-0.328</td>
<td>8</td>
</tr>
<tr>
<td>z10</td>
<td>0.446</td>
<td>0.871</td>
<td>1.317</td>
<td>-0.425</td>
<td>4</td>
</tr>
<tr>
<td>z11</td>
<td>0.452</td>
<td>0.110</td>
<td>0.562</td>
<td>0.341</td>
<td>9</td>
</tr>
<tr>
<td>z12</td>
<td>0.367</td>
<td>0.000</td>
<td>0.367</td>
<td>0.367</td>
<td>15</td>
</tr>
<tr>
<td>z13</td>
<td>0.058</td>
<td>0.340</td>
<td>0.398</td>
<td>-0.282</td>
<td>14</td>
</tr>
<tr>
<td>z14</td>
<td>0.640</td>
<td>0.139</td>
<td>0.779</td>
<td>0.501</td>
<td>7</td>
</tr>
<tr>
<td>z15</td>
<td>0.417</td>
<td>0.000</td>
<td>0.417</td>
<td>0.417</td>
<td>12</td>
</tr>
<tr>
<td>z16</td>
<td>0.226</td>
<td>0.057</td>
<td>0.282</td>
<td>0.169</td>
<td>16</td>
</tr>
<tr>
<td>z17</td>
<td>0.191</td>
<td>0.057</td>
<td>0.248</td>
<td>0.134</td>
<td>17</td>
</tr>
<tr>
<td>z18</td>
<td>1.295</td>
<td>0.422</td>
<td>1.717</td>
<td>0.873</td>
<td>1</td>
</tr>
</tbody>
</table>

From the correlation of factors in Table 2. The order of measures is: financial risk (z18), decrease in digital trade (z5), increase in trade barriers (z3), increase in the spillover of digital financial risk (z10), intensive supply chain crises (z4), suppression intensive export effect (z2), poor digital transformation (z14), national strategic decision making error (z9), intensive digital trade competition (z11), intensive digital trade management deficit (z7), force majeure factor (z6), slowing cross-border flows of R&D factors (z15), increased tariff sourcing risk (z8), loss of digital trade dividends (z13), downgraded corporate credit rating (z12), reduced value chain length (z16), poor adaptation to laws.

4. Result

4.1 Correlation and importance of influencing factors
and regulations (z17), and increased tissue risk (z1). In a comparison of the different degrees of influence and degrees of influence, the digital trade management deficit increased (z7), digital trade competition increased (z11), corporate ratings decreased (z12), digital transformation was not good (z14), cross-border flows of R & D elements slowed (z15), increased trade barriers (z3), force majeure factors (z6), national decision making errors (z9) The difference between the degree of influence and the level of influence is significant. The first five levels of influence are larger than the levels of influence, indicating that the factors are mostly external in nature, and the last three factors are more susceptible to external influences. In addition, the centrality of the financial index decline (z18) is 1.71, the impact is 1.295, and the reason is 0.873, ranking first, representing the core of the system, with the most significant impact, indicating that the financial index is an indispensable index for enterprises. When a business fails to operate normally or is poorly managed, it is more susceptible to other risks. Second, the influence, influence and centrality of the decline in digital trade are at relatively high levels, 0.738, 0.791 and 1.529, respectively, indicating that the digital trade economy is crucial to digital trade enterprises. Easily affected by other factors, also easily affected by other factors. The combined influence between factors (the sum of influencing and influenced factors) is low. The less active factors are increased network risk, slowed cross-border flow of R & D factors, reduced value chain length, and poor adaptation to laws and regulations.

![Figure 2](image)

**Figure 2**: Factor centrality-cause degree distribution of digital trade enterprise risk indicators

It can be observed that the factors z1 ~ z3, z5, z6, z9, z10 and z13 below the cause value of less than 0 indicate that the factor has little effect on other factors and is expressed as a result factor, while the factor above greater than 0 is expressed as a cause factor. In the upper right part of Figure 2, the factors are expressed as strongly driven, and their combined influence is greater than that of the driving factors expressed in the sitting part.

### 4.2 Hierarchical structure of the system

According to the reachable matrix M, according to the ISM method, the hierarchical structure of the risk path of digital trade enterprises is obtained. According to Figure 3, it is found that the risk influencing factors of digital trade enterprises are divided into seven hierarchical systems. The top layer includes z15 and z12, both of which belong to the internal factors of the enterprise. It is the direct cause of enterprise risk and the ultimate impact target of the path. The second and third layers of the model are transitional elements, including z18, z17, z14 and z16. The fundamental cause of the middle layer and the direct influencing factors of the top layer are the influencing paths in the model. The fourth layer belongs to the middle layer, including fundamental influencing factors such as z1, z2, z4, z5, z7, z8, z10, z11 and z13, which are closely related to the policy and economic environment. The fifth to seventh layers include z3, z9 and z6, which belong to the deeper root cause and affect the top-level target by affecting the middle layer and the transition layer.

![Figure 3](image)

**Figure 3**: Hierarchical frame diagram of financial risk influencing factors of digital trade enterprises

### 4.3 Dependency-driven relationship

According to the reachable matrix M and MICMAC model, Figure 4 is obtained. The dependence and driving force are the x-axis and y-axis, respectively, and are the sum of the column and row elements of the reachable matrix M, respectively. The average value of the dependence and driving force of 18 factors is 11.61. The average value is used as the dividing line perpendicular to the x-axis and the y-axis and is defined as the V zone, where zone I is the autonomous factor, zone II is the dependent factor, usually has a solid ability to link other factors, controlled by other factors. However, the driving force is not strong, zone III is the correlation factor, and zone IV is the driving factor.

![Figure 4](image)

**Figure 4**: MICMAC classification of risk factors of digital trade enterprises

According to Figure 4, the influencing factors in the model can be divided into three categories: the dependent factors in the fourth quadrant, the dependent factors in the second quadrant and the third linear correlation factors. Among them, there are six factors in the second quadrant, namely, financial risk (z18), slowing the cross-border flow of R & D elements (z15), decreasing value...
chain length (z16), poor adaptation of laws and regulations (z17), declining enterprise rating (z12), and poor digital transformation (z14), which have the characteristics of high dependence and low driving force. The factors belonging to the dependent group are easily affected by other factors. There are nine factors in the third quadrant, which are the decline of digital trade (z5), the increase of digital financial risk spillover (z10), the increase of supply chain crisis (z4), the increase of digital trade competition (z11), the increase of digital trade management deficit (z7), the increase of tariff source risk (z8), the disappearance of digital trade dividend (z13), the increase of network risk (z1), the increase of digital trade management deficit (z7), which have the characteristics of a high driving force and high dependence, indicating that the factors studied in this paper have a strong correlation. There are practice group factors belonging to the fuzzy correlation concept. There are three factors in the fourth quadrant, which are the increase of trade barriers (z3), the failure of national strategic decision-making (z9), and the force majeure factor (z6). They have the characteristics of a high driving force and low dependence. Conclusions 

This paper combines the three models to analyze the risk factors of digital trade enterprises. International economic and trade cooperation and lower trade barriers are the main factors for the development of enterprises. The research in this paper is not only applicable to provide theoretical supplement and practical guidance for digital trade enterprises under dual circulation, but also applicable to the analysis and research of risk paths in various industries.

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