

Evaluation of Equipment Development Strategies Based on SWOT

Xiaowei ZHANG^{1*}, Wentao DONG², Yuanyuan LIN³, Yucai DONG⁴

{yourzhxw@163.com^{1*}, 1182575438@qq.com², linyuanyuan_001@163.com³,
dongyucai_001@163.com⁴}

The 15th Research Institute of China Electronics Technology Group Corporation, Beijing 100083, China

Abstract. SWOT method is an important tool in the research and development of strategic planning process. Using SWOT method, the analytical framework model for equipment development strategy assessment is developed, strategic environment analysis of weapons and equipment development is carried out, the impact of environmental factors is analyzed, internal and external strengths, weaknesses, threats and opportunities are scored to provide a more accurate support basis for future strategic development.

Keywords: SWOT, equipment development, environmental factors

1. Introduction

The strategic environment, also known as the macro environment, refers to the objective situation and conditions faced by a country in a certain period of time that affect the overall situation of the country. It mainly includes the international and domestic political, economic, scientific and technological, geographical and other aspects of the basic situation, as well as the resulting strategic posture. Weapons and equipment development strategic environment, refers to the development of weapons and equipment in a certain period of time faced by the objective situation and conditions affecting the overall situation of equipment confrontation, as well as the resulting strategic posture. The strategic environment of weapon and equipment development often changes with the development of the domestic and international situation^[1-3].

Strategic environmental analysis of weapon and equipment development is a process of systematic and comprehensive evaluation of the environmental impact of policies, plans and alternatives for weapon and equipment development at a strategic level. As an important element of strategic research on equipment development, the conclusions of the strategic environmental analysis of weapons and equipment development have a great impact on the systematic justification of weapons and equipment development^[4-7].

The SWOT method is a combination of qualitative and quantitative analysis, and is a systematic analysis method that correlates internal and external factors^[8-16]. The SWOT analysis focuses on the potential threats and opportunities of the external environment and the inherent strengths and weaknesses of the internal environment. The SWOT analysis focuses on the potential threats and opportunities of the external environment, and the inherent strengths and weaknesses of the internal environment, cross-relating internal and external

environmental factors according to the logic of seizing opportunities, strengthening strengths, avoiding threats and overcoming weaknesses, and providing a theoretical basis for the organization to adapt to the environment and formulate development strategies with clear and concise quantitative assessment conclusions. Based on this model, a more objective and accurate understanding and analysis of the strategic environment can be carried out to develop a more realistic strategy^[17].

2. Principle of the algorithm

2.1. Brief introduction

The SWOT method is a new approach to strategic environmental analysis and one of the most common and effective methods in strategic management, first proposed by K. J. Andrews of Harvard Business School in 1971. The SWOT method is a method of strategic environmental analysis and one of the most common and effective methods in strategic management. The so-called SWOT analysis, that is, based on the internal and external competitive environment and competitive conditions of the situation analysis, is closely related to the object of study of the various major internal strengths, weaknesses and external opportunities and threats, etc., through the survey listed and arranged in the form of a matrix, and then using the idea of system analysis, the various factors match each other to analysis, from which a series of corresponding conclusions, and the conclusions usually The conclusions are usually of a decision-making nature.

S (strengths), W (weaknesses), O (opportunities) and T (threats) are the four factors of the SWOT approach. According to the complete concept of competitive strategy, strategy should be an organic combination of what a country is 'able to do' (i.e. its strengths and weaknesses) and what it is 'likely to do' (i.e. the opportunities and threats of the environment). Using the SWOT method, a comprehensive, systematic and accurate study of the situation in which the subject of the study is located can be carried out, so that corresponding development strategies, plans and countermeasures can be formulated based on the results of the study.

2.2. Basic steps

- (1) Establish a SWOT analysis framework model and construct a system of indicators for external strategic environmental factors and internal strategic environmental factors for weapons and equipment development;
- (2) Determining indicator weights and quantifying assessment values;
- (3) To build a mathematical model for comprehensive calculation and analysis to obtain assessment conclusions.

2.3. Specific processes

- (1) Establish a SWOT analysis framework model and construct a system of indicators of external strategic environmental factors and internal strategic environmental factors for the development of weapons and equipment, as showed in table 1.

Table 1. SWOT analysis framework

S (internal strengths)	W (internal disadvantage)
O (external opportunities)	T (external threat)

(2) The coefficient of variation method is used to calculate the weights. The coefficient of variation is an important indicator of the trend away from the centre, reflecting the differences and fluctuations in the values taken, and is numerically equal to the standard deviation divided by the mean value.

1) Collection and collation of raw data

Assuming a sample of n to be evaluated and p evaluation indicators, a data matrix of raw data indicators is formed:

$$X = \begin{pmatrix} x_{11} & \cdots & x_{1p} \\ \vdots & \ddots & \vdots \\ x_{n1} & \cdots & x_{np} \end{pmatrix}$$

Where x_{ij} indicates the value of the j indicator for the i sample.

2) Calculate the mean and standard deviation of the evaluation indicators at j .

$$\bar{x}_j = \frac{1}{n} \sum_{i=1}^n x_{ij}, j = 1, 2, \dots, p \quad (1)$$

$$s_j = \sqrt{\frac{\sum_{i=1}^n (x_{ij} - \bar{x}_j)^2}{n-1}}, j = 1, 2, \dots, p \quad (2)$$

3) Calculate the coefficient of variation of the j evaluation indicator

$$v_j = \frac{s_j}{\bar{x}_j}, j = 1, 2, \dots, p \quad (3)$$

4) Normalization of the coefficient of variation and hence the weights of each indicator

$$w_j = \frac{v_j}{\sum_{i=1}^p v_i} \quad (4)$$

Then the final indicator weights are calculated

$$W = \{w_1, w_2, \dots, w_p\} \quad (5)$$

(3) To build a mathematical model for comprehensive calculation and analysis to obtain assessment conclusions.

$$OT = \frac{\text{opportunities final score}}{\text{Threat final score}} \quad (6)$$

If $OT > 1$, then the opportunities outweigh the threats and the external environment is attractive;

$$SW = \frac{\text{strengths final score}}{\text{weaknesses Final Score}} \quad (7)$$

If $SW > 1$, then the advantages outweigh the disadvantages and the army is internally competitive.

Based on the two calculated ratios, a strategic choice moment diagram is produced. Based on the type of strategic choice, strategic development planning is carried out.

3. Model flow chart

The flowchart of the equipment development strategy evaluation algorithm is shown in Figure 1.

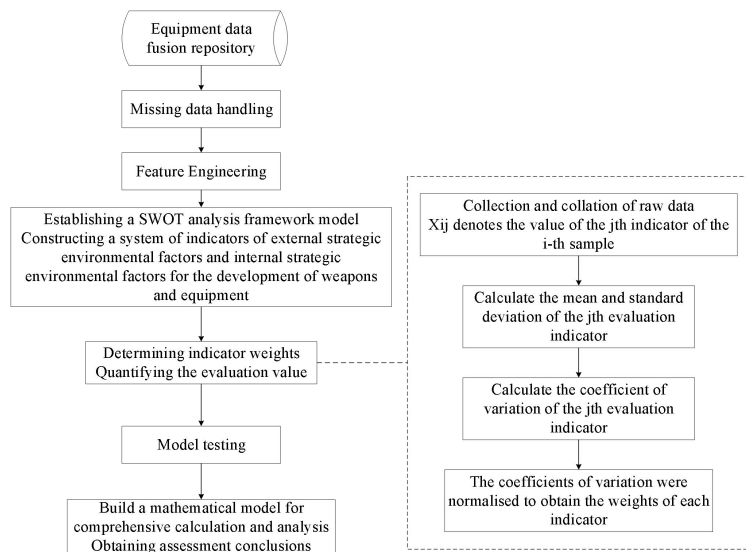


Fig. 1. Flow chart of the development strategy evaluation model

4. Example analysis

4.1. SWOT analysis framework model

After expert argumentation, the SWOT analysis framework model is established to construct the indicator system of external strategic environmental factors for weaponry development and the indicator system of internal strategic environmental factors, including a total of five indicators of S (internal advantages), a total of five indicators of W (internal disadvantages), a total of five indicators of O (external opportunities), and a total of five indicators of T (external threats), as shown in table 2.

Table 2. SWOT analysis framework model

Serial number	Tier 1 indicators	Secondary indicators
1	S (internal strengths)	S ₁ : Rapid growth of the country's economic power
2		S ₂ : National interest expansion and defence security needs pull
3		S ₃ : Strong equipment buying power
4		S ₄ : Traction of force combat composition on weaponry requirements
5		S ₅ : Strong weapons and equipment chain and low production costs
6	W (internal disadvantage)	W ₁ : Slow update of equipment and low intactness rate
7		W ₂ : Insufficient capacity for military science and technology innovation
8		W ₃ : Key technologies are constrained, and there is a lack of key military high technology and high tech equipment
9		W ₄ : Relatively low defense spending
10		W ₅ : Inadequate equipment security and maintenance capacity
11	O (external opportunities)	O ₁ : The evolution of the world's geostrategic landscape, and geo-advantage
12		O ₂ : Significant target characteristics such as the main competitor carrier platforms and high pressure on survival protection
13		O ₃ : Limited number of major competitors' backbone equipment
14		O ₄ : High manufacturing costs of major competitors' weaponry
15		O ₅ : Some of the technologies of the main competitors have not yet been converted into equipment capacity
16	T (external threat)	T ₁ : Military power of the target of combat is increased
17		T ₂ : Advanced combat performance of the main competitors' sea and air platforms, with long-range, stealthy, high-speed and other mobile combat capabilities
18		T ₃ : Major competitor space-based and network systems have the edge
19		T ₄ : Major competitors have an absolute nuclear advantage
20		T ₅ : Technology more than one generation ahead of major competitors, fast development

4.2. Indicator weights

Determination of indicator weights and quantification of assessment values, as showed in table 3 - table 6.

Table 3. Internal strengths indicators and scores

Internal strength indicators	5	4	3	2	1
S ₁ : Rapid growth of the country's economic power	100	50	40	10	0
S ₂ : National interest expansion and defence security needs pull	80	55	32	10	23
S ₃ : Strong equipment buying power	77	40	43	31	7
S ₄ : Traction of force combat composition on weaponry requirements	80	60	21	22	14
S ₅ : Strong weapons and equipment chain and low production costs	75	48	52	10	15

Table 4. Internal Disadvantage Indicators and Ratings

Internal Disadvantage Indicators	5	4	3	2	1
W ₁ : Slow update of equipment and low intactness rate	93	43	20	14	30
W ₂ : Insufficient capacity for military science and technology innovation	97	41	15	19	28
W ₃ : Key technologies are constrained, and there is a lack of key military high technology and high tech equipment	103	38	20	15	14
W ₄ : Relatively low defense spending	71	37	40	23	29
W ₅ : Inadequate equipment security and maintenance capacity	60	48	48	35	25

Table 5. External opportunity indicators and scores

External Opportunity Indicators	5	4	3	2	1
O ₁ : The evolution of the world's geostrategic landscape, and geo-advantage	110	58	20	7	5
O ₂ : Significant target characteristics such as the main competitor carrier platforms and high pressure on survival protection	95	43	32	10	20
O ₃ : Limited number of major competitors' backbone equipment	80	70	30	30	52
O ₄ : High manufacturing costs of major competitors' weaponry	100	55	30	5	10
O ₅ : Some of the technologies of the main competitors have not yet been converted into equipment capacity	75	48	52	10	15

Table 6. External threat indicators

External threat indicators	5	4	3	2	1
T ₁ : Military power of the target of combat is increased	41	45	30	50	34
T ₂ : Advanced combat performance of the main competitors' sea and air platforms, with long-range, stealthy, high-speed and other mobile combat capabilities	20	30	50	40	60
T ₃ : Major competitor space-based and network systems have the edge	103	50	34	13	0

T4: Major competitors have an absolute nuclear advantage	95	55	35	6	9
T5: Technology more than one generation ahead of major competitors, fast development	40	20	35	60	45

The weights and weighted averages of the indicators were calculated by the coefficient of variation method using equations (1)-(4), as showed in table 7 - table 10.

Table 7. Internal strengths weights and weighted average scores

Internal strength indicators	Rating	Weighting	Weighted average
S ₁ : Rapid growth of the country's economic power	4.200	0.1434	0.6023
S ₂ : National interest expansion and defence security needs pull	3.795	0.2266	0.8599
S ₃ : Strong equipment buying power	3.753	0.2112	0.7926
S ₄ : Traction of force combat composition on weaponry requirements	3.863	0.2113	0.8164
S ₅ : Strong weapons and equipment chain and low production costs	3.790	0.2075	0.7863
Weighted summation			3.8575

Table 8. Internal disadvantage weights and weighted average scores

Internal Disadvantage Indicators	Rating	Weighting	Weighted average
W ₁ : Slow update of equipment and low intactness rate	3.775	0.2044	0.7717
W ₂ : Insufficient capacity for military science and technology innovation	3.800	0.2038	0.7745
W ₃ : Key technologies are constrained, and there is a lack of key military high technology and high tech equipment	4.058	0.1654	0.6714
W ₄ : Relatively low defense spending	3.490	0.2167	0.7564
W ₅ : Inadequate equipment security and maintenance capacity	3.384	0.2096	0.7092
Weighted summation			3.6832

Table 9. External opportunity weights and weighted average scores

External Opportunity Indicators	Rating	Weighting	Weighted average
O ₁ : The evolution of the world's geostrategic landscape, and geo-advantage	4.305	0.1406	0.6052
O ₂ : Significant target characteristics such as the main competitor carrier platforms and high pressure on survival protection	3.915	0.2116	0.8285
O ₃ : Limited number of major competitors' backbone equipment	3.366	0.2817	0.9481
O ₄ : High manufacturing costs of major competitors' weaponry	4.150	0.1648	0.6839
O ₅ : Some of the technologies of the main competitors have not yet been converted into equipment capacity	3.790	0.2013	0.7631

Weighted summation

3.8288

Table 10. External threat weights and weighted average scores

External threat indicators	Rating	Weighting	Weighted average
T ₁ : Military power of the target of combat is increased	3.045	0.2322	0.7071
T ₂ : Advanced combat performance of the main competitors' sea and air platforms, with long-range, stealthy, high-speed and other mobile combat capabilities	2.550	0.2610	0.6655
T ₃ : Major competitor space-based and network systems have the edge	4.215	0.1132	0.4772
T ₄ : Major competitors have an absolute nuclear advantage	4.105	0.1323	0.5431
T ₅ : Technology more than one generation ahead of major competitors, fast development	2.750	0.2613	0.7186
Weighted summation			3.1115

4.3. Calculation and analysis

Using public notices (5)-(7), calculate OT , SW .

$$OT = \frac{3.8288}{3.1115} = 1.2305$$

$$SW = \frac{3.8575}{3.6832} = 1.0473$$

According to the calculations: $OT > 1$ indicates that the opportunities outweigh the threats and the external environment is attractive: $SW > 1$, indicates that the advantages outweigh the disadvantages and the army is internally competitive.

4.4. Choice moments

Based on the two calculated ratios, a diagram of strategic choice moments is produced, as showed in figure 2.

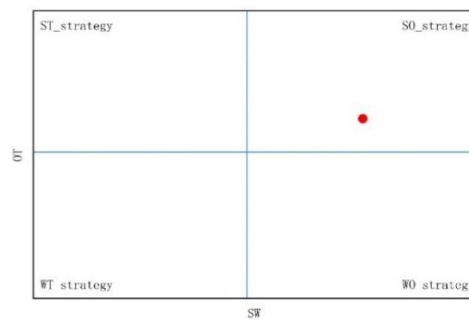


Fig. 2. Matrix of strategic options

The strategy type is SO strategy, which is an aggressive strategy that should take advantage of internal strengths and seize opportunities.

5. Conclusion

Based on the SWOT method, this paper has developed a reasonable analysis model and made an accurate analysis and assessment of the external strategic environmental factors index system and internal strategic environmental factors for the development of weapons and equipment. Seizing the opportunity of the evolution of the world's geostrategic pattern and its geopolitical advantages, the paper actively promotes the implementation of the army's development strategy, relies on national security needs traction and economic support, strengthens equipment and technology construction, actively improves the technical and tactical level of weapon and equipment informatization of the troops, focuses on the characteristics of future information-based combat, and promotes the innovation of the command system and training mode of the troops.

References

- [1] Wang Wenrong. Strategic Studies [M]. Beijing: National Defense University Press, 1999.
- [2] Xi Jinping. Accelerating the development of strategic, cutting-edge and disruptive technologies Accelerating the implementation of major strategic projects in national defense science and technology and weaponry [J]. China Military to Civilian, 2020, 244(8):10.
- [3] Li Daguang. Strategic high technology innovation and weapons and equipment development in national defense[J]. China Economic and Trade Journal,2016, 841(30):77-79.
- [4] Zhang Jian. Application of SWOT analysis in the evaluation of strategic environment for weapons and equipment development [J]. Defense Technology Fundamentals, 2010, 232(8):41-45.
- [5] Zhang Jian. SWOT analysis of strategic environment evaluation of weapons and equipment development[J]. Journal of the Academy of Equipment Command Technology,2011,22(1):21-25.
- [6] Li M., Liu P.. Methodology and Application of Systematic Argumentation for Weapon and Equipment Development [M]. Beijing:National Defense Industry Press, 2000.
- [7] Chen Junliang, Wang Changchun, Chen Chao. A scenario-based approach to strategic environmental analysis of equipment development[J]. Systems Engineering Theory and Practice,2011,31(9):1816-1824.
- [8] Zhang Qinyuan. Application of SWOT analysis in strategic management [J]. Enterprise Reform and Management,2006(2):62-63.
- [9] Jiang Tao, Jiang Mei. A brief discussion on the application of SWOT method in the strategic analysis of urban planning in China[J]. Modern Urban Research,2005(12):51-55.
- [10] David W. Pickton, Sheila Wright. What's swot in strategic analysis.[J]. Strategic Change, 1998, 7(2).
- [11] Ruijian Liu, Yuhan Wang, Zeqiang Qian. JHybrid SWOT-AHP Analysis of Strategic Decisions of Coastal Tourism: A Case Study of Shandong Peninsula Blue Economic Zone. urnal of Coastal Research,2019, 94(spl):671-676.
- [12] Collins Okello, Stefania Pindozi, Salvatore Faugno, Lorenzo Boccia. Appraising Bioenergy Alternatives in Uganda Using Strengths, Weaknesses, Opportunities and Threats (SWOT)-Analytical Hierarchy Process (AHP) and a Desirability Functions Approach. Energies,2014,9&3):1171-1192.

- [13] Edward Bernroider, Robert G. Dyson. Strategic development and SWOT analysis at the University of Warwick. *European Journal of Operational Research*, 2004, 152(3): 631-640.
- [14] Factors in SWOT Analysis Applied to Micro, Small-to-Medium, and Large Software Enterprises: an Austrian Study. *European Management Journal*, 2002, 20(5): 562-573.
- [15] Luo Wenjin, Lei Limei, Guo Yingying, Ren Yunxia. Research on Development Countermeasures of Prefabricated Buildings in Chongqing Based on SWOT Analysis [J]. *IOP Conference Series: Earth and Environmental Science*, 2021, 702(1).
- [16] Chen Lu; Wu Husheng. Demand Analysis Based on SWOT 's Intelligent Unmanned Aerial Vehicle Swarm. *Journal of Physics: Conference Series*, 2021, 2037(1): 012121-012129.
- [17] Wang Xue Gang, Hukai Kai Kai, Zhang Zhuo Ya, Hu Jing Jing. Research on the development strategy of militia protection force equipment maintenance--analysis based on SWOT-QSPM model[J]. *Military Operations and Evaluation*, 2022, 37(5): 58-63.