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Study on the Interpretive Structural Modeling of Military-Civilian Integration

Xin Yang[1], Chuanwu Zhang[2]

[1]Business School, Chengdu University

[2]College of Electrical and Information Engineering, Southwest Minzu University

Chengdu, 610106

***Abstract*—Based on the components of the military industry system and civilian industry system, we can use the Interpretive structural modeling method to analyze the elements' interaction and interrelationship between the military industry system and civilian industry system in their process of implementing the application system project or providing service. We can construct the Adjacency Matrix for the elements military industry system and civilian industry system from direct interactions of their elements, and the reachability matrix of military industry system and civilian industry system can be achieved by the operations of matrix. By Using the hierarchical decomposition algorithm of system elements in the Interpretive structural modeling, we can obtain the hierarchical structure model which describes the inner structure of the military industry system and civilian industry system. The hierarchical structure model obtained by the Interpretive structural modeling clearly demonstrated the interrelationships of the system elements, whose hierarchical elements are corresponded to the layer of the military-civilian integration. Which means that the relationship between the Interpretive structural modeling and the integration path indicate the way that we can deploy on the way of military-civilian integration.**

Keywords—Military-Civilian integration; Interpretive Structural Modeling; Adjacency matrix; Reachability matrix

I. INTRODUCTION

The Military-Civilian Integration mainly refer the intergration problem between the military industry system and civilian industry system. The definitions of the Military-Civilian Integration vary by different Country. Chinese scholars define the Military-Civilian Integration as: the process of the integration between the military scientific and technological industry system and civilian scientific and technological industry system, which become the foundation of the military science & technology industry system [1]. While the U. S. A. scholars describe as: the process of the formation of the national scientific and technological innovation system according to combination of the military science and technology industry system and civilian scientific and technological industry system [2].

January 22, 2017, the Central Military-Civilian Integration and Development Commission of China was founded. June 20, 2017, the First Plenary Session of the Central Military-Civilian Integration and Development Commission issues that: Upgrading the Military-Civilian Integration to National Strategy is the milestone and significant result in the way of exploring coordinated development between the economic construction and military construction. It shows the Major policy decisions from the viewpoints of national development and global security. And it is important countermeasure to deal with the complex security threaten and to obtain the National Strategic Advantage.

The scholars have concentrated on the Military-Civilian Integration for different area such as the system construction [3], industry standard [4], the relationship to the innovation [5], the relationship to the intelligent manufacture [6], and the relationship to the industrial upgrading [7]. The Military-Civilian Integration become the national strategy and deeply related to the national security and global development [8]. up to present, there has not any issues about the interpretive structural modeling for the Military-Civilian Integration.

II. THE INTERPRETIVE STRUCTURAL MODELING METHOD

The interpretive structural modeling method [9] is invented by professor Warfield in 1973. It is a structural analysis method used to analyze the complex social economic issues. In the ISM method, firstly, it decomposes the system to structural elements. And establish the adjacency matrix according to the relationships of the elements. Then transform the reachability matrix and result the reachability matrix. Furthermore, we can obtain the hierarchical structure model of the Military-Civilian Integration system.

The process of the interpretive structural modeling method can be described as follow [10]:

Relation Table: establish the relation table according to the relationships among the elements of the military science and technology industry system and civilian scientific and technological industry system.

Adjacency Matrix: set up the adjacency matrix from the relation table of the military science and technology industry system and civilian scientific and technological industry system.

Reachability Matrix: compute the adjacency matrix to obtain the reachability matrix of the military science and technology industry system and civilian scientific and technological industry system.

Hierarchy Decomposition: using the algorith of the interpretive structural modeling method to decompose the reachability matrix of the military science and technology industry system and civilian scientific and technological industry system.

Hierarchy Diagram: establish the hierarchy diagram according to the relationships of hierarchy decomposition of the military science and technology industry system and civilian scientific and technological industry system.

Interpretive Structural Modeling: from the hierarchy diagram, we can found the interpretive structural modeling of the military science and technology industry system and civilian scientific and technological industry system.

The interpretive structural modeling method has applied in different area such as energy demand analysis [11], supply chain system [12], and construction project management [13], and has gain good reputation.

III. THE MILITARY-CIVILIAN INTEGRATION ANALYSIS BASED ON THE INTERPRETIVE STRUCTURAL MODELING METHOD

From above analysis of the interpretive structural modeling method, we can analyze the military science and technology industry system and civilian scientific and technological industry system as following:

A. The System Elements and their relationships

In the military science and technology industry system and civilian scientific and technological industry system, we list and inquiry the potent elements of the system in our team, most of us has confirmed the elements as the scientific and technical workers and researchers (STW), scientific and technical system (STS), manufacturing industry system (MIS), application system (AS), financing support system(FSS), and organizational systems (OS). And the relationships among the elements as show in table 1:

TABLE I SYSTEM ELEMENTS RELATIONSHIPS

	STW	STS	MIS	AS	FSS	OS
STW		actor	actor	actor		
STS			support	support		
MIS				support		
AS						
FSS	support	support	support	support		
OS	support	support	support	support	support	

In the table, the ‘actor’ and ‘support’ indicate that the row of table has cause to the column of table. If a row cause the effect of column, which means that the row element is one of the base of column element. For example, that row of STS support column of AS indicate that the row of STS is the base of column of AS.

B. Construction of the Adjacency Matrix

From table 1, we map the row elements of table to the rows of the adjacency matrix, while map the column elements of table to the columns of the adjacency matrix. For the elements of the adjacency matrix, if the row element is the cause factor of the column element, then we take the element as 1; otherwise, we take the element as 0. Thus we can obtain the adjacency matrix as equal (1):

$$A=\begin{bmatrix}0&1&1&1&0&0\\0&0&1&1&0&0\\0&0&0&1&0&0\\0&0&0&0&0&0\\1&1&1&1&0&0\\1&1&1&1&1&0\end{bmatrix} \tag{1}$$

C. Computation the Reachability Matrix

Firstly, we compute the sum of the unit matrix and the adjacency matrix and obtained equation (2):

$$A+I=\begin{bmatrix}1&1&1&1&0&0\\0&1&1&1&0&0\\0&0&1&1&0&0\\0&0&0&1&0&0\\1&1&1&1&1&0\\1&1&1&1&1&1\end{bmatrix} \tag{2}$$

The square of the sum of the unit matrix and the adjacency matrix is show as equation (3):

$$(A+I)^2=\begin{bmatrix}1&1&1&1&0&0\\0&1&1&1&0&0\\0&0&1&1&0&0\\0&0&0&1&0&0\\1&1&1&1&1&0\\1&1&1&1&1&1\end{bmatrix} \tag{3}$$

Because the $(A+I)^2$ equal to the A+I, we obtained the reachability matrix according to the alogrithm of the interpretive structural modeling method as equation (4):

$$M = \begin{bmatrix} 1 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 1 & 1 & 0 \\ 1 & 1 & 1 & 1 & 1 & 1 \end{bmatrix} \quad (4)$$

D. Hierarchy Decomposition of the System Elements

Based on the reachability matrix M, the reachability set R(Si) and the antecedent set Q(Si) show as table 2:

TABLE II THE REACHABILITY SET, ANTECEDENT SET, AND THEIR INTERSECTION

i	R(Si)	Q(Si)	R(Si)∩Q(Si)
1	1,2,3,4	1,5,6	1
2	2,3,4	1,2,5,6	2
3	3,4	1,2,3,5,6	3
4	4	1,2,3,4,5,6	4
5	1,2,3,4,5	5,6	5
6	1,2,3,4,5,6	6	6

In the decomposition of the reachability matrix, the highest level must satisfy the equation (5) as:

$$R(S_i) = R(S_i) \cap Q(S_i) \quad (5)$$

In table 2, there exist one element, 4 which represent AS conforms to the rule of equation (5). Thus we reach the conclusion that the AS (application system) is the highest level of the military scientific and technological industry system and civilian scientific and technological industry system.

Then we eleminate the element 4 and continue the alogrithm, we can achieve the result that the element 3 is the second layer of the system. And so on, we obtain that the element 2 is the third layer, element 1 is the fouth layer, element 5 is the fifth layer, and element 6 is the lowest layer.

E. Conformation of the Interpritive Structrual Modeling

From above, we can obtain the interpretive structural modeling of the military scientific and technological industry system and civilian scientific and technological industry system. The architecture diagram show as figure1:

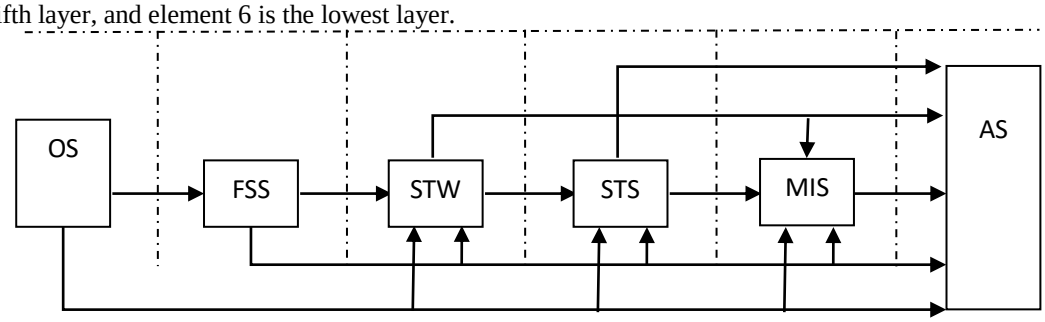

Fig. 1 The hierarchy structure of the system

Figure 1 indicates the hierarchy structure of the military scientific and technological industry system and civilian scientific and technological industry system. From which it demonstrates that the object of the system is implementing and providing the functions and services of the application system. While the system elements include the organizational system (OS), the financing support system (FSS), the scientific and technological workers and researchers (STW), the scientific and technological system (STS), manufacturing industry system (MIS), and application system (AS). The hierarchy layers from top to bottom as sequence as: the application system (AS), manufacturing industry system (MIS), the scientific and technological system (STS), the scientific and technological workers and researchers (STW), the financing support system (FSS), and organizational system (OS). The traditional military system and civilian system are separated. While the characters of the system elements have natural sharability such as the universality application of the science and technology, the statistic multiplexing usability of the manufacturing industry system, and the horizontal and vertical mobility of the researchers and works. The sharability of these three elements are the inner source for the Military-Civilian Integration, by which we can increase the efficiency of the elements of productivity and promote the demand response. In conclusion, the Military-Civilian Integration based on the elements sharability can improve the development speed of the military scientific and technological industry system and civilian scientific and technological industry system.

IV. CONCLUSION

The Military-Civilian Integration can be implemented in different layer. The most fundamental integration is achieved from the most bottom layer, which means the deeper of the bottom layer integration, the deeper integration. For example, the integration on the application system is lowest integration which means its involves fewest elements to deal with, while the integration on the organizational system is the highest integraion which means its relate to maximum elements to handle. The path of the Military-Civilian Integration may from the lowest integration to the highest integration.

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[14] Biography: Yang Xin, female, Doctor of Judicial Science. Who is a lecturer of Chengdu University. The interesting area include regional economics and management.

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