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An Intuitionistic Linguistic DEMATEL-Based Network Model for Effective National Defense and Force Innovative Project Planning

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ABSTRACT The COVID-19 pandemic will accelerate the shift toward multipolarity, and will have major long-term impacts on territorial security within the Indo-Pacific. In addition, COVID-19 is likely to have a long-term effect on risk evaluation in the Indo-Pacific states. Therefore, it is vital to oversee and execute remedial activities quickly and successfully, amid the COVID-19 pandemic. This paper proposes a national defense and military budget planning strategy. It applies a decision-making trial and evaluation laboratory linguistic data strategy for group decision-making, in order to collect group opinions and analyze the causal relationship of complicated social science issues in indistinct situations. These concepts are divided into causal and impact groups, to provide an improved understanding of the relationship among them, as well as making recommendations to improve their general execution. This paper employed the fuzzy DEMATEL method to analyze the model and considered suggestions as the key influencing factors in budget planning strategy. Through this well-constructed fuzzy DEMATEL approach our research results show that a proper operations strategy and management of both resource usage and task arrangement in accordance with policy making will accomplish excellent budget planning strategy results. The results reveal that the Mission Requirement is a major causal factor. The study can provide a successful national defense and military budget strategy assessment with satisfactory criteria that fit the decision-makers' requirements, particularly when the assessment criteria are various and entwined. We offer recommendations for government authorities to plan national defense and military budget planning strategies.

INDEX TERMS COVID-19 pandemic, Indo-Pacific, budget planning, DEMATEL, mu1tiple criteria decision-making (MCDM).

I. INTRODUCTION

Asia is looked upon as huge, with unclear boundaries, at least within the domains of policymaking and popular opinion. The term "Asia Pacific" usually suggests "Asian littorals of the Pacific," which does not describe the complete picture. The main aim of Taiwan's National Military Armed Forces is to avoid war, and to guarantee the security of the Taiwan Strait [1], [2]. The current Indo-Pacific environment is complex and very unstable, due to security collusions and competition among powerful nations, especially when considering interconnected financial development, technological advancement, and rapid data flows.

Taiwan must maintain a suitable defense capability to ensure the survival of the island, as well as the security and success of its inhabitants [2]–[5]. Although its national assets are constrained, the requirements for political, financial, military, and intellectual improvements are boundless. Defense budget necessities are based on military expansion plans; in this way, a sensible budget is designated, and executed according to regulatory needs and project timetables. Budgets are usually allocated at diverse levels according to the division of specialists and obligations [4], [6]. Budgetary assets are legitimately designated for national defense, to improve the nation's general financial situation, the government's

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monetary burdens, national security, adversary dangers, and current national defense planning [1]. Moreover, budgeting and execution are based on the rule of economizing, in order to apportion a sensible, appropriate, and attainable budget under the supervision of open scrutiny, and to maximize the advantages obtained from this budget [7], [8]. Budget planning can be a strategy to control funds, guarantee that organizations can continue to support current commitments, empower organizations to make certain financial choices and meet objectives, and guarantee that organizations have sufficient cash for future ventures [9]–[11].

Budget planning can create a financially sound official budget that meets the practical objectives of the state and missions of the organizations; for authority heading to state offices concerning the inner operations of state government; and for providing dependable budgetary oversight [10], [12], [13]. There are a number of benefits of budget planning, such as improved ability to viably oversee monetary assets. Organizations require a profound understanding of where budgetary assets are obtained and precisely where they are spent. Hence, budget planning helps organizations to distribute suitable assets to ventures [14]–[16]. Asset allotment is utilized to distribute the accessible assets in a conservative way, and budget planning is an aspect of asset administration. Moreover, fruitful budget planning administration requires the ongoing assessment of execution, by obtaining information with which to judge the success or failure of particular methodologies. Improved execution can be practically accomplished when the administration is legitimately educated about current execution [14], [17]. All known standards in today's world are seeing huge advances; this calls for rearrangements and a clearer approach to evaluation. The previous post-World War II agreement is failing, and a modern one is yet to emerge. This study creates a decision-making mechanism for national defense and military budget planning strategies. Therefore, in this paper, we propose a national defense and military budget planning framework. We investigate the national defense and constrained budget planning criteria by utilizing the multiple criteria decision-making (MCDM) approach [18]–[21].

The future of the Indian Ocean region depends on how well the territorial commons concur on narrowing their differences, and resolve to collaborate for the ongoing development and well-being of the area, through financial and political benchmarks. Firstly, we show a multi-criteria model composed of different measurements. Secondly, we present an apparatus, fuzzy DEMATEL, to analyze the basic variables in national defense and budget arranging. This paper demonstrates an integrated multiple criteria decision making (MCDM) technique that is more appropriate for national defense and force budget planning. We employed the Decision Making Trial and Evaluation Laboratory (DEMATEL) method to clarify the intertwined sub-criteria interrelationships in the complex structural hierarchy of a national defense and force budget planning problem. This paper proposes a novel hybrid method to cope with the various interdependence and feedback dimensions problem in the national defense and force budget planning problem. This proposed hybrid method can provide a better understanding of the interrelationship among the evaluation and selection dimensions and solve a complex interacting national defense and force budget planning issue that can enhance decision making quality.

Thirdly, we offer a few preparatory experiences for national defense and military budget planning [22]–[25]. This century demands an Asia of participation instead of an Asia of contention, which should proceed to shape this century. Therefore, nations must adopt and incorporate all the essential offered assistance that they can secure, in order to improve the efficiency of peace initiatives within the region.

II. FUZZY DEMATEL METHOD FOR BUILDING THE ASSESSMENT METHOD

COVID-19 has shown how addressing the present crisis as a multi-part player in the creation of new knowledge for a social purpose, has the capacity to renew the social license of universities. The COVID-19 pandemic has squeezed budgets and resources; it is becoming more evident that increased collaboration between universities, sector bodies, and industry will be required to help fuel the sector's recovery. Over many months, COVID-19 has spread over the Indo-Pacific, infecting thousands and causing enormous social and financial disturbance. In the near future, COVID-19 will disrupt military preparation within the Indo-Pacific. COVID-19 has allowed for a brief re-emergence of public and government trust in expertise. COVID-19 has come with a set of pressing social challenges. These include environmental catastrophes such as the Australian droughts and bushfires, and the impending crisis of global warming. Social and health issues, such as debilitating poverty, racial and income inequality, and chronic diseases, also loom large. In a situation of national defense with budget constraints, a specific list of criteria is required to assess national defense and military budget planning, amid shifts in the nature and context of these issues.

DEMATEL helped to develop a strategy by directly comparing the interrelationships of the key factors from the problem. The relations and the strength of influence among the key factors were obtained from the complex problems. DEMATEL turned the relations among the criteria into a clear structural model and dealt with a series of interrelations among the criteria. This paper discusses the key national defense and military budget planning strategy factors. However, because of the high complexity and the interrelations in the numerous factors, with limited resources, we had to allocate resources to the most critical key factors. All of the above was in line with the DEMATEL characteristics. Therefore, we adopted this analysis method to achieve the goal of this study.

Within the following sections, we portray the organizations where the specialists worked and the participants who provide the fundamental data, summarize the experts' primary conclusions on all the topics, and then classify these opinions into four categories that can be used as the basic system for the ensuing survey. In addition to answering the survey on developing this assessment, the specialists provided their professional information and involvement in strategic alliances, as well as a mechanical point of view.

We examine variables that may impact national defense and constrain budget planning [1]–[4], [6]. As a confirmation of the concept, we consider 18 vital subjective criteria. The evaluation measurements are: Program Completeness dimension (D1), Mission Requirement dimension (D2), Battle Threat dimension (D3), Future Scenario dimension (D4), and Fiscal Sufficient dimension (D5). Applied evaluation criteria are as follows: the Ability of self-manufacturing (C1), the Supervision of procurement programs (C2), the Availability of industrial cooperation (C3), the Domestic R&D level (C4), the Integrity of the procedure (C5), Meeting future mission requirements (C6), the Conformation to cost-effective requirements (C7), Needs with regard to balance in national forces (C8), Logistics support (C9), Matching of the joint operational policies (C10), Meeting immediate battle needs (C11), the Ability to threaten opponents (C12), the Availability of weapons (C13), Meeting the current force planning policy (C14), Meeting future military force needs (C15), the Ability of fiscal support (C16), the Substitution of current force plans (C17), and the Acceptability by the Congress (C18). The above-mentioned evaluation measurement model contributes to our understanding of national defense and military budget planning variables.

The above-mentioned evaluation model contributes to our understanding of national defense and military budget planning strategy, with a set of possibly pertinent variables for national defense and military budget planning strategy. In addition, it is apparent that there is a research gap with regard to a multi-criteria investigation of national defense and military budget planning strategy determination, and in creating an understanding of the cause–effect relationship of complex social science issues. Next, we examine the investigative strategy, DEMATEL, in detail.

A. THE DEMATEL METHOD

A national defense and military budget planning strategy is composed of many interacting elements. A case study of the Taiwan national defense and military budget planning strategy was implemented to demonstrate the proposed hybrid method. It can provide informative and practical suggestions to the budget planning strategy. This paper employed the fuzzy DEMATEL method to analyze the model and considered suggestions as the key influencing factors in budget planning strategy. Through this well-constructed fuzzy DEMATEL approach our research results show that a proper operations strategy and management of both resource usage and task arrangement in accordance with policy making will accomplish excellent budget planning strategy results.

The DEMATEL strategy was created to investigate the auxiliary relations in a complex framework [5], [26]–[30]. The structure of the proposed model is shown in Figure 1.

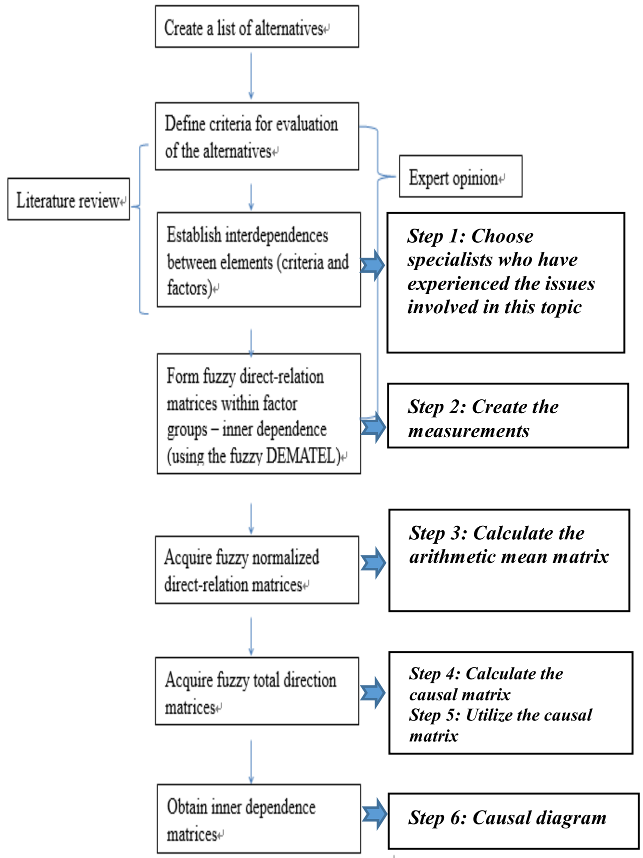

FIGURE 1. The structure and method of the fuzzy DEMATEL strategy.

The following step is to recognize the interrelationships among the measurements within the assessment, by applying the DEMATEL strategy. DEMATEL has been adopted in numerous scholarly fields, such as industrial research.

1) STEP 1: CHOOSE SPECIALISTS WHO HAVE EXPERIENCED THE ISSUES INVOLVED IN THIS TOPIC

According to the chosen objective, set up a specialists' group.

2) STEP 2: CREATE THE MEASUREMENTS

The linguistic scale items are assigned values characterized by their term group [31]–[33].

Linguistic variables take on values defined in its term set - a set of linguistic terms [24], [47]. General form of a triangular fuzzy number is presented in Figure 2. Linguistic terms are subjective categories for a linguistic variable. A linguistic variable is a variable whose values are words or sentences in a natural or artificial language [34], [38]. The membership function of a triangular fuzzy number $\tilde{Z} = (l, m, u)$ (TFN) is described by the following Equation (1):

$$\mu_{\tilde{A}}(x) = \begin{cases} (x-L)/(M-L), & L \le x \le M \\ (U-x)/(U-M), & M \le x \le U \\ 0, & otherwise \end{cases} \quad (1)$$

$$\begin{aligned} \tilde{A}_1 \oplus \tilde{A}_2 &= (L_1, M_1, U_1) \oplus (L_2, M_2, U_2) \\ &= (L_1 + L_2, M_1 + M_2, U_1 + U_2) \end{aligned} \quad (2)$$

Multiplication of the fuzzy number $\otimes$

$$\begin{aligned} \tilde{A}_1 \otimes \tilde{A}_2 &= (L_1, M_1, U_1) \oplus (L_2, M_2, U_2) \\ &= (L_1 L_2, M_1 M_2, U_1 U_2) \quad L_i > 0,\ M_i > 0,\ U_i > 0 \end{aligned} \quad (3)$$

Subtraction of the fuzzy number ()

$$\begin{aligned} \tilde{A}_1 - \tilde{A}_2 &= (L_1, M_1, U_1)\text{-}(L_2, M_2, U_2) \\ &= (L_1 - U_2, M_1 - M_2, U_1 - L_2) \end{aligned} \quad (4)$$

Reciprocal of the fuzzy number

$$\begin{aligned} \tilde{A}_1^{-1} &= (L_1, M_1, U_1)^{-1} \\ &= (1/U_1, 1/M_1, 1/L_1) \quad L_1,\ M_1,\ U_1 > 0 \end{aligned} \quad (5)$$

These pair-wise comparisons between any two components are indicated by and are given as number scores of 0–4, meaning "No influence (0)," "Low influence (1)," "Medium influence (2)," "High influence (3)," and "Very high influence (4)" [33], [34] as Table 1.

TABLE 1. Linguistic scales for the importance.

Linguistic terms	Linguistic values
Very high influence(VH)	(0.5,0.75,1)
High influence(H)	(0.25,0.5,0.75)
Low influence(L)	(0,0.25,0.5)
Very low influence(VL)	(0,0,0.25)
No influence(No)	(0,0,0)

3) STEP 3: CALCULATE THE ARITHMETIC MEAN MATRIX

To measure the relationships between the factors $F = \{F_i | i = 1, 2, \ldots, n\}$, the experts were asked to make sets of pair-wise comparisons. The fuzzy matrices $\tilde{Z}_{(1)}, \tilde{Z}_{(2)}, \ldots, \tilde{Z}_{(n)}$ can be thus obtained. Fuzzy matrix $\tilde{Z}_{(k)}$ denotes the initial direct relation (direct influence) fuzzy matrix provided by the k-th expert as following Equation (6).

$$\tilde{Z}^k = \begin{bmatrix} 0 & \tilde{Z}_{12}^{(k)} & \cdots & \tilde{Z}_{1n}^{(k)} \\ \tilde{Z}_{21}^{(k)} & 0 & \cdots & \tilde{Z}_{2n}^{(k)} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{Z}_{n1}^{(k)} & \tilde{Z}_{n2}^{(k)} & \cdots & 0 \end{bmatrix}; \quad k = 1, 2, \ldots, P$$

$$\tilde{Z}_{ij}^{(k)} = (l_{ij}^{(k)}, m_{ij}^{(k)}, u_{ij}^{(k)}) \quad (6)$$

$\tilde{Z}_{ij}^{(k)}$ which are triangular fuzzy numbers. Suppose we have K experts in this study and n factors to consider. Each respondent is asked to indicate the degree to which he or she believes a factor, i, affects factor j. These pair-wise comparisons between any two factors are denoted by $\tilde{Z}_{ij}^{(k)}$ and are given an integer score of 0-4. Fuzzy matrix $\tilde{Z}_{ij}^{(k)}$ called the initial direct-relation fuzzy matrix of expert k.

The values of $\tilde{\alpha}_i^{(k)}$ and $r^{(k)}$ are the triangular fuzzy numbers in Equations (7) and (8).

$$\tilde{\alpha}_i^{(k)} = \sum \tilde{z}_{ij}^{(k)} = (\sum_{j=1}^{n} l_{ij}^{(k)}, \sum_{j=1}^{n} m_{ij}^{(k)}, \sum_{j=1}^{n} u_{ij}^{(k)}) \quad (7)$$

$$r^{(k)} = \max(\sum_{j=1}^{n} u_{ij}^{(k)})\ 1 \le i \le n \quad (8)$$

4) STEP 4: CALCULATE THE CAUSAL MATRIX

The causal connection network and the total-relation lattice outline the interrelated effect in each calculation; the equation is shown below [20], [39]–[41]. The casual matrix can be obtained as $X^{(k)}$. The linear scale transformation is used to transform the criteria scale into comparable scales. The normalized direct-relation fuzzy matrix can be gotten as $\tilde{X}^{(k)}$

$$\tilde{X}^k = \begin{bmatrix} \tilde{X}_{11}^{(k)} & \tilde{X}_{12}^{(k)} & \cdots & \tilde{X}_{1n}^{(k)} \\ \tilde{X}_{21}^{(k)} & \tilde{X}_{22}^{(k)} & \cdots & \tilde{X}_{2n}^{(k)} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{X}_{n1}^{(k)} & \tilde{X}_{n2}^{(k)} & \cdots & \tilde{X}_{nn}^{(k)} \end{bmatrix}; \quad k = 1, 2, \ldots, P$$

$$\tilde{Z}_{ij}^{m.b(k)} = (l_{ij}^{(k)}, m_{ij}^{(k)}, u_{ij}^{(k)}) \quad (9)$$

where $\tilde{x}_{ij}^{(k)} = \frac{\tilde{z}_{ij}^{(j)}}{r^{(k)}} = (\frac{l_{ij}^{(k)}}{r^{(k)}}, \frac{m_{ij}^{(k)}}{r^{(k)}}, \frac{u_{ij}^{(k)}}{r^{(k)}})$.

The normalized total influence matrix $\tilde{X}^k$ for the criteria is shown above (9).

It is assumed that at least one i exists, such that $\sum_{j=1}^{n} u_{ij}^{k} < r^{(k)}$. Equations (10) and (11) are used to calculate the average matrix of $\tilde{X}$.

$$\tilde{X} = \frac{(\tilde{x}^{(1)} \oplus \tilde{x}^{(2)} \oplus \cdots \oplus \tilde{x}^{(p)})}{P} \quad (10)$$

$$\tilde{X}^k = \begin{bmatrix} \tilde{X}_{11} & \tilde{X}_{12} & \cdots & \tilde{X}_{1n} \\ \tilde{X}_{21} & \tilde{X}_{22} & \cdots & \tilde{X}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{X}_{n1} & \tilde{X}_{n2} & \cdots & \tilde{X}_{nn} \end{bmatrix} \quad (11)$$

where $\tilde{x}_{ij} = \frac{\sum_{k=1}^{p} \tilde{x}_{ij}^{(k)}}{P}$.

5) STEP 5: UTILIZE THE CAUSAL MATRIX

Once the normalized direct-relation X is obtained, the total-relation matrix T can be calculated, it should be ensured that the convergence of $\lim_{w \to \infty} \tilde{X}^w = 0$. The total-relation fuzzy matrix is shown as Equations (12), (13) and (14). Let $X^{(k)}$ the quality of the given y be calculated for the direct/indirect network T, and $i, j = 1, 2, \ldots, n$ [42]–[45]. Add up the columns of the direct/indirect matrix (T); the equation is given below. It incorporates direct and indirect effect, which is the degree of direct and indirect effect on the other variables. The causal matrix is shown as Equations (2) and (3) [47-50]. Once the normalized direct-relation X is obtained, the total-relation matrix T can be calculated, it should be ensured that the convergence of $\lim_{w\to\infty} \tilde{X}^w = 0$. The total-relation fuzzy matrix is shown as Equations (12), (13) and (14).

$$\tilde{T} = \lim_{w\to\infty} (\tilde{X} + \tilde{X}^2 + \cdots + \tilde{X}^w) \tag{12}$$

$$\tilde{T} = \begin{bmatrix} \tilde{t}_{11} & \tilde{t}_{12} & \tilde{t}_{1n} \\ \tilde{t}_{21} & \tilde{t}_{22} & \tilde{t}_{2n} \\ & & \\ \tilde{t}_{n1} & \tilde{t}_{n1} & \tilde{t}_{nn} \end{bmatrix} \tag{13}$$

where $\tilde{t}_{ij} = (l''_{ij}, m''_{ij}, u''_{ij})$ (14) and (15), as shown at the bottom of the page.

6) STEP 6: CAUSAL DIAGRAM

The causal graph is delineated in a two-dimensional design, where the full $(\tilde{R}_i + \tilde{C}_i)^{def}$ is the horizontal axis and the contrast $(\tilde{R}_i - \tilde{C}_i)^{def}$ is the vertical axis. This realization can rearrange the complex causal relations into a clearly visible structure and enable us to understand the issues [50]–[52]. When $(\tilde{R}_i - \tilde{C}_i)^{def}$ is positive and found above the x axis, the variable is regarded as a cause, but in case $(\tilde{R}_i - \tilde{C}_i)^{def}$ is negative and found below the x axis, the variable is seen as an effect [20], [52], [53], [53]–[58].

III. RESEARCH RESULTS AND DISCUSSIONS

In this segment, the basic components of national defense and military budget planning are distinguished and analyzed. We collected usable measurements and criteria for national defense and constrained budget planning. To decide the reasonable measurements and criteria for each measurement, the researchers met specialists to screen the appropriate measurements and criteria, based on our literature review [59]–[61]. From the literature review, we collected usable dimensions and criteria national defense and force budget planning.

After meeting the specialists and examining the literature, the system of this research incorporates five measurements and 18 assessment criteria. This digraph can act as a guide for best practice, to recognize the course of activity that is vital for Taiwan's national defense and military budget planning.

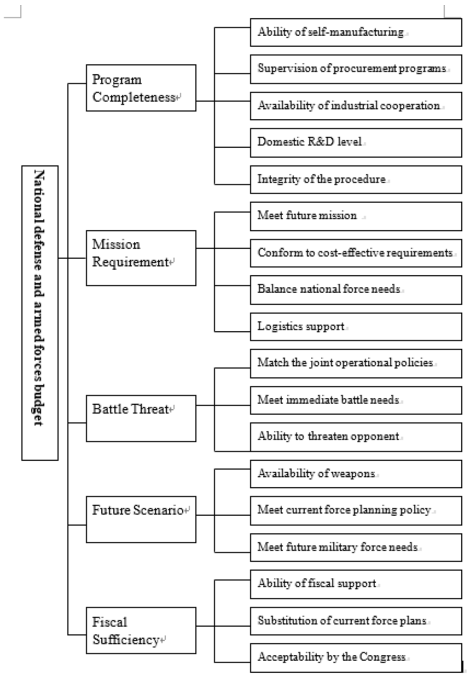

FIGURE 2. Research evaluation framework.

A. STEP 1: BUILDING A SYSTEM FOR NATIONAL DEFENSE AND MILITARY BUDGET PLANNING

The primary step includes distinguishing how numerous properties or criteria are included in national defense and military budget planning. We construct the assessment model using the literature review and interviews with specialists. In order to better determine the suitable dimensions and criteria for each dimension, this research interviewed experts to screen for the suitable dimensions and criteria based on our literature review. This research then summarized and constructed an evaluation model with four dimensions and fourteen criteria that are most suitable. In the sections that follow, this paper describes the organizations where experts are working and the interview themes that provide basic information, summarizes the experts' main opinions about all themes and then classifies these opinions into five categories that can be adopted as the structural framework for the subsequent questionnaire. In addition to replying to the questionnaire in constructing this evaluation and selection model, the experts also provided their professional knowledge and

$$Matrix\left[l''_{ij}\right] = X_l \times (I - X_l)^{-1}$$
$$Matrix\left[m''_{ij}\right] = X_m \times (I - X_m)^{-1}$$
$$Matrix\left[u''_{ij}\right] = X_u \times (I - X_u)^{-1} \tag{14}$$

$$L = \min(l_k), \quad R = \max(u_k), \quad \Delta = R - L$$
$$\tilde{N}_k^{def} = L + \Delta \times \frac{(m-L)(\Delta+u-m)^2(R-l) + (u-L)^2(\Delta+m-l)^2}{(\Delta+m-l)(\Delta+u-m)^2(R-l) + (u-L)(\Delta+m-l)^2(\Delta+u-m)} \tag{15}$$

experience. After interviewing the experts and reviewing literature, the framework of this research includes five dimensions and eighteen evaluation criteria. The interviews were conducted during December 12–25, 2010, in person.

B. STEP 2: CHOICE OF A COMMITTEE OF SPECIALISTS WITH INVOLVEMENT IN THIS ISSUE

Sixteen specialists were invited to assess the criteria (Appendix 1). We expected that the meeting would take two hours. The great majority of the experts had taken an interest within the past meet; consequently, they were now familiar with our approach. The committee taken after the proposed strategy with a following method [62]–[64].

C. STEP 3: PLANNING THE FUZZY LINGUISTIC SCALE

The research incorporates five examination measurements and 18 assessment criteria, adjusted by the committee. The multi-level structure of this decision model is shown in Figure 2.

D. STEP 4: PRODUCING THE APPRAISALS OF DECISION-MAKERS

$\tilde{Z}_{(1)}, \tilde{Z}_{(2)}, \ldots, \tilde{Z}_{(n)}$ can now be obtained for the first-level measurement $\tilde{Z}^1$, as shown at the bottom of the page.

E. STEP 5: NORMALIZING THE DIRECT-RELATION FUZZY NETWORK

Conditions (3)–(4) were utilized to calculate the normalized direct-relation fuzzy network $\tilde{X}^1$, $matrix[l''_{ij}]$, $matrix[m''_{ij}]$, $matrix[u''_{ij}]$, and $\tilde{T}$, as shown at the bottom of the page.

F. STEP 6: CREATING A CAUSAL CHART

We produce the causal chart by mapping a dataset of $(\widetilde{R}_i + \widetilde{C}_i, \widetilde{R}_i + \widetilde{C}_i)$. Table 2 portrays the direct and indirect impacts

$$\tilde{Z}^1 = \begin{bmatrix} (0,0,0) & (0.5,0.75,1) & (0.25,0.5,0.75) & (0,0.25,0.5) & (0,0,0.25) \\ (0,0.25,0.5) & (0,0,0) & (0.5,0.75,1) & (0.5,0.75,1) & (0,0.25,0.5) \\ (0,0.25,0.5) & (0.25,0.5,0.75) & (0,0,0) & (0.5,0.75,1) & (0,0,0.25) \\ (0,0.25,0.5) & (0,0.25,0.5) & (0.25,0.5,0.75) & (0,0,0) & (0,0,0.25) \\ (0,0,0.25) & (0,0,0.25) & (0,0,0.25) & (0,0,0.25) & (0,0,0) \end{bmatrix}$$

$$matrix\left[l''_{ij}\right] = \begin{bmatrix} (0.011,0.061,0.057,0.071,0.081) \\ (0.067,0.019,0.071,0.065,0.112) \\ (0.082,0.069,0.015,0.079,0.071) \\ (0.041,0.066,0.078,0.014,0.071) \\ (0.032,0.079,0.042,0.053,0.015) \end{bmatrix}$$

$$matrix\left[m''_{ij}\right] = \begin{bmatrix} (0.097,0.208,0.207,0.229,0.225) \\ (0.224,0.117,0.238,0.240,0.271) \\ (0.224,0.207,0.104,0.240,0.189) \\ (0.177,0.209,0.225,0.103,0.193) \\ (0.155,0.193,0.149,0.170,0.085) \end{bmatrix}$$

$$matrix\left[u''_{ij}\right] = \begin{bmatrix} (0.658,0.843,0.824,0.872,0.847) \\ (0.883,0.730,0.894,0.923,0.927) \\ (0.830,0.825,0.651,0.869,0.787) \\ (0.781,0.822,0.823,0.666,0.789) \\ (0.703,0.749,0.686,0.730,0.572) \end{bmatrix}$$

$$\tilde{T} = \begin{bmatrix} (0.011,0.097,0.658) & (0.061,0.208,0.843) & (0.057,0.207,0.824) & (0.071,0.229,0.872) & (0.081,0.225,0.847) \\ (0.067,0.224,0.883) & (0.019,0.117,0.730) & (0.071,0.238,0.894) & (0.065,0.240,0.923) & (0.112,0.271,0.927) \\ (0.082,0.224,0.830) & (0.069,0.207,0.825) & (0.015,0.104,0.651) & (0.079,0.240,0.869) & (0.071,0.189,0.787) \\ (0.041,0.177,0.781) & (0.066,0.209,0.822) & (0.078,0.225,0.823) & (0.014,0.103,0.666) & (0.071,0.193,0.789) \\ (0.032,0.155,0.703) & (0.079,0.193,0.749) & (0.042,0.149,0.686) & (0.053,0.170,0.730) & (0.015,0.085,0.572) \end{bmatrix}$$

TABLE 2. **Results of calculations for distinguishing the impacts among the five measurements.**

	R_i	C_i	R_i+C_i	R_i-C_i
Program Completeness	(0.281,0.966,4.044)	(0.233,0.877,3.857)	(0.514,1.842,7.900)	(0.048,0.089,0.187)
Mission Requirement	(0.333,1.089,4.358)	(0.294,0.934,3.968)	(0.628,2.023,8.326)	(0.039,0.155,0.389)
Battle Threat	(0.317,0.966,3.961)	(0.263,0.924,3.878)	(0.580,1.889,7.840)	(0.054,0.042,0.083)
Future Scenario	(0.269,0.907,3.882)	(0.283,0.982,4.060)	(0.552,1.889,7.942)	(-0.013,-0.075,-0.178)
Fiscal Sufficiency	(0.222,0.752,3.440)	(0.349,0.962,3.922)	(0.571,1.714,7.363)	(-0.128,-0.211,-0.482)

TABLE 3. **Obtained values for indices for the five considered dimensions.**

	$(R_i+C_i)^{def}$	$(R_i-C_i)^{def}$
Program Completeness	2.811	0.102
Mission Requirement	3.006	0.172
Battle Threat	2.840	0.054
Future Scenario	2.852	-0.049
Fiscal Sufficiency	2.644	-3.974

of the five first-level measurements, and their causal connections are illustrated in the digraph in Figure 3.

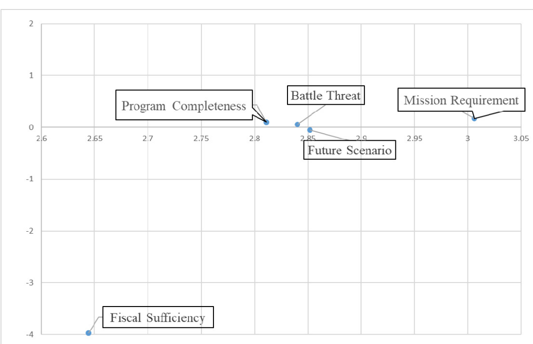

FIGURE 3. **Diagram showing causal relations among the five measurements.**

Table 2 portrays the direct and indirect impacts of the five first-level measurements. The digraph of these five measurements appears in Figure 3. The substance of Table 3 affirms that the *Program Completeness measurement*, the *Mission Requirement measurement*, and the *Battle Threat measurement* are the net causes, while *Future Scenario* and *Fiscal Sufficiency* are the effects. With respect to the five measurements, we will discuss the impact and interrelation. "Mission Requirement" and "Program Completeness" were the major key factors impacting the other factors, and "Fiscal Sufficiency" was the factor being impacted. The causal diagram of the five measurements is shown in Figure 3. This showed that from the "Mission Requirement" was the factor impacting the other factors and was the factor to be considered first. From Figure 3 it is evident that the *Mission Requirement* measurement is the foremost basic measurement. The *Mission Requirement* measurement and the *Battle Threat* measurement are influenced by each other, as well as by Program Completeness, Mission Requirement, and Battle Threat.

The causal connections among the five second-level criteria of the *Program Completeness* measurement are portrayed in Tables 4-5 and Figure 4. The causal connections among the four second-level criteria of the *Mission Requirement* measurement are shown in Tables 6–7 and Figure 5. Tables 8-9 and Figure 6 summarize the causal connections among the three second-level criteria of the *Battle Threat* measurement. The causal connections among the three second-level criteria of the *Future Scenario* measurement are displayed in Tables 10-11 and Figure 7. Finally, Tables 12-13 and Figure 8 summarize the causal connections among the three second-level criteria of the *Fiscal Sufficiency* measurement.

Tables 4 and 5 show that the *Availability of industrial cooperation* and the *Integrity of the procedure* are the net causes, while the *Ability of self-manufacturing*, the *Supervision of procurement programs*, and the *Domestic R&D level* are impacts. It is obvious from Figure 4 that the *Availability of industrial cooperation* is the foremost basic cause. The *Ability of self-manufacturing*, the *Supervision of procurement programs*, and the *Domestic R&D level* are influenced by each other, as well as by the *Availability of industrial cooperation* and the *Integrity of the procedure*.

Figure 4 shows that obviously infer that "Availability of industrial cooperation" was the factor impacted by the other five factors. In this analysis, "Availability of industrial cooperation" was the only factor that positively impacted the other factors, showing that among the Program Completeness subaspects, it was the key factor that impacted the other factors the most.

Tables 6 and 7 affirm that *Meeting the future mission* and *Logistics support* are the net causes, while *Conforming to cost-effective requirements* and the *Needs with regard to balance in national forces* are net recipients. From Figure 5, it is obvious that Logistics support is the foremost basic causal factor.

Figure 5 shows that "Logistics support" and "Meet future mission" impacted "Conform to cost-effective requirements" and "Balance national force needs" respectively. In this analysis, "Logistics support" was the most important factor that positively impacted the other factors. Accordingly,

TABLE 4. Results of calculations for identification of influences among the second-tier criteria for the program completeness dimension.

	R_i	C_i	R_i+C_i	R_i-C_i
Ability of self-manufacturing	(0.295,0.907, 3.764)	(0.349,0.957, 3.834)	(0.644,1.864, 7.598)	(-0.053,-0.050,-0.070)
Supervision of procurement programs	(0.175,0.678, 3.268)	(0.221,0.726, 3.224)	(0.396,1.404, 6.492)	(-0.047,-0.049,0.043)
Availability of industrial cooperation	(0.298,0.908, 3.791)	(0.238,0.759, 3.480)	(0.536,1.667, 7.271)	(0.061,0.149,0.311)
Domestic R&D level	(0.267,0.854, 3.714)	(0.277,0.926, 3.977)	(0.545,1.779, 7.691)	(-0.010,-0.072,-0.263)
Integrity of the procedure	(0.223,0.775, 3.519)	(0.173,0.753, 3.540)	(0.396,1.528, 7.059)	(0.050,0.022,-0.021)

TABLE 5. Obtained values for indices of second-tier criteria for the Program Completeness dimension.

	$(R_i+C_i)^{def}$	$(R_i-C_i)^{def}$
Ability of self-manufacturing	2.765	-0.049
Supervision of procurement programs	2.253	-0.036
Availability of industrial cooperation	2.572	0.159
Domestic R&D level	2.710	-3.518
Integrity of the procedure	2.430	0.023

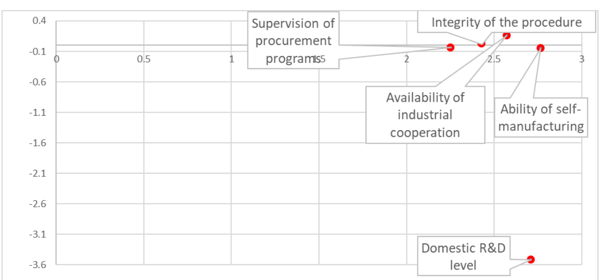

FIGURE 4. Diagram showing the casual relations among the second-tier criteria for the program completeness dimension.

it showed that in the Fiscal Sufficiency sub-aspects, "Logistics support" was the key factor that impacted the other factors the most.

TABLE 6. Results of calculations for identification of influences among second-tier criteria for the Mission Requirement dimension.

	R_i	C_i	R_i+C_i	R_i-C_i
Meet future Mission	(0.304,1.117 ,5.419)	(0.278,0.934 ,4.928)	(0.582,2.051, 10.347)	(0.027,0.183, 0.491)
Conform to Cost-effective requirements	(0.288,0.931 ,4.727)	(0.255,0.970 ,4.832)	(0.543,1.900, 9.558)	(0.033,-0.039,-0.105)
Balance national force needs	(0.291,0.980 ,4.868)	(0.273,1.009 ,4.946)	(0.564,1.989, 9.814)	(0.017,-0.029,-0.078)
Logistics support	(0.245,0.932 ,4.731)	(0.323,1.046 ,5.039)	(0.568,1.978, 9.770)	(-0.077,-0.115,-0.307)

TABLE 7. Obtained values for indices for four criteria of the mission requirement dimension.

	$(R_i+C_i)^{def}$	$(R_i-C_i)^{def}$
Meet future mission	3.393	0.209
Conform to cost-effective requirements	3.168	-0.029
Balance national force needs	3.271	-0.025
Logistics support	3.257	0.297

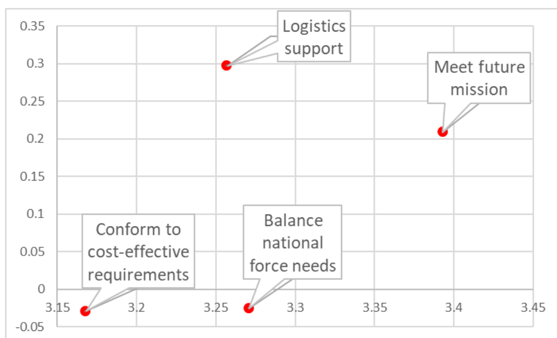

FIGURE 5. Chart showing the causal relations among the second-level criteria for the fiscal sufficiency measurement.

Tables 8 and 9 illustrate that *Meeting immediate battle needs* and the *Ability to threaten opponents* are the net causes, while *Matching the joint operational policies* is the net recipient. From Figure 6, it is obvious that the *Ability to threaten opponents* is the foremost basic causal factor.

To facilitate national defense and military budget planning success, the "Ability to threaten opponent" and "Meet immediate battle needs" were the two key aspects as

TABLE 8. Results of calculations for identification of influences among second-tier criteria for the mission requirement dimension.

	R_i	C_i	$R_i + C_i$	$R_i - C_i$
Match the joint operational policies	(0.275,1.074, 8.491)	(0.306,1.167, 8.864	(0.581,2.241,17.355)	(-0.031,-0.093,-0.373)
Meet immediate battle needs	(0.252,1.025, 8.299)	(0.240,1.007, 8.227)	(0.492,2.031,16.527)	(0.012,0.018,0.072)
Ability to threaten opponent	(0.297,1.202, 9.007)	(0.279,1.128, 8.705)	(0.576,2.330,17.712)	(0.019,0.075,0.302)

TABLE 9. Obtained values for indices for three criteria on the battle threat dimension.

	$(R_i + C_i)^{def}$	$(R_i - C_i)^{def}$
Match the joint operational policies	4.783	-2.693
Meet immediate battle needs	4.495	0.027
Ability to threaten opponent	4.901	0.108

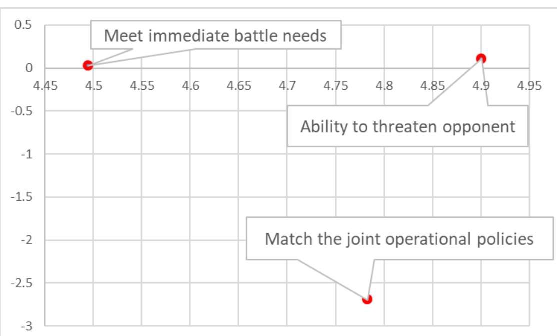

FIGURE 6. Diagram showing the causal relations among the second-tier criteria for the battle threat dimension.

shown in Figure 6. From the interrelation analysis diagram, we observed the direction and the level of the interrelation impact between the aspects. Accordingly, it showed that in the Battle Threat dimension sub-aspects, "Meet current force planning policy" was the key factor that impacted the other factors the most.

Tables 10 and 11 express that *Meeting the current force planning policy* is the net cause. From Figure 7 it is obvious

TABLE 10. Results of calculations for identification of influences among second-tier criteria for the future scenario dimension.

	R_i	C_i	$R_i + C_i$	$R_i - C_i$
Availability of weapons	(0.450,1.379,6.476)	(0.321,1.071,5.607)	(0.771,2.450,12.082)	(0.129,0.307,0.869)
Meet current force planning policy	(0.311,1.117,5.736)	(0.413,1.295,6.241)	(0.724,2.412,11.976)	(-0.102,-0.178,-0.505)
Meet future military force needs	(0.318,1.100,5.687)	(0.345,1.229,6.051)	(0.663,2.328,11.739)	(-0.027,-0.129,-0.364)

TABLE 11. Obtained values for indices of three criteria for the future scenario dimension.

	$(R_i + C_i)^{def}$	$(R_i - C_i)^{def}$
Availability of weapons	3.91	0.35
Meet current force planning policy	3.86	0.44
Meet future military force needs	3.77	0.02

that *Meeting the current force planning policy* is the foremost basic causal factor.

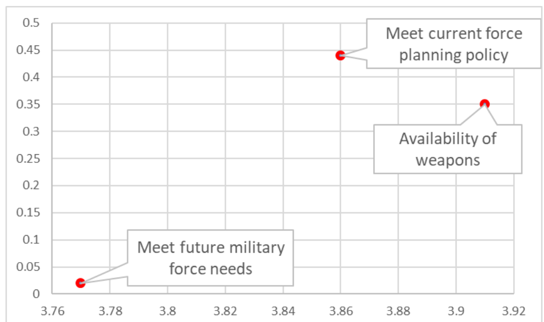

FIGURE 7. Chart showing the causal relations among the second-level criteria for the future scenario measurement.

Figure 7 shows that "Meet current force planning policy" and "Availability of weapons" impacted "Meet future military force needs" Moreover, obviously, "Meet current force planning policy" was the factor impacted by the other two factors. In this analysis, it showed that in the Future Scenario sub-aspects, "Meet current force planning policy" was the key factor that impacted the other factors the most.

Tables 12 and 13 indicate that *Meeting immediate battle needs* and *Ability to threaten opponents* are the net causes, while *Matching the joint operational policies* is the impact. From Figure 8 it is evident that *Ability to threaten opponents* is the foremost basic causal factor.

With respect to the Fiscal Sufficiency measurement, we will discuss the impact and interrelation. "Substitution of current force plans" impacted "Ability of fiscal support" and "Acceptability by the Congress" respectively shown in Figure 8. This showed that from the "Substitution of

TABLE 12. Results of calculations for identification of influences among second-tier criteria for the fiscal sufficiency dimension.

	R_i	C_i	R_i+C_i	R_i-C_i
Ability of fiscal support	(0.323,1.111,5.814)	(0.333,1.141,5.888)	(0.656,2.252,11.701)	(-0.010,-0.029,-0.074)
Substitution of current force plans	(0.267,1.068,5.794)	(0.187,0.887,5.282)	(0.454,1.955,11.076)	(0.080,0.182,0.512)
Acceptability by the Congress	(0.315,1.087,5.742)	(0.385,1.239,6.180)	(0.700,2.326,11.922)	(-0.071,-0.152,-0.438)

TABLE 13. Obtained values for indices of three criteria for the fiscal sufficiency dimension.

	$(R_i+C_i)^{def}$	$(R_i-C_i)^{def}$
Ability of fiscal support	3.794	-0.03
Substitution of current force plans	3.472	0.22
Acceptability by the Congress	3.882	-10.52

current force plans'' was the factor impacting the other factors and was the factor to be considered first.

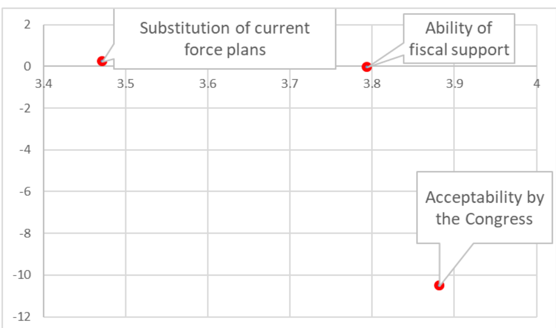

FIGURE 8. Chart showing the causal relations among the second-level criteria for the fiscal sufficiency measurement.

According to the observed findings, this investigation concludes with a few administrative suggestions, as follows. **The obtained results indicate that the major causal measurements are: the Mission Requirement (D2) and the Battle Threat (D3). Thus, these two measurements have greater scope for enhancement, compared to other components, allowing the decision-makers to plan more clearly and successfully.** The committee thought that the Accessibility of mechanical participation is the most causal factor for the national defense and military force budget planning within the Program Completeness measurement (D1). We discover that Coordination support is the foremost causal factor for the national defense and military force budget planning within the case of the Mission Requirement measurement (D2). The specialists also indicated that the Capacity to debilitate adversaries could be a pivotal and determinative component.

IV. CONCLUDING REMARKS

Military forces across the region have had to forfeit large-scale training exercises that help maintain readiness. In a real situation for a national defense and force budget planning problem, the specific list of criteria used to evaluate national defense and force budget planning during formation varies based on the nature and context of the national defense and force budget-planning problem. A case study of Taiwan's national defense and military budget planning was conducted to illustrate the proposed hybrid strategy. This can provide instructive and viable recommendations for Taiwan's national defense and military budget planning. The results clearly indicate the key components for deciding the national defense and military budget planning, on the premise of genuine needs communicated by expert opinions [65]–[67]. The findings show that the Mission Requirement measurement is of the greatest importance. Suitable factual methods are applied to confirm the outcomes regarding the social structure, in order to affirm its productivity. Future research should apply this hybrid method to confirm its pertinence by utilizing the results of other budget planning approaches [68], [69].

Firstly, we displayed a multi-criteria model composed of different measurements. Secondly, we presented a system, DEMATEL, to analyze the basic components in decision-making for the national defense and military budget planning. Thirdly, we obtained some preparatory experiences regarding national defense and military budget planning. This study also provides an assessment framework for national defense and military budget planning, which incorporates causal connections between the influential variables, to illuminate this issue [70]–[72]. This investigation reveals that when policy-makers are considering how to achieve efficiency in national defense and military budget planning as a whole, they must consider the key influential variables and their impacts on the other measurements. Employing influential variables can more effectively result in the anticipated enhancement. The Mission Requirement measurement is found to have the greatest influence on all other measurements.

This result showed that from the ''Mission Requirement'' was the factor impacting the other dimensions and was the factor to be considered first. Could the selected program exist in synergy with national defense and military budget planning strategy? Are there any conflicts between the dissemination and the national defense and military budget planning strategy? Industrial collaboration and logistics support has become an important trend for complementing the national defense and military budget planning strategy. We should try to develop a more skilled and specialized labor force. Educators classify their programs by occupation, but the skills used in the workplace are defined by the context in which they are applied. Mission skill centers could become the lead entities for surveying budget planning strategy needs, developing new curricula, staying in touch with councils, updating skills

TABLE 14. Expert profile.

	Service Unit	Official rank	Specialty	Educational background	seniority
A	Ministry of National Defense	Lieutenant Colonel	Resource Planning	Master	20
B	Ministry of National Defense	Lieutenant Colonel	Resource Planning	Bachelor	20
C	Ministry of National Defense	Major General	Communications, Information and Electronics	Master	20
D	Ministry of National Defense	Lieutenant Colonel	Resource Planning	Bachelor	20
E	Ministry of National Defense	Lieutenant Colonel	Communications, Information and Electronics	Master	15
F	Ministry of National Defense	Lieutenant Colonel	Communications, Information and Electronics	Bachelor	20
G	Ministry of National Defense	Lieutenant Colonel	Procurement Section, Logistics	Bachelor	20
H	Ministry of National Defense	Colonel	Communications, Information and Electronics	Bachelor	20
I	Ministry of National Defense	Major	Resource Planning	Bachelor	15
J	Ministry of National Defense	Colonel	Resource Planning	Bachelor	20
K	Ministry of National Defense	Colonel	Resource Planning	Bachelor	20
L	Ministry of National Defense	Lieutenant Colonel	Resource Planning	Bachelor	20
M	Army Headquarters	Colonel	Intelligence Training	Doctor	20
N	Ministry of National Defense	Lieutenant Colonel	Comptroller	Doctor	11
O	Ministry of National Defense	Major	Comptroller	Doctor	11
P	Ministry of National Defense	Colonel	Comptroller	Master	20

standards, benchmarking practices in other places and collecting information about budget planning strategy programs.

The obtained results contribute to future research by providing a valuable reference to assist the change in social models for national defense and military budget planning. This helps the financial specialists to diminish the obstructions and obtain much data from various powerful components, utilizing expert information. These findings will support future research, as a useful reference for analysts to build national defense and military budget planning strategy models. However, as with any experimental investigation, this study has limitations. First, the observational information was obtained for only one budget-planning case. Differences in budget planning mean that conclusions from this study may be not appropriate for the cases of other nations. Nevertheless, the method is sufficiently adaptable to be easily used for other cases of national defense and military budget planning. Second, the utilization of a single investigation strategy presents limitations. The application of other approaches in future, to confirm the obtained results, would be advantageous. Future research can be conducted to further test the variables displayed in this study, by utilizing diverse strategies and a larger data sample.

APPENDIX

See Table 14.

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