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The Comparative of the AHP Topsis Analysis Was Applied for the Commercialization Military Aircraft Logistic Maintenance Establishment

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Abstract: In order to implement the military aircraft maintenance provider policies, law legislators gradually released various types of military aircraft entrusted to civil aviation maintenance management. The management system in military aircraft maintenance operations maintenance of limited resources, vendor management is not easy because of the huge investment. The technology and resource release are still missing. The resource integration, the whole management system were not built completely yet. To overcome the above problems, the study aggregated by the relevant literature, logistic information management system, LIMS, total logistics support, TLS, expert opinion is to establish commonality military aircraft maintenance provider competitive assessment criteria model, using practical experience and expert recommendations. The evaluation criteria is assigned an appropriate score, the application of AHP TOPSIS analysis of two civil aviation that aim at five military aircraft suppliers dimensional project, to achieve the overall integration of maintenance resources. The study found that by AHP TOPSIS to quantify the comparative analysis of α and β companies suppliers military aircraft maintenance company overall ranking value between 0.82~0.18°C case preference sort the two companies differ in 0.15, enough to understand the case of the two companies compete for C is very intense, comprehensive study of the above highlights the importance and value and contribution.

Key words: AHP TOPSIS, commercialization military aircraft logistic maintenance, total logistics support, TLS, logistic information management system, LIMS, AHP TOPSIS

INTRODUCTION

Government started to facilitate the military aircraft maintenance to Civil Aviation since 1995. Recently, the legislative process gradually released military aircraft entrusted to civil aviation maintenance management, facing him following issues of Commercialization Military Aircraft Logistic Maintenance: the market is very competitive. Incapability to build military aircraft maintenance, logistics management and other maintenance releases because of lacking management system. Military aircraft maintenance resource integration and management system are not matures. The study was to integrate the relevant researches and expert opinions to establish Analytic Hierarchy Process (AHP) Technique for Order Preference by Similarity to Ideal Solution, TOPSIS (AHP TOPSIS) for the aviation industry, applied to the military aircraft maintenance provider's mode. The contribution of this study is to provide valuable practical experience with the integration of resource allocation to Industry experts and to serve the government and the military, industry and other units with the reference of the military aircraft maintenance in the future.

Literature review: Commercialization military aircraft logistic maintenance evaluation criteria according to the research and support manuals from US Department of Defense in 1983, the nation prioritizes the policy, community, economy, implementation, technology, Logistic Information Management System (LIMS) and Total Logistics Support (TLS) (Chung and Fon, 2005) and expert interviews. This study is to establish military aircraft by supplier's dimensional evaluation criteria 4 dimensions and 24 indicators. Logistics is also an important issue for military equipment maintenance (Hsiung, 2004; Shan, 1998; Military Standard, 1983). According to experts score in practical experience and suggestions for this study, the evaluation criteria by AHP TOPSIS analysis build military aircraft maintenance provider mode,

MATERIALS AND METHODS

AHP: In 1971, T, L. Saaty proposed AHP application on multiple evaluation criteria decision and the situation of uncertainty to simplify the problem through the hierarchy. And the decision makers of the evaluation criteria analyze the relative importance to quantify

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Table 1: Commercialization military aircraft logistic maintenance evaluation criteria

Logistics support	Logistics management	Logistics engineering	Maintenance services
Procurement capacity	Quality control	Customer demand	Maintenance planning
Technical documents	Lead time	Maintenance capability	Material requirements planning
Material supply	Cost control	Sale service	Material requirements analysis
Facilities planning	Logistics capability repair experience	Maintenance records	RMS (Reliability, Maintainability, System security)
Support testing equipment	Product discipline	Function test	Human resources training
Computer information	Intellectual property rights	Overhauled capacity	Analysis of data collection service

research (Table 1). There are three main phases: Phase 1: establish hierarchy: the problems were divided to different levels. Each level assessment criteria was recommended seven or less than the decision-makers can reasonably compare with the consistency. Phase 2: weighting principle can be applied to at all level of the evaluation criteria of the recalculation which further divided into three steps. To establish a pair wise comparison matrix: the level of assessment criteria pair wise comparison, n with the assessment criteria shall be n (n-1)/2 times pair wise comparisons, pair wise comparisons ratio scale 9, 8, 7.2, 1, 1/2, ..., 1/8, 1/9. To calculate eigenvectors and eigenvalues. After establishing pair wise comparison matrix, via numerical analysis eigenvalues obtained in feature vector eigenvector which is the weighting principle of evaluation criteria. Consistency test: pair wise comparison matrix quantization value for policy-makers to judge value by the consistency test ratio consistency ratio; CR to check policymakers assessed criteria converted pair wise comparison matrix, whether the data is consistent or not. Phase 3: the overall level of assessment criteria: weighting principle weight calculation: calculate the level of assessment criteria, summarized the overall level of integration assessment criteria weighting principle weights.

TOPSIS: In 1980, Yoon Hwang University and Kansas State provided TOPSIS in a multi-method assessment in decision-making to help policy makers deal with multiple solutions as following: ideal solution: I* alternative scenarios based on guidelines of max value. Negative-ideal solution: I-alternative scenarios based on guidelines of min value. The best alternative is "the farthest distance from the ideal solution"; "the shortest from the negative ideal solution"; assumed that each criterion has decreasing effects (Kittur, 2015; Leen *et al*., 2013; Li *et al*., 2015; Yan *et al*., 2014; Mokhtar *et al*., 2015).

Case study, AHP: These findings of the study are as following:

- To establish hierarchical structure: establish military aircraft maintenance model
- The establishment of military aircraft repair assessment guidelines comparison matrix: according to the hierarchical structure, paired with relative importance of evaluation criteria comparison

$$A^s = \begin{bmatrix} 1 & a_{12}^s & L & a_{1n}^s \\ \frac{1}{a_{12}^s} & 1 & L & a_{2n}^s \\ M & M & O & M \\ \frac{1}{a_{1n}^s} & \frac{1}{a_{2n}^s} & K & 1 \end{bmatrix}, s = 1, 2, \cdots\cdots, n \quad (1)$$

$$a_{ij} = \frac{1}{a_{ji}} \quad (2)$$

To calculate eigenvectors and eigenvalues; to calculate eigenvector:

$$W_i = \frac{\left(\prod_{j=1}^{n} a_{ij}\right)^{1/n}}{\sum_{i=1}^{n}\left(\prod_{j=1}^{n} a_{ij}\right)^{1/n}} \quad (3)$$

n is the numbers of evaluation criteria. To calculate maximum eigenvalue λ^{max}:

$$A^s = \begin{bmatrix} 1 & a_{12}^s & L & a_{1n}^s \\ \frac{1}{a_{12}^s} & 1 & L & a_{2n}^s \\ M & M & O & M \\ \frac{1}{a_{1n}^s} & \frac{1}{a_{2n}^s} & K & 1 \end{bmatrix} \times \begin{bmatrix} W_1 \\ W_2 \\ \vdots \\ W_n \end{bmatrix} = \begin{bmatrix} W_1' \\ W_2' \\ \vdots \\ W_n' \end{bmatrix} \quad (4)$$

$$\lambda_{max} = (1/n) \times \left(W_1'/W_1 + W_2'/W_2 \cdots + W_n''/W_n\right) \quad (5)$$

Consistency verification: the ratio of CI value RI value were called Consistency Ratio (CR) when CR value is >0.1, the degree of consistency of the matrix is very high:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (6)$$

$$CR = \frac{CI}{RI} \quad (7)$$

Weighted value calculation: to evaluate based on weighted value calculation, ranking in the orders of max-min numbers to help policy makers in making decisions (Table 2).

Table 2: Commercialization military aircraft logistic maintenance evaluation criteria weight

Level	Evaluation criteria	Weight	Evaluation criteria	Weight
2	Logistics support	0.22	Maintenance services	0.30
3	Procurement capacity	0.18	Customer demand	0.23
3	Technical documents	0.20	Maintenance capability	0.18
3	Material supply	0.18	Sale service	0.17
3	Facilities planning	0.18	Maintenance records	0.15
3	Support test equipment	0.17	Function test	0.13
3	Computer information	0.09	Overhauled capacity	0.13
2	Logistics management	0.27	Logistics engineering	0.21
3	Quality control	0.21	Maintenance planning	0.19
3	Lead time	0.20	Material requirements planning	0.18
3	Cost control	0.17	Material requirements analysis	0.18
3	Logistics capability	0.19	RMS (Reliability, Maintainability, System security)	o.16
3	Repair experience	0.18	Human resources training	0.15
3	Product discipline	0.05	Analysis of data collection service	0.14

RESULTS AND DISCUSSION

TOPSIS: This research program is assumed known, described as following: decision matrix establishment $R_{n\times m}$:

$$R = \left[r_{ij}\right]_{m\times n} \tag{8}$$

$$R = \begin{bmatrix} x_{11} & L & x_{1j} & L & x_{1jn} \\ M & & M & & M \\ x_{i1} & L & x_{ij} & L & x_{in} \\ M & & M & & M \\ x_{m1} & L & x_{mj} & L & x_{mn} \end{bmatrix} = \begin{bmatrix} R_1(x_1) \\ M \\ R_i(X_j) \\ M \\ R_m(X_n) \end{bmatrix} = \left[X_1(x_1), L, X_j(x_i), L, X_n(x_m)\right] \tag{9}$$

To calculate weight matrix:

$$w_1 = \frac{x_1}{\sum x_{ij}} \tag{10}$$

$$\Sigma w_i = 1 \tag{11}$$

To calculate the normalized evaluation value:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_i^n x_{ij}^2}} \tag{12}$$

To calculate the evaluated normalized weighted value:

$$z_{ij}\ w_{ij} \times r_{ij} \tag{13}$$

To decide the positive ideal solution I* and negative ideal solution I (Table 3 and 4):

$$I^* = \{z1^*,\ z2^*, \ldots, zn^*\} \tag{14}$$

$$I- = \{z1-,\ z2-, \ldots, zn-\} \tag{15}$$

To calculate positive ideal solution Y* and negative ideal solution Y-of Euclidean distance (Table 5 and 6):

$$Y^* = \sqrt{\sum_{j=1}^{n}(z_{ij} - z_{ij}^*)^2} \tag{16}$$

$$Y^- = \sqrt{\sum_{j=1}^{n}(z_{ij} - z_{ij}^-)^2} \tag{17}$$

To calculate each alternative scheme for the relative degree of similarity to ideal solution (Table 7):

$$K_i^* = \frac{Y^*}{Y^* + Y^-} \quad 0 \geqq Ki^* \geqq 1$$

To rank the preference of the decision makers by Ki* values based on the numbers of max-min (Table 8). These findings of this study are as following: process evaluation criteria ranking by military aircraft case, 1A case: α>β company, 2B case α>β company, 3C case α>β company, 4D case α>β company, 5E case α>β company, evaluation criteria ranking by two companies α company: commercialization military aircraft logistic maintenance evaluation criteria ranking A>B>C>D>E case, 2α company: commercialization military aircraft logistic maintenance evaluation criteria ranking A>B>C>D>E case 3, the overall ranking of two companies: commercialization military aircraft logistic maintenance evaluation criteria

Table 3: Positive ideal solution I* value

I*	Values	I*	Values	I*	Values	I*	Values
Procurement capacity	0.010	Customer demand	0.019	Quality control	0.017	Maintenance planning	0.011
Technical documents	0.013	Maintenance capability	0.017	Lead time	0.014	Material requirements planning	0.011
Material supply	0.012	Sale service	0.014	Cost control	0.012	Material Requirements Analysis	0.011
Facilities planning	0.012	Maintenance records	0.013	Logistics capability repair experience	0.016	RMS(Reliability, Maintainability, System security)	0.011
Support test equipment	0.110	Function test	0.012	Product discipline	0.015	Human resources training	0.009
Computer information	0.006	Overhauled capacity	0.011	Intellectual property rights	0.005	Analysis of data collection service	0.009

Table 4: Negative ideal solution I- value

I*	Values	I*	Values	I*	Values	I*	Values
Procurement capacity	0.009	Customer demand	0.016	Quality control	0.009	Maintenance planning	0.009
Technical documents	0.010	Maintenance capability	0.011	Lead time	0.012	Material requirements planning	0.008
Material supply	0.009	Sale service	0.012	Cost control	0.010	Material requirements analysis	0.008
Facilities planning	0.008	Maintenance records	0.009	Logistics capability repair experience	0.009	RMS (Reliability, Maintainability, System security)	0.007
Support test equipment	0.008	Function test	0.008	Product discipline	0.010	Human resources training	0.007
Computer information	0.004	Overhauled capacity	0.008	Intellectual property rights	0.003	Analysis of data collection service	0.006

Table 5: Positive ideal solution Y* value of euclidean distance

	Commercialization military aircraft logistic maintenance case				
Company	A	B	C	D	E
α	0.017	0.015	0.012	0.011	0.011
β	0.013	0.012	0.008	0.005	0.004

Table 6: Negative ideal solution Y-value of Euclidean distance

	Commercialization military aircraft logistic maintenance case				
Company	A	B	C	D	E
α	0.004	0.005	0.009	0.009	0.009
β	0.009	0.009	0.011	0.014	0.016

Table 7: Ki* value

	Commercialization military aircraft logistic maintenance case				
Company	A	B	C	D	E
α	0.82	0.75	0.57	0.55	0.54
β	0.61	0.58	0.42	0.26	0.18

Table 8: Ki* value ranking

	Commercialization military aircraft logistic maintenance case				
Company	A	B	C	D	E
α	1	2	3	4	5
β	1	2	3	4	5

ranking 1α company of A case 2α company of B case, 3β company of A case, 4β company of B case, 5β company of C case, 6β company of D case, 7β company of E case, 8β company of C case, 9α company of D case, 10α company of E case (Table 8).

CONCLUSION

These findings of the paper are as following: comparative AHP TOPSIS analysis of the overall ranking value of and α company is between 0.82-0.18. The preference of C case between two companies differ in 0.15 indicates that the company towards C case are very competitive for C case, the overall ranking of two companies: commercialization Military Aircraft Logistic maintenance evaluation criteria ranking 1α company of A case 2α company of B case, 3β company of A case, 4β company of B case, 5α company of C case, 6α company of D case, 7α company of E case 8 β company of C case, 9 β company of D case, 10β company of E case (Table 7) and 8. Both two companies have forty years of experience in the maintenance of military aircraft, military aircraft in service due to various data with alertness, can not collect all military aircraft and establish a case of material requirements planning and materials analysis and other information so the relative cost analysis and control is not easy. They can not grasp each military aircraft in service status, when military aircraft out order, they can't solve the problem immediately and can not reach short-term troubleshooting.

This study generally applies military aircraft maintenance assessment criteria for each type of machine commonality for military aircraft maintenance provider to release various types of military aircraft in order to understand the company's competitive advantages and disadvantages of proposed improvement plan which reduce costs.

The study established "maintenance operations", "logistical support", "logistics management", "logistics engineering" to improve 24 evaluation criteria which can be developed into maintenance of core technologies, efficient allocation of resources, applied to various military aircraft project management of the evaluation and government military aircraft maintenance business inventory. In recent years, big data research has been constantly innovated and developed. Hopefully, the government provides civil service with big data through legislation, to find the normal channels and to establish

service to serve old military aircraft, to further reduce the spare parts of huge defense budget, to establish the cooperation of military and civil supply chain management. It is a very important part for military aircraft which highlights the importance and value and contribution of this study.

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