Journal of Social Sciences 4 (1): 56-61, 2008
ISSN 1549-3652

Combining ANP and TOPSIS Concepts for Evaluation the Performance of Property-Liability Insurance Companies

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Abstract: This is a significant problem for the property-liability insurance industry. The study first uses Modified Delphi Method to sift influence property-liability insurance effects out norms. Moreover, the evaluation weights are determined using Analytic Network Process (ANP). Finally, the technique for ordering preference by similarity to the ideal solution (TOPSIS) constructs performance evaluation model of property-liability insurance companies in Taiwan. This research use financial statements of property-liability insurance industry calculated efficiency placing and through the positive research. Findings may do for the government the important reference of the insure policy.

Key words: Analytic Network Process (ANP), performance evaluation, property-liability insurance industry, modified delphi method, TOPSIS

INTRODUCTION

According to Sweden Reinsurance sigma 2007 global insurance industry statistical data, North America total premium income shares rate is 35.66%, the Europe premium income is 33.55%. Regarding the ratios of premium income derived from property-liability versus life insurance: in North America the ratio was about 1:0.82, Europe 1:1.54, Asia 1:3.33, Oceania 1:1.14 and Africa 1:3.57. In Taiwan the ratio of property-liability to life insurance was approximately 1:3.81, with maturity higher Europe and America various countries nearly 1:1 by comparison, property-liability insurance still have the quite big development space. The economy of Taiwan will recover prosperous in 2006, will drive the trade and folk consuming capacity of increase, meaning it will be important to establish effective management methods for property-liability insurance companies. From the annual property-liability insurance market important Index fluctuation tendency experience, the Property-liability insurance to show adagio growth in 2006, to have Total Assets to add and Net Income decline.

Pertinent literature on assessing the performance of property-liability insurance is as follows: Cummins *et al*.[4] presents a theoretical and empirical analysis of the capacity of the US property-liability insurance industry to finance catastrophic property losses in the $100 billion range. Brockett *et al*.[1] presents the non-parametric properties of DEA coupled with rank order statistics to study the relative efficiency of the different organization structures used by US property and liability insurance companies. Gatzert and Shmeiser[6] proposal focus on property-liability insurance companies and analyze the effect of corporate taxation on pricing and competitive equity-premium combinations for different asset and liability models.

Sarkis[11] applications ANP analyze systematic choose of environment tactic. Sarkis and Sundarraj[12] application ANP model for choice of Hub Location. Chen *et al*.[2,3] presents ANP model for environmentally conscious construction planning. Wu *et al*.[13] integrated environmental assessment of the location selection with Fuzzy ANP.

MATERIALS AND METHODS

The ANP methodology: In ANP, like AHP, decision elements at each component are compared pair-wise with respect to their importance towards their control criterion and the components themselves are also compared pair-wise with respect to their contribution to the goal. Decision makers are asked to respond to a series of pair-wise comparisons where two elements or two components at a time will be compared in terms of how they contribute to their particular upper level criterion[10,11]. In addition, if there are interdependencies among elements of a component, pair-wise

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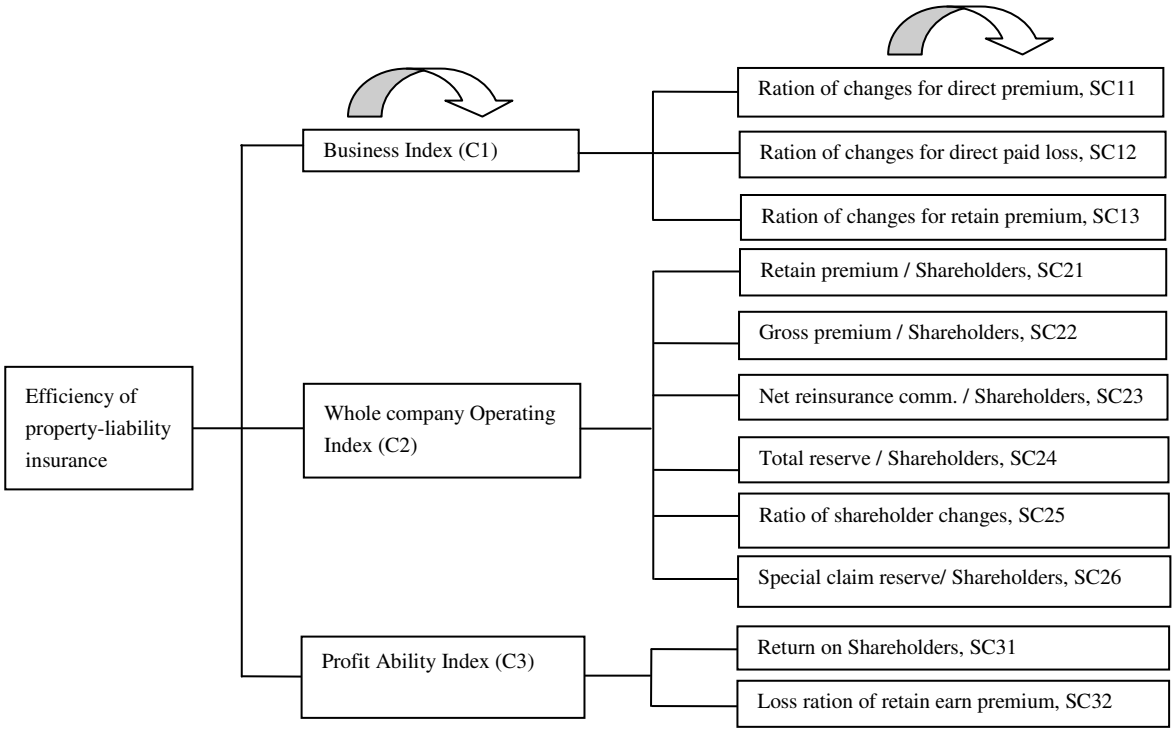

Fig. 1: Criteria carcass of property-liability insurance efficiency

comparisons also need to be created and an eigenvector can be obtained for each element to show the influence of other elements on it. The relative importance values are determined with a scale of 1 to 9, where a score of 1 represents equal importance between the two elements and a score of 9 indicates the extreme importance of one element (row component in the matrix) compared to the other one (column component in the matrix)[10,11].

The supermatrix concept is similar to the Markov chain process[7]. To obtain global priorities in a system with interdependent influences, the local priority vectors are entered in the appropriate columns of a matrix, known as a supermatrix. As a result, a supermatrix is actually a partitioned matrix, where each matrix segment represents a relationship between two nodes (components or clusters) in a system[11].

In essence, this solution algorithm derives weights that account for component interaction, which is a clear benefit of the dynamic ANP model over static models.

TOPSIS methodology: The TOPSIS was first proposed by Hwang and Yoon[5]. The underlying logic of TOPSIS is to define the ideal solution and the negative ideal solution. The ideal solution is the solution that maximizes the benefit criteria and minimizes the cost criteria; whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria. The optimal alternative is the one, which is closest to the ideal solution and farthest to the negative ideal solution. The ranking of alternatives in TOPSIS is based on 'the relative similarity to the ideal solution', which avoids from the situation of having same similarity to both ideal and negative ideal solutions.

PROCEDURE OF EVALUATING THE PROPERTY-LIABILITY INSURANCE COMPANIES

The modified Delphi method is then adopted to summarize the expert opinions in order to construct an evaluation model to assess the property-liability insurance companies. Based on factors to evaluate property-liability insurance, i.e., whole company operating, business and profit ability, ANP is used to illustrate the problems and combine the three factors to establish the model for performance evaluation in this study. Finally, 14 renowned property-liability insurance

companies in Taiwan are an example in which this evaluation model is applied to the ranking their evaluate performance. This ANP model for evaluating the property-liability insurance comprises the following steps:

Step 1: Establish an ANP model and define the evaluative criteria and sub-criteria: This study according to disclosure information management method determines relevant important indicator makes to this study to weigh research variables of performance. Based on the modified Delphi method, a general consensus among experts can be reached to establish a model. The ultimate goal of evaluating the ideal efficiency performance can be achieved, followed by three-evaluation criterion and eleven sub-criteria (Fig. 1). The evaluation criteria and sub-criteria used to evaluate the efficiency performance are defined as follows:

(a) Business Index (C1)

- **Ration of changes for direct premium (SC11):** To check insurance company reinsurance before, direct influence trade grow up or turn down situation, attest insurance company evaluate of sales ability.
- **Ration of changes for direct paid loss (SC12):** To show insurance company the same year state of settling a claim and paying, is reverse index.
- **Ration of changes for retain premium (SC13):** To ponder insurance company retain premium income grow up situation and check insurance company retain acceptance of risk caliber, advantage chance and of accept insurance business quality.

(b) Whole company operating index (C2)

- **Retain premium/shareholders (SC21):** After reinsure retain business financial leverage degree, can show dangerous exposed range and degree of company. The leverage is high, the risk improves relatively, but make a profit or lost chance is the greater.
- **Gross premium/shareholders (SC22):** The business leverage before the insurance company reinsures. The leverage is high, the risk improves relatively, but make a profit or lost chance is the greater. This is reverse index.
- **Net reinsurance comm./shareholders (SC23):** Because insurance company manages a part can by reinsurance commission income is it increase account surplus. So, this index can understand the influence to the company managed in the insurance.
- **Total reserve/shareholders (SC24):** Weigh the potential impact to owner's rights and interests of reserve.
- **Ratio of shareholder changes (SC25):** Represent the change that on the accountant, the assets are deducted the rights and interests of owner after being in debt in current year.
- **Special claim reserve/shareholders (SC26):** Show the special capital reserve to the proportion of owner's rights and interests, in order to evaluate the company to the operation risk extra capital reserve and cost.

(c) Profit ability index (C3)

- **Return on shareholders (SC31):** Knowable the earning capacity of shareholder's investment company.
- **Loss ration of retains earn premium (SC32):** Evaluate quality of accepts insurance controls the tube and reinsurance arranged result. To show the more lower the effects the more better. The index is reverse.

Step 2: Establish the pair-wise comparison matrix and determine eigenvectors: The weights of criteria and sub-criteria are then determined for a sample group of twelve matching the above characteristics with each respondent making a pair-wise comparison of the decision elements and assigning them relative scores. The relative scores provided by twelve experts are aggregated using the geometric mean method.

Step 3: Establish pair-wise comparison matrices of interdependencies: Based on the modified Delphi method, acquire inner interdependence; the dependencies among criteria are shown in Fig. 2. Note that zeros are assigned to the eigenvector weights of criteria that are independent. The inner dependence among the sub-criteria is analyzed next. The schematic representation of the relationship among sub-criteria is shown in Fig. 3.

Step 4: Establish supermatrix and the limit matrix: A supermatrix allows for the resolution of the effects of interdependence between the elements of the system. It is a partitioned matrix, where each sub-matrix is composed of the vectors obtained from the pair-wise comparison.

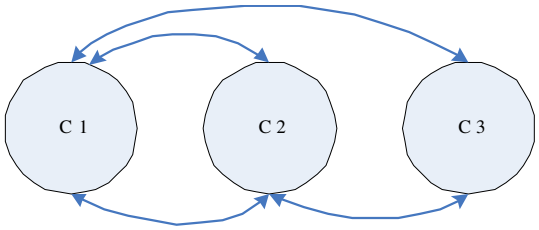

Fig. 2: Inner dependence among criteria

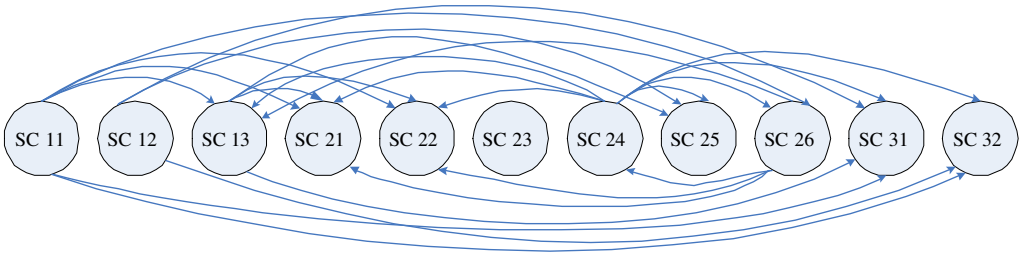

Fig. 3: Inner dependence among sub-criteria

Table 1: The Un-weighted Super-matrix

	Goal	C1	C2	C3	SC11	SC12	SC13	SC21	SC22	SC23	SC24	SC25	SC26	SC31	SC32
C1	0.435	0.000	0.800	0.750	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C2	0.240	0.333	0.000	0.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
C3	0.325	0.667	0.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SC11	0.000	0.190	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SC12	0.000	0.263	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SC13	0.000	0.547	0.000	0.000	0.113	0.000	0.000	0.000	0.000	0.000	0.098	0.000	0.115	0.000	0.000
SC21	0.000	0.000	0.319	0.000	0.093	0.000	0.306	0.000	0.000	0.000	0.081	0.000	0.095	0.000	0.000
SC22	0.000	0.000	0.145	0.000	0.116	0.000	0.282	0.000	0.000	0.000	0.101	0.000	0.118	0.000	0.000
SC23	0.000	0.000	0.180	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
SC24	0.000	0.000	0.090	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.000	0.000
SC25	0.000	0.000	0.187	0.000	0.000	0.100	0.210	0.000	0.000	0.000	0.133	0.000	0.000	0.000	0.000
SC26	0.000	0.000	0.079	0.000	0.118	0.000	0.000	0.000	0.000	0.000	0.107	0.000	0.000	0.000	0.000
SC31	0.000	0.000	0.000	0.167	0.099	0.100	0.202	0.000	0.000	0.000	0.083	0.000	0.100	0.000	0.000
SC32	0.000	0.000	0.000	0.833	0.461	0.800	0.000	0.000	0.000	0.000	0.398	0.000	0.472	0.000	0.000

As discussed in the appendix and shown by the dotted bracket in Fig. 3, the supermatrix in this study covers all the elements in the network. The supermatrix, inserted with respective vectors and matrices obtained before is shown in Table 1. A weighted supermatrix is transformed first to be stochastic. After entering the normalized values into the supermatrix and completing the column stochastic, the supermatrix is then raised to sufficient large power until convergence occurs[7,11]. The current supermatrix reached convergence and attained unique eigenvector.

Step 5: Estimate the relative weighted of the elements of each level: After entering the normalized values into the supermatrix and completing the column stochastic, the supermatrix is then raised to sufficient large power until convergence occurs[7,11]. The current super-matrix reached convergence and attained unique eigenvector. Table 2 provides the final limit this limit matrix is column stochastic and represents the final eigenvector. The property-liability insurance to manage weight of main-criteria are in order C1 (0.435)>C3 (0.336)>C2 (0.229) and weight of sub-criteria are in order SC32 (0.290)>SC13 (0.131)>SC21 (0.129).

Step 6: Determine the property-liability insurance company's performance by TOPSIS Establishing and normalizing the D matrix: According to 2005 disclosure information management method of

property-liability insurance get 14 number of property-liability insurance companies sub-criteria primary data[14] in Table 5. After the decision matrix was determined. Based on Table 3 normalize matrix by Eq. 3. Since the sub-criteria weights (W_{ANP}) have been obtained from ANP, the weighted normalized performance matrix can be calculated by Eq. 4.

Table 2: weights of the criteria, sub-criteria

Name	Normalized by cluster	Name	Normalized by cluster
C1	0.435	SC22	0.107
C2	0.229	SC23	0.020
C3	0.336	SC24	0.014
SC11	0.040	SC25	0.090
SC12	0.055	SC26	0.021
SC13	0.131	SC31	0.105
SC21	0.129	SC32	0.290

Table 3: The decision-making matrix

Company	SC11	SC12	SC13	SC21	SC22	SC23	SC24	SC25	SC26	SC31	SC32
Taiwan Fire and Marline	0.149	0.001	0.097	33.111	64.183	4.643	64.939	1.199	24.871	1.440	0.548
Chung Kuo	0.234	0.221	0.129	33.359	64.810	4.649	64.880	1.317	24.839	1.359	0.642
Taiping	0.230	0.336	0.095	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.685
Fubon	0.168	0.188	0.184	33.151	64.147	4.635	64.782	1.082	24.769	1.413	0.595
Zurich	0.000	1.198	0.077	34.091	65.454	4.668	66.577	1.096	25.525	1.334	0.536
Taian	0.170	0.732	0.046	33.570	65.255	4.759	65.496	1.159	25.081	1.379	0.534
Mingtai	0.177	0.328	0.071	34.425	67.003	4.929	66.977	1.202	25.731	1.418	0.572
Central	0.195	1.938	0.153	33.498	65.147	4.728	65.111	1.110	24.914	1.353	0.560
The First	0.241	0.267	0.116	33.949	65.354	4.713	65.734	1.047	25.176	1.346	0.531
Union	0.230	0.000	0.024	33.378	64.922	4.703	64.914	1.073	24.795	1.356	0.640
Shonkong	0.238	0.151	0.147	34.557	66.250	4.723	66.517	1.171	25.298	1.445	0.569
South-China	0.216	0.090	0.208	33.925	65.640	4.748	66.207	1.078	25.470	1.422	0.470
Cathay Century	0.202	0.887	0.124	34.500	66.074	4.687	66.577	1.083	25.379	1.513	0.563
Tokio Marznrzue Newa	0.439	0.479	0.277	34.189	65.346	4.644	65.906	1.577	25.185	1.417	0.548

Table 4: Resultant of S_i^* and S_i^-

Compamy	S_i^*	S_i^-
Taiwan Fire and Marline	0.0021	0.0021
Chung Kuo	0.0014	0.0026
Taiping	0.0038	0.0007
Fubon	0.0011	0.0028
Zurich	0.0018	0.0022
Taian	0.0023	0.0020
Mingtai	0.0021	0.0022
Central	0.0007	0.0032
The First	0.0017	0.0021
Union	0.0029	0.0021
Shonkong	0.0014	0.0026
South-China	0.0014	0.0029
Cathay Century	0.0012	0.0025
Tokio Marznrzue Newa	0.0006	0.0044

Table 5: Summary of the TOPSIS

Rank	Company	C_i^*
1	Tokio Marznrzue Newa	0.8767
2	Central	0.8119
3	Fubon	0.7085
4	South-China	0.6760
5	Cathay Century	0.6735
6	Chung Kuo	0.6493
7	Shon-kong	0.6449
8	The First	0.5543
9	Zurich	0.5479
10	Mingtai	0.5075
11	Taiwan Fire and Marline	0.5001
12	Taian	0.4674
13	Union	0.4159
14	Taiping	0.1468

Determining the C_i^* : First, determine the ideal solution and negative ideal solution using formulae 7 and 8. Table 4 displays those results. Next, calculate the relative closeness to the ideal solution of each alternative, C_i^*, using Eq. 9.

According to Table 5 the ranking order of the three property-liability insurance companies are Tokio Marznrzue Newa (0.8767), Central (0.81195) and Fubon (0.7085).

DISCUSSION

This proposal further combines the concepts of the ANP and TOPSIS models to evaluate and rank property-liability insurance company performance. The ANP and TOPSIS -based decision-making method for constructing an evaluation method can provide property-liability insurance company decision makers or administrators with a valuable reference for evaluating the company performance. In particularly, investors and administrators frequently lack objective

decision-making procedures and assessment criteria. Moreover, there are simply too many property-liability insurance companies and thus selecting insurance companies with optimal efficiency is extremely difficult.

Finally, by applying ANP in obtaining criteria weight and TOPSIS in ranking on those results, the Tokio Marznrzue Newa (0.8767) insurance company is identified as the optimal insurance company. This study used limited financial data for the performance evaluation and each property-liability insurance company organized its statements differently, creating further limitations.

Moreover, regarding of the non- financial factor can accede to in the treat discussion item, for example: service quality of property-liability insurance, customer's satisfaction etc. Second, follow-up research can be the same method but adopt during different study, to judge the stability of the study results; and the present approach can be applied to other industries, for example: Life Insurance Industry, electronics industry etc.

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