An analytic decision making framework to evaluate multiple marketing channels

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MCDM

Abstract
Marketing channel evaluation is a crucial and complex task. Although empirical studies have made efforts to identify key constructs, no models have been developed to comprehensively assess the viability of different marketing channels for business. With this research, we propose an analytic decision-making framework for multi-channel evaluation. We first develop an analytic network, based on the inputs of managers and literature, to depict the interrelationships between decision criteria. Multi-Criteria Decision Making methods are then adapted to determine the weight of each evaluation criterion and to rank the practicality of alternative marketing channels. The model is tested with Cisco China. Sensitivity analysis is conducted in order to understand the impact of criteria uncertainties on channel rankings and the robustness of the proposed model. The management at Cisco found the model to be transparent, logical, practical, and it provided a valid and reliable guide for evaluating channel alternatives.

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1. Introduction

Marketing channel management is an important and demanding task particularly in multi-channel environments. Due to the emergence of electronic commerce on the Internet (Chiang, Chhajed, & Hess, 2003) and the micro-segmentation of consumer groups (Day, 2011), multi-channel distribution systems have been adopted by many manufacturers in order to reach unexplored markets and help to lower distribution costs (Rangaswamy & Van Bruggen, 2005). Despite the potential merits of multiple distribution systems, marketing channel managers have to deal with many challenging issues such as understanding priorities confronting channel members, creating channel synergies, resolving channel conflicts, and indentifying optimal channel mix (Achrol & Etzel, 2003; Rosenbloom, 2007).

For channel managers, choosing the optimal distribution mix in multiple distribution systems is extremely puzzling since each distribution channel possesses particular strengths and weaknesses. For example, websites have the benefits of displaying products online, building virtual communities for customers to share shopping experiences, and collecting product reviews for further market analysis (de Valck, van Bruggen, & Wierenga, 2009; Duan, Gu, & Whinston, 2008). However, websites tend to have lower sales per account (Sharma & Mehrotra, 2007), longer lead times, and higher rates of product return. On the other hand, companies that have key account management teams, have higher sales per account, are more costly and riskier to manage (Pillai & Sharma, 2003), and focuses exclusively on VIP customers (Guenzi, Pardo, & Georges, 2007).

Another challenge associated with the management of multiple marketing channels is to unravel various ways relevant factors may interact with each other in a specific distribution situation. For example, different autonomous distribution channels may target the same customer segment, leading to channel conflict and in turn, an increase of channel coordination cost. On the other hand, perceived unfairness in channel relationship is also likely to exacerbate negative feelings (Sprecher, 1986), and motivates channel members to punish or retaliate the offending party (Fehr & Gächter, 2000; Offerman, 2002), thus also resulting in increased coordination costs. In addition, other factors in multi-channel environment such as channel functions and channel performance are likely to be highly correlated. Effective information exchange can enhance channel capabilities which in turn affect a firm’s market performance (Kim, 2007). For instance, in order to attract online customers to purchase multiple products in one transaction, online recommendation system (ORS) is developed to gauge customers’ preferences which provide valuable information to cross-sell products that might interest customers (Linden, Smith, & York, 2003). The acquired market information from online channel can also be applied to boost
sales in offline channels. In short, unlike managing a single distribution channel, management and evaluation of multiple marketing channels involves significantly more complex analysis.

In response, decision procedures need to be developed to help marketing channel managers understand how to deploy multiple channels so as to realize their full potential (Frazier, 1999). Within the field of decision sciences, the evaluation of multiple marketing channels can be seen as Multi-Criteria Decision Making (MCDM), because it involves trade-offs between many important concerns. The strength of the MCDM approach lies in its ability to address a complicated problem by considering many relevant variables (decisive factors) as well as the strategic goals of the firm. With the aid of the MCDM framework, we feel channel managers can better assess the importance of the pertinent factors, rank the alternatives, and then select the most appropriate marketing channel strategy for their business.

2. Literature review

A firm is said to employ a multi-channel strategy when it launches products to market through two or more channels, directly or through third parties (Coelho & Easingwood, 2008; John & Weitz, 1988; Shervani, Frazier, & Challagalla, 2007). Key Account teams are responsible for handling the firm’s largest accounts, while external distributors are sometimes used for medium or small customers (Moriarty & Moran, 1990). In order to attract customers and increase market share, marketers often adopt several channels to reach diverse customers. For example, Internet distribution strategy has become an effective and formidable alternative. U.S. online retail sales reached $141.3 billion in 2008 and rose to $156.1 billion in 2009 (Internetretailer.com, 2009). E-commerce has had a substantial impact on the way businesses communicate with their customers. To establish an online marketing channel, several alternatives are available. For instance, Dell uses a company-based website, while other firms may adopt shared website such as eBay. Driven by the emerging online channel and the complexity of the markets, the number of distribution channels has increased from three to more than ten, including company stores, shared and exclusive dealers, telemarketing agents, and affinity partners (Day, 2011). Specifically, the direct distribution channel includes company sales force, company sales branch, telemarketing, internet, and catalog, while the distribution channel through third parties includes sales agents, brokers, distributors, and value added resellers.

To address the issues in multi-channel management, researchers have identified a number of critical factors that affect multi-channel strategies. For example, a number of studies indicate that distribution costs play a key role in selecting a channel. Kabadayi (2011) suggests that firms are able to minimize the transaction costs in sales channels if the channel chosen properly matches its business. Past research has also examined the relationship among crucial constructs in channel management (Agatz, Fleischmann, & van Nunen, 2008; Kabadayi, 2011; Kim, 2007; Luo, Liu, & Xue, 2009). The results indicate that there exists a complex interdependence relationship among them (Cheng, Tsao, Tsai, & Tu, 2007; Panayides, 2007). These general findings provide insights into multi-channel environments and form the basis for the development of an analytical model that can be used for selecting an optimal mix of distribution channels.

### 2.1 Evaluating distribution channels based on channel performance

Although studies have identified a number of relevant factors that should be considered, it would be particularly helpful if a reliable model was available for management to use to assess the viability of different marketing channel options. In response to that need, several processes have been proposed. A number of these methods tie channel performance with financial metrics, such as sales per account, cost and profit (Gensler, Dekimpe, & Skiera, 2007; Kabadayi, 2011; Sharma & Mehrotra, 2007). Specifically, Cravens, Ingram, and LaForge (1991) presented a selling effort portfolio model to enable sales management to allocate marketing responsibilities and restructure distribution channels. With the goal of minimizing channel cost. Alptekinoglu and Tang (2005) developed a distribution policy strategy to be used across different marketing channels. Using customers’ intrinsic loyalty and switching behavior as indexes of channel performance. Gensler et al. (2007) provided a maximum likelihood estimation method to evaluate multi-channel systems. In addition, Sharma and Mehrotra (2007) proposed a breakeven based decision-making procedure to determine a financially optimal distribution mix for B2B marketers by addressing the trade-offs between market coverage and potential conflicts. Though these models provide important insights to developing an effective channel, financial considerations are just one of the concerns that must be taken into account.

Specially, another key factor to understand when choosing appropriate channels is the relationship between channel members. A distribution system that has discordant relationships between members will eventually be a dysfunctional one over the long run, even if it excels financially at present. Thus, evaluation models focusing solely on channel performance are very likely to overlook other key objectives and their interrelationships, and mostly will derive sub-optimal solutions.
2.2. MCDM methods for evaluating marketing channel alternatives

To effectively incorporate numerous factors in solving complex problems, decision makers often apply MCDM methods. According to Wind and Saaty (1980), MCDM models are designed to evaluate alternatives for a small group of experts to make decisions involving multiple criteria and alternatives. Some MCDM models relevant to our research are discussed next.

2.2.1. The AHP method and the TOPSIS method

Saaty (1980) developed the AHP (Analytic Hierarchy Process) to solve MCDM decision making problems. The AHP method involves three basic steps: (1) conceptualize a complex decision problem as a hierarchy, (2) estimate the importance of decision criteria on each level of the hierarchy by adopting pairwise comparisons, and (3) rank the alternatives based on the derived weights of decision criteria. Bernasconi, Choi, and Seri (2010) concluded that AHP was a reliable decision-making tool for subjective measurement of alternative courses of action. An advantage of AHP is that it can overcome the ambiguities in identifying different attributes and handle more complex problems by extending levels in the hierarchy (Armacost & Hosseini, 1994).

The AHP has been found to be an effective evaluation technique in marketing applications. Huang, Chen, and Wu (2009) used AHP to evaluate distribution channels in the tourism industry by considering overall cost, gross profit, target audience respondent rate, impression rates, and transactional capabilities. To overcome uncertain judgment provided by decision makers, Fu, Chao, Chang, and Chang (2008) applied fuzzy AHP to study whether small and medium-sized enterprises should adopt a third-party electronic marketplace channel strategy or establish their own. Overall, using AHP has become a widely accepted procedure for solving MCDM problems.

TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution), developed by Hwang and Yoon (1981) and Chen and Hwang (1992), is another useful MCDM method. The basic principle of TOPSIS is to choose the alternative which is the shortest distance from the ideal solution and longest distance from the worst-case scenario (Opricovic & Tzeng, 2003). Requiring only simple mathematical functions to assess alternatives, TOPSIS avoids enormous pairwise comparisons and reduces the large number of matrix operations required in AHP (Olson, 2004; Peng, Kou, Wang, & Shi, 2011). However, because the method lacks the ability to derive weights for decision criteria, TOPSIS often serves as a complement to AHP and other MCDM methods. For example, Yu, Guo, Guo, and Huang (2011) developed a hybrid evaluation model by introducing TOPSIS into AHP to assess B2C websites in e-alliance.

Although AHP and TOPSIS allow channel managers the flexibility to include multiple evaluation criteria, they cannot address the interrelationship among evaluation criteria in multi-channel environments since built-in assumptions of AHP and TOPSIS require evaluation criteria should be independent with each other. Such deficiency leads us to explore another more advanced MCDM approach, the Analytic Network Process (ANP). Table 1 summarizes the managerial decision-making methods applied in the evaluation of distribution channels.

2.2.2. The hybrid method of fuzzy ANP and fuzzy TOPSIS

ANP is a multi-criteria decision-making aid which helps unravel interactions between evaluation criteria. As an extension and more general form of AHP, ANP structures the decision making problem as a network of interconnections between variables and outcomes and allows for mutual dependencies and feedback among the criteria (Ergu, Kou, Peng & Shi, 2011). With ANP, we can handle the interaction issues among criteria and understand their joint impact on the final ranking of alternative solutions.

Traditional data collection in MCDM requires experts to provide numerical judgments for pairwise comparisons. However, numerical scale will get into trouble when respondents are reluctant or unable to make exact numerical comparisons. To make up for this shortcoming, fuzzy theory is introduced to allow experts to give uncertain judgments. In this research we propose a hybrid method of fuzzy ANP and fuzzy TOPSIS to assess multiple distribution channels. The rationale for our choice is due to its three advantages. First, the interdependence relationship among evaluation criteria can be handled relatively easily using ANP. Second, the introduction of TOPSIS can simplify calculations for when evaluating channels. And finally, fuzzy method is more accurate than numerical scale in terms of collecting respondents' opinions.
3. The evaluation framework of multi-channel strategies

An integrated analytic evaluation framework, which incorporates fuzzy ANP and fuzzy TOPSIS, is proposed to assess multi-channel distribution strategies. The implementation procedure of the framework can be divided into five steps (Fig. 1). First, we identify the relevant criteria that will be used in the evaluation of the channel options. Second, we determine the interrelationships among evaluation criteria from literature. Next, we validate the relationship network of evaluation criteria through in-depth interviews with channel managers or correlation tests, and subsequently establish the analytic decision making model in the case study. Furthermore, we introduce fuzzy ANP to calculate weights of evaluation criteria (Peng, Kou, Wang, Wu, & Shi, 2011). Finally, fuzzy TOPSIS is adopted to rank the various distribution alternatives based on the derived weights.

3.1. Step 1 — identification of evaluation criteria

The process of extracting pertinent factors in managing marketing channels can be divided as follows. First, collect relevant studies comprehensively. Agatz et al. (2008), Gensler et al. (2007), Sharma and Mehrotra (2007), and Samaha, Palmatier, and Dant (2011) have addressed issues in multi-channel strategy. Based on these references, we identify more literature which has recently cited those papers. We also search key words associated with multi-channel management in trade journals.

Second, extract crucial factors validated in extant studies. For example, channel relationship is identified as a key concern in operating distribution channels based on the following studies. Good relationship is crucial to maintaining the stability of a marketing channel system (Weitz & Jap, 1995). Relationship marketing suggests that marketing strategies should focus on long-term customer associations, not short-term business transactions (Grönroos, 2000). Relationship-oriented strategies can improve logistics service effectiveness and firm performance (Nyaga & Whipple, 2011; Panayides, 2007). Similarly, other three factors, which are channel function, channel cost, and channel performance, are identified due to previous studies.

Third, obtain dimensions of each key factor. Since dimensions of a factor may vary among different studies, we take union of different dimensions. For example, problems within channel relationships can be broadly divided into three dimensions: conflict, opportunism, and perceived unfairness (Samaha et al., 2011). However, trust, conflict, and opportunism are found to be crucial aspects of channel relationship (Frazier & Rody, 1991; Watthe & Heide, 2000). Thus, we take union of these dimensions and obtain four dimensions of channel relationship.

Overall, all identified factors and their dimensions in managing marketing channels are summarized in Table 2.

3.2. Step 2: determining the relationships among evaluation criteria

Similar to identify key factors and their dimensions, the validated interactions is extracted from previous studies. For example, Stump and Heide (1996) suggest that as opportunism decreases so do coordination costs and channel uncertainty. As a result, channel members are better motivated to facilitate partner cooperation and limit interparty tensions (Brown, Dev, & Lee, 2000). These conclusions tell us that there exists a relationship between channel relationship and channel cost. Other relationships, such as the interactions between channel relationship and channel performance, can also be detected based on well-known cases. For instance, the dynamic pricing endeavor by Amazon.com who based on a particular customer’s profile charged different prices for the same product. This was viewed as unfair and received many negative reactions, which forced Amazon to cancel the practice shortly after it began (Elmaghraby & Kesanok, 2003; Jiang, Shang, Kemerer, & Liu, 2011). Similarly, all examined relationships are located in extant studies, and are presented in Table 3.

3.3. Step 3: validate relationship network of evaluation criteria in the case study

Two major obstacles are usually present in fitting empirical findings into multi-channel environments of a specific firm. First, channel account managers dealing with mundane management tasks are not familiar with abstract constructs developed in academic research. Second, crucial factors in daily channel management of a specific firm are likely to be a portion of all the identified criteria in extant studies.

Therefore, we need to examine the external validity of identified criteria and their relationships from extant studies while evaluating multi-channel environments of a specific firm. In general, there are two methods to reconcile the differences between the academic research results and the conviction or practice of industry practitioners. Correlation testing the association between the evaluation criterion and the response variable is recommended, particularly if financial or sales data are available (Gensler et al., 2007). Otherwise, focus groups can be assembled to gather relevant information. In-depth interviews with senior marketing executives have been proven to be effective (Hughes, 2006; Valos, 2008). When interviewed, senior marketing executives should be asked to identify all the factors they consider relevant in channel evaluation. Then, researchers and practitioners work together by employing structured group discussion, using methods such as the Nominal Group Technique (NGT) (Delbecq, Van De Ven, & Gustafson, 1975), to group relevant factors into categories. Afterwards, an analytic evaluation network, which includes validated criteria and their relationships, can be developed specifically for the case firm. Questionnaires adopting fuzzy scales are finally constructed in order to rank marketing channel alternatives (Appendix A).

3.4. Step 4: calculating weights of evaluation criteria by fuzzy ANP

An analytic decision making network involves at least two layers of evaluation criteria, i.e. cluster criteria and sub-criteria. For example,
channel performance, channel cost, channel function, and channel relationships are regarded as cluster criteria, and their dimensions are sub-criteria. The objective of ANP is to calculate the weights of sub-criteria by the following four steps. First, fuzzy method is adopted to collect experts’ opinions on evaluation criteria. Human cognition often entails uncertainties (Zadeh, 2005); and instead of expressing their judgments precisely, respondents regularly use vague notions such as ‘strongly,’ ‘moderately,’ ‘equally,’ etc. Fuzzy numbers are well-suited for such occasions as they have the advantages of allowing respondents to express uncertain judgment. Zadeh (1965) introduced fuzzy set theory to deal with uncertainty and imprecision. Specifically, TFN (triangular fuzzy numbers), which is a widely used fuzzy method, is adopted to represent expert’s opinion in evaluating multiple marketing channels.

Second, the weights of cluster criteria and sub-criteria given each cluster are estimated respectively from fuzzy numbers by extent analysis (Chang, 1996). Then, the weighted supermatrix is built by multiplying these two groups of weights together according to interdependence relationships between evaluation criteria. Finally, unconditional weights of sub-criteria are obtained by calculating the limiting value of the supermatrix.

3.5. Step 5: ranking multi-channel distribution alternatives by fuzzy TOPSIS

The basic principle of TOPSIS is that ranking results of alternatives are positively correlated with distance to ideal solution, and negatively correlated with distance to negative ideal solution. Similar to fuzzy ANP, TFN is also applied to fuzzy TOPSIS in this article to collect experts’ opinions on all marketing channel alternatives with respect to each evaluation criterion. Then, the judgment data provided by experts is multiplied by the weights derived by fuzzy ANP to form the weighted judgment matrix. Subsequently, ideal solution and negative ideal solution, which has the highest and lowest evaluation respectively, in the weighted judgment matrix is identified. And, the distance of each marketing channel alternative to ideal solution and negative ideal solution is calculated respectively. Finally, the ranking results are derived according to the closeness of each alternative to ideal solution and negative ideal solution.

4. A case study

4.1. Analytic evaluation model development for Cisco China

This research was motivated by the need of evaluating the marketing distribution practice in Cisco China Systems Incorporation. The multiple channel distribution profile of Cisco China was being reshaped in the vanguard of cloud computing technology. At this turning point, Cisco China was compelled to evaluate its ongoing distribution strategies and establish guidelines for their future multiple channel development. The executive marketing managers of Cisco China requested us to uncover two things: (i) the crucial factors that would influence the operations of multiple distribution channels of Cisco China; (ii) the potential marketing channel alternatives Cisco China may need to invest and develop in the near future.

We first conducted an exhaustive interview with channel managers to understand the marketing channel alternatives in Cisco China. We found that there are six types of marketing channels available for their business: Go-deep sales team, Go-wide sales team, Value-added distributors, Ordinary distributors, Exclusive web channel, and Shared web channel. Targeted market and major functions of these six strategies are summarized in Table 4.

Second, pertinent evaluation criteria were examined for fuzzy ANP. Because of the unavailability of sales data of Cisco China, in-depth interviews and focus groups were used to validate empirical results of literature (see Table 2) in Cisco China. It turns out that channel managers of Cisco China did not consider information exchange when evaluating channel functions, and they prefer to measure channel performance in a non-financial way by indicators such as customers loyalty and attraction to new customers, instead of using market share and profitability. Therefore, information exchange, market share and profitability listed in Table 2 are excluded in evaluating multiple channels of Cisco China. Their interrelationships pertaining to these factors are also removed.

Similarly, the interactions and trade-offs within and among evaluation criteria are constructed according to both managers’ opinions and relevant empirical results (see Table 3). For example, given trust impacts channel performance, if trust among channel member is improved, it would be more beneficial to attract new customers or to increase existing customer loyalty? After collecting opinions, feedbacks, and three rounds of communication about each sub-criterion and associated relationships, the revised relationship network of evaluation criteria is formalized and summarized in Fig. 2. As a result, Channel managers of Cisco China participated in the interviews consistently claim that the concept model in Fig. 2 is an appropriate decision framework for marketing channel practice in Cisco China.

Third, based on Fig. 2, we developed the questionnaire following the standard format in fuzzy ANP and fuzzy TOPSIS. The questionnaire is presented to a focus group of channel account managers of Cisco China to verify the face validity. Given the inputs of marketing scholars, literature, and industrial practitioners, we develop a 54-item questionnaire to compare the relative importance of evaluation criteria (see Appendix A).

4.2. Results

We invited executive channel account managers to evaluate each item and complete the questionnaire independently. As mentioned in Section 3.4, the weights of cluster criteria and sub-criteria were derived respectively from linguistic expressions by extent analysis. The results of the four cluster criteria — channel relationship, function, cost, and performance, and their interdependence relationships are summarized in Table 10, where nonfuzzy weights are shown on the rightmost
The fuzzy pairwise comparison matrices of sub-criteria under each cluster are presented in Tables 11–13, where nonfuzzy weights are also derived. As the ANP suggests, the supermatrix is formed by multiplying the weights of sub-criteria by the weights of cluster criteria according to their interrelationship (see Table 14). Finally, the unconditional weights of evaluation sub-criteria were determined by normalizing the weighted supermatrix and calculating the limits. If matrix $W$ is irreducible and primitive, the limiting values obtained by raising $W$ to powers such as $\lim_{k \to \infty} W^k$ in order to obtain the global priority vectors (Saaty & Vargas, 1998). Otherwise, if the supermatrix is column stochastic, it is raised to a sufficiently large power until convergence occurs (Saaty, 1996). Detailed procedures of fuzzy ANP with an application in Cisco China are in Appendix B.

Table 5 summarizes the relative importance of each evaluation sub-criterion. It shows that attractiveness to potential customers (APC) is the most important criterion with the weight value of 0.216, while inventory (INV) is the least important criterion with 0.025 weights.

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Table 5 summarizes the relative importance of each evaluation sub-criterion. It shows that attractiveness to potential customers (APC) is the most important criterion with the weight value of 0.216. Opportunism (OPT) in channel relationship is the second most important criterion with 0.16 weights, while inventory (INV) is the least important criterion with 0.025 weights.

Based on the weights derived by the fuzzy ANP for each sub-criterion, the marketing distribution alternatives are then ranked by fuzzy TOPSIS. We first normalize the decision matrix in fuzzy TOPSIS, and then build the weighted normalized decision matrix Table 15 by multiplying the normalized decision matrix with the weights of fuzzy ANP. Subsequently, both ideal solution and negative solution are identified in the evaluation matrix. Then, the relative closeness of alternative with reference to positive ideal solution is calculated. Finally, the ranking of alternatives is derived according to the sequence of relative closeness. A more detailed explanation of the procedures using fuzzy TOPSIS is contained in Appendix C. The ranking results of marketing distribution channels available for Cisco China are given in Table 6. It shows that value added distributor (VAD) is the best distribution strategy whereas Go-deep sales team (GDT) is the worst distribution strategy.

From the ratings of evaluation criteria and rankings of alternatives, we derive several insights to assist the management of multiple channels in Cisco China. First, the results of Table 5 demonstrate that among all factors which may affect the management of multiple marketing channel system, exploring new market is currently the most influential one which heavily impacts the rankings of multi-channels. Second, unfairness is not a critical issue in channel relationship, while opportunism should be taken seriously in order to strengthen channel relationship among channel

<table>
<thead>
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<th>Table 7</th>
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<tr>
<td>The weights comparison among fuzzy ANP, ANP, and CA.</td>
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<tr>
<td>TRT</td>
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<tr>
<td>Fuzzy ANP</td>
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<td>Ranking</td>
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<tr>
<td>ANP</td>
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<tr>
<td>Ranking</td>
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<tr>
<td>CA</td>
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</table>

Table 8 Predictive validity test by HR.

<table>
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<th>HR (%)</th>
<th>Fuzzy ANP</th>
<th>ANP</th>
<th>CA</th>
</tr>
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<tbody>
<tr>
<td>HR First Choice</td>
<td>75</td>
<td>71.8</td>
<td>68.8</td>
</tr>
<tr>
<td>HR All</td>
<td>59.4</td>
<td>56.3</td>
<td>53.1</td>
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</table>
members. Third, within the cluster of channel function, the importance of sub-criteria is roughly the same, except that inventory has negligible effect on the operations of multi-distribution environment. Last, the ranking in Table 6 indicates that external marketing channels and internal sales team, which concentrate on attracting new customers, should be emphasized and strengthened by the executive channel managers of Cisco China. In contrast, web channels and internal sales team providing exclusive services to VIP customers, despite their merits, play less important role.

4.3. Sensitivity analysis

The managerial objective of sensitivity analysis is to help channel managers well-versed in the possible effects on the multi-channel system performance when various criterion weights are encountered. For example, what if trust or opportunism in channel relationship becomes less (or more) important than the current level? How will the ranking of marketing channels change accordingly? In this sense, the sensitivity analysis could demonstrate the relative performance of different marketing channels under different scenarios.

Attractiveness to potential customers, opportunism, and trust are chosen for sensitivity analysis since they are more important than other criteria in their current levels. Fig. 3 shows the respective changes in alternative ratings when the weight of each criterion varies from 0.1 to 0.9 in increment of 0.1, holding other evaluation criteria constant.

We find that if the priority of trust is increased from 0.1 to 0.9, the Go-deep sales team would change from the least preferred alternative to be the best choice while the relative ratings of other alternatives remains roughly stable. Since the major function of Go-deep sales team is to serve VIP customers, trust is very crucial. If trust dominates other factors, Go-deep sales channel becomes the best channel alternative.

Then again, if the priority of opportunism is increased from 0.1 to 0.9, value-added distributors would become less important. The value-added distribution channels will be less preferred since high opportunism poisons channel relationship. Finally, the sensitivity analysis of attractiveness to potential customers shows that the priorities of distribution alternatives are robust except for a minor disturbance.

4.4. Model validation

4.4.1. Comparisons with ANP and conjoint analysis

Weights derived by fuzzy ANP are compared with ANP and CA (conjoint analysis) which are two classical methods to calculate the weights of evaluation criteria (Pullman, Dodson, & Moore, 1999; Sawtooth Software, 2005). The ANP method is the same as the fuzzy ANP except the fuzzy method adopted to collect opinions. In CA method, orthogonal design is adopted to construct 12 combinations of the evaluation criteria. Thirty-two experts in Cisco China participated in the procedure of ANP and CA. They were asked to express their preferences about evaluation criteria and assess each marketing channel with respect to each criterion.

The comparison-derived weights are displayed in Table 7. It shows that the Top 3 weights of the fuzzy ANP, ANP and CA are comparable. The absolute paired differences of weight among fuzzy ANP, ANP and CA are all under 0.05.

Although the results from the three methods are basically consistent, fundamentally there exist clear differences among them as to the importance of each factor. For example, the display function has a larger

Table 9

<table>
<thead>
<tr>
<th>Linguistic scale for importance</th>
<th>Triangular fuzzy scale</th>
<th>Triangular fuzzy reciprocal scale</th>
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</thead>
<tbody>
<tr>
<td>Just equal</td>
<td>(2/5, 1, 5/2)</td>
<td>(2/5, 1, 5/2)</td>
</tr>
<tr>
<td>Weakly more important</td>
<td>(1/2, 2, 7/2)</td>
<td>(2/7, 1/2, 2)</td>
</tr>
<tr>
<td>Fairly more important</td>
<td>(3/2, 3, 9/2)</td>
<td>(2/9, 1/3, 2/3)</td>
</tr>
<tr>
<td>Very strongly important</td>
<td>(5/2, 4, 11/2)</td>
<td>(2/11, 1/4, 2/5)</td>
</tr>
<tr>
<td>Absolutely more important</td>
<td>(7/2, 5, 13/2)</td>
<td>(2/13, 1/5, 2/7)</td>
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Note: CR: channel relationship, CF: channel function, CC: channel cost, CP: channel performance.
Table 11
The fuzzy pairwise comparison matrix of evaluation sub-criteria with respect to channel relationship.

<table>
<thead>
<tr>
<th>TRT</th>
<th>OPT</th>
<th>PEU</th>
<th>w</th>
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Matrix 1. Inner dependence fuzzy pairwise matrix of channel relationship with respect to PEU

<table>
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<tr>
<th>TRT</th>
<th>OPT</th>
<th>PEU</th>
<th>w</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>3</td>
<td>4.5</td>
<td>0.858</td>
</tr>
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</table>

Matrix 2. Fuzzy pairwise comparison matrix of sub-criteria with respect to PEU

<table>
<thead>
<tr>
<th>ACC</th>
<th>COC</th>
<th>PRC</th>
<th>ECL</th>
<th>APC</th>
<th>w</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>2</td>
<td>3.5</td>
</tr>
<tr>
<td>0.5</td>
<td>2</td>
<td>3.5</td>
<td>1</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>0.286</td>
<td>0.333</td>
<td>0.667</td>
<td>0.286</td>
<td>0.5</td>
<td>2</td>
</tr>
<tr>
<td>0.142</td>
<td>0.342</td>
<td>0.023</td>
<td>0.142</td>
<td>0.058</td>
<td></td>
</tr>
</tbody>
</table>


Table 12
The fuzzy pairwise comparison matrix of evaluation sub-criteria with respect to channel cost and channel performance.

<table>
<thead>
<tr>
<th>DIP</th>
<th>DEL</th>
<th>w</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Matrix 1. Fuzzy pairwise comparison matrix of sub-criteria with respect to ACC

<table>
<thead>
<tr>
<th>DIP</th>
<th>DEL</th>
<th>w</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.286</td>
</tr>
<tr>
<td>0.5</td>
<td>2</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Matrix 2. Fuzzy pairwise comparison matrix of sub-criteria with respect to COC

<table>
<thead>
<tr>
<th>TRT</th>
<th>OPT</th>
<th>PEU</th>
<th>DIP</th>
<th>DEL</th>
<th>INV</th>
<th>w</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>2</td>
<td>3.5</td>
<td></td>
<td>0.580</td>
</tr>
<tr>
<td>0.286</td>
<td>0.5</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0.222</td>
<td>0.333</td>
</tr>
<tr>
<td>0.5</td>
<td>2</td>
<td>3.5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Matrix 3. Fuzzy pairwise comparison matrix of sub-criteria with respect to PRC

<table>
<thead>
<tr>
<th>TRT</th>
<th>OPT</th>
<th>PEU</th>
<th>DIP</th>
<th>DEL</th>
<th>INV</th>
<th>w</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.286</td>
<td>0.333</td>
<td>0.667</td>
<td>0.4</td>
<td>1</td>
</tr>
<tr>
<td>1.5</td>
<td>3</td>
<td>4.5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4.5</td>
</tr>
<tr>
<td>0.4</td>
<td>1</td>
<td>2.5</td>
<td>0.222</td>
<td>0.333</td>
<td>0.667</td>
<td>1</td>
</tr>
<tr>
<td>0.580</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Matrix 4. Fuzzy pairwise comparison matrix of sub-criteria with respect to ECL

<table>
<thead>
<tr>
<th>TRT</th>
<th>OPT</th>
<th>PEU</th>
<th>DIP</th>
<th>DEL</th>
<th>w</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0.286</td>
<td>0.333</td>
<td>0.667</td>
<td>0.4</td>
</tr>
<tr>
<td>1.5</td>
<td>3</td>
<td>4.5</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>0.4</td>
<td>1</td>
<td>2.5</td>
<td>0.222</td>
<td>0.333</td>
<td>0.667</td>
</tr>
<tr>
<td>0.580</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

weight in fuzzy ANP than in ANP, while the acquisition cost is less important in fuzzy ANP than in CA. From our extensive discussion with channel managers of Cisco China, we found that the product display function matters significantly especially in the web channel, while acquisition cost is not as crucial since Cisco China is a dominant player in the market. Similar observations are found in other criteria. In summary, the fuzzy ANP model provides a transparent and justifiable approach to depict the true sentiment and judgment of decision makers, and help management evaluate distribution channels more accurately.

For comparison, we compute the three groups of ranking based on the weights derived by fuzzy ANP, ANP, and the CA respectively. The results indicate that ranking derived by fuzzy ANP is generally consistent with that by ANP and CA. However, differences in ranking results can also be found among these three methods. Specifically, even though the ranking of Go-wide sales team is 2 as indicated by the fuzzy ANP (see Table 5), both ANP and CA tend to underestimate its importance with a ranking of 3.

4.4.2. Predictive validity

RM (reference method) is employed to collect a sample of realistic ranking information to examine predictive validity of three decision making methods (Scholl, Manthey, Helm, & Steiner, 2005). As the RM procedure suggests, regional sales manager of Cisco China and its channel partners are invited to rank marketing channel alternatives based on their experiences. The ranking results are reliable since these experts are particularly familiar with marketing channel alternatives of Cisco China. The results provide an observational sample, which serves as a surrogate of reality for comparison of rankings results.

HR (hit rates) is then utilized to measure predictive validity, taking ranking results given by RM as benchmark. HR refers to the frequency with which a ranking method matches benchmark (Scholz, Meissner, & Decker, 2010). In our study, we consider two types of HR.

HRFirstChoice: Frequency with which the ranking results derived by fuzzy ANP, ANP, and CA respectively match those derived by RM in terms of the same first-ranked marketing channel alternative.

HRAll: Frequency with which the ranking results derived by fuzzy ANP, ANP, and CA respectively match those derived by RM in terms of all the same ranked marketing channel alternatives.

In Table 8, fuzzy ANP shows some advantages over ANP and CA in both HRFirstChoice and HRAll. This result indicates that fuzzy ANP is more accurate in predicting actual evaluation compared with ANP and CA in the evaluation of marketing channel alternatives of Cisco China.

5. Discussions and managerial implications

Selecting the best distribution strategy from a diversified set of marketing channels is a complex and vital decision for any businesses. In order to identify the optimal structure for distributing products and
Second, evaluating marketing channels by intuitions and perceptions could be inconsistent and misleading when various criteria are involved. In contrast, the proposed decision making framework could transform the complex evaluation into a logic and accurate process. For example, our model identified value added distributors (VAD) as the best distribution strategy. However, from in-depth interview with channel manager, we find Cisco China actually views GDT team, which builds solid relationship with key customers, as the most important channel for distributing their products. The ranking result of our model is quite surprising to Cisco China. The discrepancy is due to the fact that even though management acknowledges the importance of attracting new customers and GDT team, VAD is in fact a better-suited marketing channel to reach potential customers.

Third, sensitivity analysis helps channel managers understand that optimal channel mix contingent on the weights of key evaluation criteria. Specifically, sensitivity analysis checks the robustness of the evaluation framework (Huang, Peng, Chen, & Wen, 2013), and predicts the effects of criteria weight changes on the rankings of multi-channel distributions. For example, value-added distributors which are currently the most crucial marketing channel in Cisco China could be impaired seriously by the increase of opportunism in the channel relationship. Therefore, if Cisco’s channel managers sense that their competitors are about to steal Cisco’s distributors, Cisco should anticipate that VAD may lose its edge over other channels.

In short, although multi-channel distribution strategies have been studied before, considering interdependence relationship of criteria in the evaluation of the alternative channels is understudied. To solve this problem, we develop an analytic decision making framework to estimate the importance of evaluation criteria and rank the potential marketing distribution channels. Our case study of Cisco shows that the proposed model could help practitioners to address the complex trade-offs involved in the evaluation process in a more transparent and sensible way. The model results provide valuable guidelines for channel managers to select multiple distribution channels and adapt to future events.

6. Limitations

Even though this study provides useful guidelines for practitioners to decide on appropriate distribution strategy, improvement could be achieved in data sourcing. The data necessary for the proposed framework could be the subjective judgments of channel managers or the transaction records from marketing operations. The collection of subjective judgments through key personnel is particularly useful in exploring subjective constructs and is easy to implement, but they are not as accurate as that of transaction records. On the other hand, transaction records of marketing operations are not necessarily available, and may not cover the constructs of interest. Furthermore, to match the data formats employed by the multi-criteria decision-making method, data-transformation is often needed to clean the transaction records. Weighing up the availability of transaction records and the need to explore several subjective constructs of interest, we settle on key informant surveys in our case study of Cisco China. Specifically, we obtain the measurement of channel relationship through in-depth focus group interview, as it is a subjective construct in essence and could not be obtained objectively. However, if transaction data such as channel cost and channel performance are available, they should be combined with qualitative data to maximize the potential of the proposed framework.

To sum up, although combining the qualitative data and transaction data is highly recommended, it is often difficult to achieve. For example, the case firm needs to establish a database containing relevant variables and make it accessible via authorization. However, such a database may not exist or the studied firm may be reluctant to make it available. Another limitation is that new methods are needed to transform transaction data into pairwise comparison format as the ANP requires such
data input format, while the existing business transaction data may present itself in any format. To make transaction data become valid inputs, new methods are needed to fill the gaps.

7. Conclusions

In multi-channel environment, senior channel executives often strive to understand the intertwined relationship among crucial performance indexes and struggle to identify the most promising marketing channel(s). Such a managerial problem is traditionally resolved by analyzing financial data of channel performance. In this research, we propose an analytic decision-making framework which is capable of transforming expert opinions into weights of key criteria based on their interactions and deriving the ranking of marketing channel alternatives accordingly. The case study of Cisco China shows that the framework improves managers' understandings of the multi-channel system and is particularly helpful to differentiate the performances of alternative marketing channels. The evaluation results provide valuable guidelines for companies to deploy their marketing resources and enable them to be ready for turbulences when facing unpredictable marketing environment.

Acknowledgment

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Appendix A. Questionnaire survey for managers in Cisco China

(I) Questionnaire examples of fuzzy ANP (Please refer to Ergu & Kou, 2011, for questionnaire design for ANP)

Description. Please compare the relative importance between each pair of elements and mark the appropriate box to show your preference. Note: "JE" stands for just equal; "WMO" stands for weakly more obvious; "FMO" stands for fairly more obvious; "VSO" stands for very strongly obvious; "AMO" stands for absolutely more obvious.

1. When evaluating channel mix, please compare the relative importance between the channel function and the channel cost.

<table>
<thead>
<tr>
<th>Channel function</th>
<th>AMO</th>
<th>VSO</th>
<th>FMO</th>
<th>WMO</th>
<th>JE</th>
<th>WMO</th>
<th>FMO</th>
<th>VSO</th>
<th>AMO</th>
<th>Channel cost</th>
</tr>
</thead>
</table>

2. When evaluating channel mix, please compare the relative importance between the channel function and the channel performance.

<table>
<thead>
<tr>
<th>Channel function</th>
<th>AMO</th>
<th>VSO</th>
<th>FMO</th>
<th>WMO</th>
<th>JE</th>
<th>WMO</th>
<th>FMO</th>
<th>VSO</th>
<th>AMO</th>
<th>Channel performance</th>
</tr>
</thead>
</table>

3. When channel relationship is improved, channel cost and channel performance will change accordingly. Please compare the relative importance between the decrease of channel cost and the improvement of channel performance when channel relationship is improved.

<table>
<thead>
<tr>
<th>Decrease of channel cost</th>
<th>AMO</th>
<th>VSO</th>
<th>FMO</th>
<th>WMO</th>
<th>JE</th>
<th>WMO</th>
<th>FMO</th>
<th>VSO</th>
<th>AMO</th>
<th>Increase of channel performance</th>
</tr>
</thead>
</table>

4. When channel function is improved, channel cost and channel performance will change accordingly. Please compare the relative importance between the decrease of channel cost and the improvement of channel performance when channel function is improved.

<table>
<thead>
<tr>
<th>Decrease of channel cost</th>
<th>AMO</th>
<th>VSO</th>
<th>FMO</th>
<th>WMO</th>
<th>JE</th>
<th>WMO</th>
<th>FMO</th>
<th>VSO</th>
<th>AMO</th>
<th>Increase of channel performance</th>
</tr>
</thead>
</table>

5. When channel performance is improved, channel function and channel relationship will change accordingly. Please compare the relative importance between the improvement of channel function and the improvement of channel relationship when channel performance is improved.

<table>
<thead>
<tr>
<th>Improvement of channel function</th>
<th>AMO</th>
<th>VSO</th>
<th>FMO</th>
<th>WMO</th>
<th>JE</th>
<th>WMO</th>
<th>FMO</th>
<th>VSO</th>
<th>AMO</th>
<th>Improvement of channel relationship</th>
</tr>
</thead>
</table>

6. When channel cost is decreased, channel function and channel relationship will change accordingly. Please compare the relative importance between the improvement of channel function and the improvement of channel relationship when channel cost is decreased.

<table>
<thead>
<tr>
<th>Improvement of channel function</th>
<th>AMO</th>
<th>VSO</th>
<th>FMO</th>
<th>WMO</th>
<th>JE</th>
<th>WMO</th>
<th>FMO</th>
<th>VSO</th>
<th>AMO</th>
<th>Improvement of channel relationship</th>
</tr>
</thead>
</table>

(Note: The comparisons among sub-criteria are developed similarly and are omitted here due to identical question structures).

(II) Questionnaire examples of fuzzy TOPSIS
**Description.** Please evaluate six marketing distribution alternatives from the perspective of each evaluation sub-criteria and mark the right box corresponding to your independent judgment. Note: “WMO” stands for weakly more obvious; “FMO” stands for fairly more obvious; “VSO” stands for very strongly obvious; “AMO” stands for absolutely more obvious; “NTR” represents neutral; “WNMO” stands for weakly not more obvious; “FNMO” stands for fairly not more obvious; “VSNO” stands for very strongly not obvious; “ANMO” stands for absolutely not more obvious.

1. Evaluate the effectiveness of the following distribution strategy alternatives of Cisco China, from the perspective of improving trust among marketing channel members

<table>
<thead>
<tr>
<th><strong>Go-deep sales team</strong></th>
<th>AMO</th>
<th>VSO</th>
<th>FMO</th>
<th>WMO</th>
<th>NTR</th>
<th>WNMO</th>
<th>FNMO</th>
<th>VSNO</th>
<th>ANMO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Go-wide sales team</strong></td>
<td>AMO</td>
<td>VSO</td>
<td>FMO</td>
<td>WMO</td>
<td>NTR</td>
<td>WNMO</td>
<td>FNMO</td>
<td>VSNO</td>
<td>ANMO</td>
</tr>
<tr>
<td><strong>Value-added distributors</strong></td>
<td>AMO</td>
<td>VSO</td>
<td>FMO</td>
<td>WMO</td>
<td>NTR</td>
<td>WNMO</td>
<td>FNMO</td>
<td>VSNO</td>
<td>ANMO</td>
</tr>
<tr>
<td><strong>Ordinary distributors</strong></td>
<td>AMO</td>
<td>VSO</td>
<td>FMO</td>
<td>WMO</td>
<td>NTR</td>
<td>WNMO</td>
<td>FNMO</td>
<td>VSNO</td>
<td>ANMO</td>
</tr>
<tr>
<td><strong>Exclusive web channel</strong></td>
<td>AMO</td>
<td>VSO</td>
<td>FMO</td>
<td>WMO</td>
<td>NTR</td>
<td>WNMO</td>
<td>FNMO</td>
<td>VSNO</td>
<td>ANMO</td>
</tr>
<tr>
<td><strong>Shared web channel</strong></td>
<td>AMO</td>
<td>VSO</td>
<td>FMO</td>
<td>WMO</td>
<td>NTR</td>
<td>WNMO</td>
<td>FNMO</td>
<td>VSNO</td>
<td>ANMO</td>
</tr>
</tbody>
</table>

(Note: The evaluation of distribution strategy alternatives from the perspective of other evaluation sub-criteria, such as opportunism, perceived unfairness, display function etc, is omitted here due to identical question structures).

**Appendix B. Estimating weights of evaluation criteria by fuzzy ANP**

To determine the weights of evaluation criteria in the case study of Cisco China, the following three steps is employed according to fuzzy ANP.

Step 1: Define the linguistic scale and convert expert's judgment to a triangular fuzzy number. A TFN is displayed as \((l, m, u)\) and its mathematical form (Dubois & Prade, 1978) is expressed as:

\[
\mu_{Rl}(x/M) = \begin{cases} 
0, & x < l, \\
\frac{x - l}{m - l}, & l \leq x \leq m, \\
\frac{u - x}{u - m}, & m \leq x \leq u, \\
0, & x > u.
\end{cases}
\]

\[
\mu_{Rl}(x/M) \text{ is a membership function where } M \text{ represents a fuzzy set. The objective of } \mu_{Rl}(x/M) \text{ function is to assign a number for linguistic expressions of judgment. The parameters } l, m, \text{ and } u \text{ denote the smallest possible value (lower bound), the modal value, and the largest value (upper bound) respectively.}
\]

To obtain a reasonable match of an expert's linguistic expression of each comparison and the corresponding weight result, the relationship between linguistic meaning and a triangular fuzzy number is established. Because the structure of each question is symmetrical, the triangular fuzzy reciprocal scale can be automatically defined as seen in Table 9.

Step 2: Apply Chang's extent analysis method (1996). Let \(X = \{x_1, x_2, \ldots, x_n\}\) be an object set and \(U = \{u_1, u_2, \ldots, u_n\}\) be a goal set. Denote each object \(x_i\) in extent analysis as:

\[
M_{ij}^l, M_{ij}^m, \ldots, M_{ij}^m, \quad i = 1, 2, \ldots, n;
\]

where all the \(M_{ij}^l (j = 1, 2, \ldots, m)\) are TFN. Perform the fuzzy addition operation of \(m\) extent analysis values for a particular matrix:

\[
\sum_{j=1}^{m} M_{ij}^l = \left( \sum_{j=1}^{m} l_j \right) \begin{pmatrix} \sum_{j=1}^{m} M_{ij}^l \end{pmatrix};
\]

(3)

The \(M_{ij}^l (j = 1, 2, \ldots, m)\) becomes:

\[
\left[ \sum_{i=1}^{n} \sum_{j=1}^{m} M_{ij}^l \right] = \left( \sum_{i=1}^{n} l_i \right) \begin{pmatrix} \sum_{i=1}^{n} M_{ij}^l \end{pmatrix};
\]

(4)
The inverse of the vector in Eq. (4) is:
\[
\left( \sum_{j=1}^{m} \sum_{i=1}^{n} M_{ij} \right)^{-1} = \left[ \frac{1}{\sum_{j=1}^{m} u_j} \frac{1}{\sum_{i=1}^{n} w_i} \right].
\]
From Eqs. (3) to (5), we define the value of fuzzy synthetic extent with respect to the ith object as:
\[
S_i = \sum_{j=1}^{m} M_{ij} \odot \left( \sum_{j=1}^{m} M_{ij} \right)^{-1}.
\]
The degree of possibility of \( M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1) \) becomes:
\[
V(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = \mu_{M_1}(d)
\]
\[
= \begin{cases} 
1 & \text{if } m_2 \geq m_1 \\
0 & \text{if } l_1 \geq u_2 \\
(l_1 - u_2)/[(m_2 - u_2) - (m_1 - l_1)] & \text{otherwise}
\end{cases}
\]
where \( d \) is the ordinate of the highest intersection point \( D \) between \( \mu_{M_1} \) and \( \mu_{M_2} \) (Fig. 4).

To compare \( M_1 \) and \( M_2 \), we need to find the values of \( V(M_2 \geq M_1) \) and \( V(M_1 \geq M_2) \). The degree possibility of a convex fuzzy number that is greater than \( k \) convex fuzzy numbers, \( M_i(i = 1, 2, \ldots, m) \) can be defined as \( \min V(M \geq M_i) \), \( i = 1, 2, \ldots, k \). Assume that \( d' \) \( A_k = \min V(S_k \geq S_i) \), for \( k = 1, 2, \ldots, n; k \neq i \). The normalized weight vectors can be denoted as:
\[
W = (d(A_1), d(A_2), \ldots, d(A_n))^T
\]
where \( W \) is a non-fuzzy number.

In the case study of Cisco China, following the above procedures, the weights \( W \) among evaluation clusters, i.e. channel relationship, channel function, channel cost and channel performance, is derived (Table 10). Then, by applying Step 2 repeatedly, the weights \( W \) of sub-criteria with respect to each cluster are calculated and summarized in Tables 11, 12 and 13 respectively.

Step 3: Implement ANP method (Saaty, 1996). Based on the weights derived in step 2, the normalized weighted supermatrix of evaluation sub-criteria of multiple marketing channels in Cisco China is derived according to Eq. (9). The supermatrix is represented as follows:
\[
W = \begin{bmatrix}
C_1 & C_2 & C_3 & C_4 \\
C_{11} & W_{12} & W_{13} & W_{14} \\
C_{21} & W_{22} & W_{23} & W_{24} \\
C_{31} & W_{32} & W_{33} & W_{34} \\
C_{41} & W_{42} & W_{43} & W_{44}
\end{bmatrix}
\]
where \( C_i, i = 1, \ldots, 4 \), refers to the cluster criteria, and \( w_{ij} \) is the product of the weights of cluster criteria and the weights of sub-criteria given each cluster.

The final weight of each sub-criterion is obtained by raising \( W \) to powers such as \( \lim_{k \to \infty} W^k \) (Table 14).

Appendix C. Deriving rankings of channel alternatives by fuzzy TOPSIS

The fuzzy TOPSIS method of Opricovic and Tzeng (2003) is adopted to rank marketing channel alternatives of Cisco China. The procedures could be detailed in five steps.

Step 1: Normalize the fuzzy numbers elicited from an expert. The linguistic scale dictates each element of a fuzzy number to be within the range of \([2/5, 13/2]\), which in turn will be normalized to \([0, 1]\). Suppose \( X_0 \) is an element of a fuzzy number \( M \), the normalized value \( r_{ij} \) is as follows:
\[
r_{ij} = x_{ij}/\sqrt{\sum_{j=1}^{n} x_{ij}^2}, \quad j = 1, \ldots, J; \quad i = 1, \ldots, n.
\]
where \( J \) and \( n \) are the number of alternatives and the number of criteria, respectively. For alternative \( A_i \), the performance measure of the ith criterion \( C_j \) is represented by \( x_{ij} \).

Step 2: Develop the weighted normalized fuzzy decision matrix. Suppose \( W \) is the weight vector calculated from FANP, \( w_i = \frac{1}{\sum_{j=1}^{m} w_j} \). \( r_{ij} \) is the normalized fuzzy number. The element of the weighted normalized fuzzy number \( v_{ij} \) is:
\[
v_{ij} = w_i r_{ij}, \quad \forall i, j.
\]
In the case study of Cisco China, the weighted normalized decision matrix is derived in Table 15.

Step 3: Define the fuzzy positive-ideal and negative-ideal solutions as \( \bar{v}_j^+ = (1, 1, 1) \) and \( \bar{v}_j^- = (0, 0, 0) \), respectively for \( j = 1, 2, \ldots, n \), and
\[
A^+ = \left( \bar{v}_1^+, \ldots, \bar{v}_n^+ \right) = \left( \max v_{ij} | j \in C_b \right), \left( \min v_{ij} | j \in C_p \right)
\]
\[
A^- = \left( \bar{v}_1^-, \ldots, \bar{v}_n^- \right) = \left( \min v_{ij} | j \in C_b \right), \left( \max v_{ij} | j \in C_p \right)
\]
where \( C_b \) is the set of benefit criteria and \( C_p \) is the set of cost criteria.
Step 4: Determine separation measures, using the n-dimensional Euclidean distance. The distance of each alternative from $A^+$ and $A^-$ can be derived as follows:

$$d_i^+ = \frac{1}{n} \sum_{j=1}^{n} (\sqrt{w_j v_{ij}^+}), i = 1, 2, ..., m$$  \hspace{1cm} (13)$$

$$d_i^- = \frac{1}{n} \sum_{j=1}^{n} (\sqrt{w_j v_{ij}^-}), i = 1, 2, ..., m.$$  \hspace{1cm} (14)$$

Step 5: Compute the similarities to ideal solution according to Eq. (15). The final ranking result of multiple channels in Cisco China is demonstrated in Table 5.

$$CC_i = \frac{d_i^-}{d_i^- + d_i^+}$$  \hspace{1cm} (15)$$

where $d_i^+$ and $d_i^-$ represent the n-dimensional Euclidean distance of $A_j$ to positive ideal solution $A^+$ and negative ideal solution $A^-$ respectively.

References


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