

**A Fuzzy Analytic Network Process Approach to Determining
Prospective Business Strategy in China: A Case Study for
Multinational Biotech Pharmaceutical Enterprises**

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Abstract

This study explores efforts to identify the most appropriate business strategy relative to multinational biotech pharmaceutical enterprises' strategy selection. The research uses the analytic network process (ANP) technique combining both qualitative and quantitative information to construct a hierarchical model involving interactions among various criteria for business strategy selection, and also introduces fuzzy logic to eliminate vagueness, subjectivity, and imprecision stemming from human judgment. The most important finding shows that the most suitable business strategy for MNEs is innovative focus strategy. Also, the weighted calculations present the three most important criteria affecting the location selection of FDI for second-tier cities: collaboration with local partners, governmental rules and regulations and high-quality research personnel with R&D capability.

Keywords: Business strategy selection, multinational biotech pharmaceutical enterprises, fuzzy analytic network process (FANP)

1. Introduction

Since implementing an open-door policy in 1978, China has witnessed dramatic growth in the large amounts of inflow of foreign direct investment (FDI) into China. Facing uncertainties and ambiguities prevalent in the Chinese business environment, how MNEs choose an appropriate market entry strategy has become an important issue. An accurate competitive strategy has positive impact on the business performance (Kirca et al., 2005; Matsuno & Mentzer, 2000; Olson et al., 2005; Vorhies & Morgan, 2005). Strategy is a pattern of resource allocation that enables firms to maintain or improve their performances (Barney, 1997). The study of core competency concept for strategy formulation has generated enormous interest since it is an element of successful strategy for MNEs (Grant, 1991; Hoskisson et al., 2004; Kak, 2004; O'Tegan & Ghobadian, 2004; Prahalad & Hamel, 1990; Toni & Tonchia, 2003). Core competence is a concept well known to academics, business practitioners, and consultants in strategic management. Scholars have acknowledged the importance of the core competence in formulating strategy (Grant, 1991; Lahti, 1999; Toni & Tonchia, 2003; O'Tegan & Ghobadian, 2004).

The biotech pharmaceutical industry has enormous opportunities to grow. Along with the technology development in pharmaceutical field, nowadays the necessity of biotech pharmaceutical product is increased (Business wire, 2009). Wolff (2001) mentioned that the difference between drugs from biotechnology and conventional pharmaceuticals actually go much deeper but can be summed up in a single word: specificity. The biotech approach to drug development is based on detailed information about the operations of cells and molecules. Although this body of knowledge is far from complete, it has afforded biotech companies the ability to develop drugs that act in precise ways on biological function.

The focus of previous researches in market entry strategy topic especially in the context of biotech pharmaceutical industry has been on corporate-level strategy, such as joint venture, strategic alliance, merger and acquisition, licensing agreement (Brouthers, 2002; Chen & Lou, 2004; Deeds & Hill, 1996; Richards & DeCarolis, 2003; Shan & Song, 1997). To our knowledge, no study focuses on business (competitive)-level strategy which is the foundation of successful business. Therefore, to fill the gap in the literature, the current study attempts to elaborate how multinational biotech pharmaceutical enterprises who are willing to invest in, or are currently investing in and want to expand the business select an appropriate competitive strategy to compete in China.

FDI is a complex multi-criteria decision problem. Analytic network process (ANP) introduced by Saaty can consider objective and subjective evaluation criteria and dependence among alternatives or criteria. Although ANP is a fine technique, this method is insufficient in eliminating ambiguities. In order to overcome this shortcoming, Fuzzy ANP method has been used instead of classical ANP. This study uses Fuzzy Analytic Network Process (FANP) to construct a hierarchical model involving interactions among various factors for business strategy selection based on core competency perspective.

The remainder of this paper is structured as follows. The second section presents a comprehensive review of the literature including core competency, the relationship between core competency and business strategy. The third chapter introduces fuzzy number and research method applied in this research. The empirical analysis and findings are contained in Section 4. Section 5 concludes this paper.

2. Literature Review

The resource-based perspective takes an internal analysis of the firm and suggests that the firm is a collection of heterogeneous resources (tangible and intangible) that are semi-permanent tied to the company (Wernerfelt, 1984). These resources form an important source of competitive advantage for the firm. Those core resources and core capabilities must be valuable, rare, imperfectly imitable, and non substitutable (Barney, 1991). Core competence is an activity that is performed more successfully by a corporation than by its competitors and that is in demand by the market. Specifically, the competence of a corporation is a combination of resources that are superior in competition under the whole strategy of the corporation. (Collis & Montgomery, 1995). Management writers have given the words “core competence” varied meanings. Lei et al. (1996) defined a firm’s core competence(s) as a set of problem-defining and problem-solving insights that fosters the development of idiosyncratic strategic growth alternatives. Bogner et al. (1991) analyze of the 41 largest pharmaceutical firms in USA and Western Europe in term of its core competencies and looked at how the relative competitive postures of these firms changed in the US market between 1969 and 1988. Kak (2004) explores a case study of two pharmaceutical organizations to investigate the issues related to core competence development and strategy formulation with core competence. The findings found that the core competencies in Eli Lilly & Company, a worldwide leader in pharmaceutical, are R&D and Marketing. While the core competencies of the other global pharmaceutical company, Pharmacia & Upjohn, are R&D and dedicated manpower. Another study was conducted in more specific scope of biotech pharmaceutical underlined the future of R&D leadership for this industry (Feltz, 2007).

The strategy is the way by which a firm fulfills its mission and attains its objectives.

Several strategic typologies have been proposed in the strategic management literature over the years (Barczak, 1995; Chrisman et al., 1988; Miles & Snow, 1978; Porter, 1980). Barczak (1995) suggest three strategic types based on the timing of entry, first-to market, fast follower, and delayed entrant. Porter (1980) describes a category scheme consisting of three general types of strategies: cost leadership, differentiation and focus that are commonly used by businesses to achieve and maintain competitive advantage. These strategies are applied at the business unit level, and they are not firm or industry dependent.

The concept of core competence has been developed to support more efficient identification and utilization of an organization's strength. The nature of firm's existing resources determines whether they need to engage in such resource augmentation when investing abroad (Meyer et al., 2009). Scholars have acknowledged the importance of the core competence in formulating strategy.

In this study, we held Focus Group Discussion (FGD) with 8 experts to determine preliminary core competencies that influence the multinational biotech pharmaceutical enterprise's strategy selection to FDI in China based on the aforementioned literatures and characteristics for biotech pharmaceutical industry. These are comprehensive factors involving international strategy decisions. But resource is not always linked to a core competence. Not all determinants are relevant for each enterprise, there may be only a few important factors and they dominate the decision in each business (Stevenson, 1996). In addition, the reasons this study uses Porter's (1980) approach to generate preliminary business strategies is because his typology is similar to others' and has received more empirical support from previous research than other categorizations.

3. Fuzzy numbers and research method

3.1 Fuzzy numbers

The fuzzy sets are defined in terms of membership functions. Membership functions relative to X represent fuzzy subsets of X . The membership function representing a fuzzy set is usually denoted by μ_A . For an element x of X , the value $\mu_A(x)$ is called the membership degree of x in the fuzzy set. This function assigns to each element x of the universal set X a number $\mu_A(x)$ in the unit interval $[0,1]$. The membership degree $\mu_A(x)$ quantifies the grade of membership of the element x to the fuzzy set. An element x really belongs to A if $\mu_A(x)=1$ and clearly does not if $\mu_A(x)=0$.

A triangular fuzzy number can be denoted by three real numbers (l, m, u) . The parameters l , m , and u respectively stand for the smallest possible value, the most promising value, and the largest possible value. Its membership function can be defined as

$$(d) = \left\{ \begin{array}{ll} 1, & \text{if } m_2 \geq m_1, \\ 0, & \text{if } l_1 \geq u_2, \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & \text{otherwise,} \end{array} \right\}$$

3.2 Research method

Chang's method has been applied in this study. Let $X=\{x_1, x_2, \dots, x_n\}$ be an object set, and $U=\{u_1, u_2, \dots, u_n\}$ be a goal set. According to Chang's extent-analysis method (1992; 1996), each object is taken and an extent analysis for each goal (g_i) is performed. Therefore, m extent analysis values for each object can be obtained with the following signs:

$$M_{g_i}^1, M_{g_i}^2, \dots, M_{g_i}^m, \quad i = 1, 2, \dots, n \quad (1)$$

where all the $M_{g_i}^j$ ($j = 1, 2, \dots, m$) are TFNs. The steps of Chang's extent analysis can

be given as in the following:

Step 1: The value of fuzzy synthetic extent with respect to the i^{th} object is defined as

$$S_j = \sum_{j=1}^m M_{g_i}^j \otimes \left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right]^{-1} \quad (2)$$

To obtain $\sum_{j=1}^m M_{g_i}^j$, perform the fuzzy addition operation of m extent analysis

relative to values for a particular matrix such that

$$\sum_{j=1}^m M_{g_i}^j = \left(\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j \right) \quad (3)$$

and to obtain $\left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right]^{-1}$, perform the fuzzy addition operation of

$M_{g_i}^j$ ($j = 1, 2, \dots, m$) values such that

$$\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j = \left(\sum_{j=1}^m l_i, \sum_{j=1}^m m_i, \sum_{j=1}^m u_i \right) \quad (4)$$

and then compute the inverse of the vector in Eq. (4) such that

$$\left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^n u_i}, \frac{1}{\sum_{i=1}^n m_i}, \frac{1}{\sum_{i=1}^n l_i} \right) \quad (5)$$

Step 2: The degree of the possibility of $M_2 = (l_2, m_2, u_2) \geq M_1(l_1, m_1, u_1)$ is defined as

$$V(M_2 \geq M_1) = \sup_{y \geq x} [\min(u_{M_1}(x), u_{M_2}(y))]$$

and can be equivalently expressed as follows:

$$(6) \quad V(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = u_{M_2}(d) = \left\{ \begin{array}{ll} 1, & \text{if } m_2 \geq m_1, \\ 0, & \text{if } l_1 \geq u_2, \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & \text{else,} \end{array} \right.$$

where d is the ordinate of the highest intersection point D between u_{M_1} and u_{M_2} .

To compare M_1 and M_2 , we need both the values of $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$. This is given in Fig. 3-1.

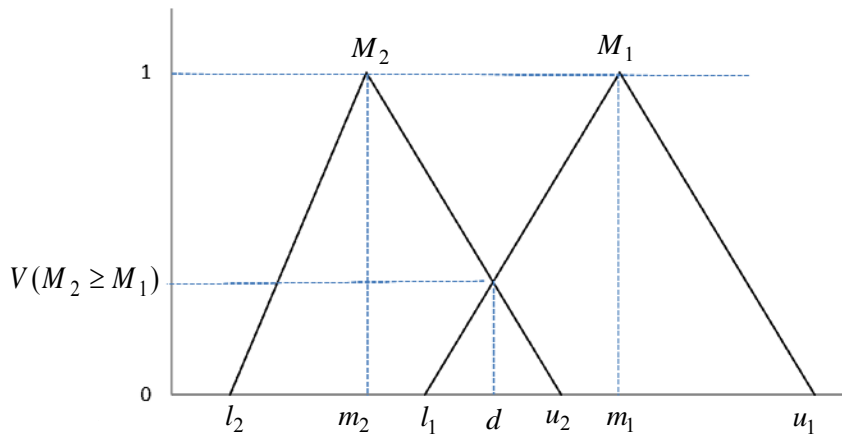


Fig. 3-1 Intersection of M_1 and M_2 .

Step 3: The degree possibility for a convex fuzzy number to be greater than k convex fuzzy numbers M_i ($i = 1, 2, \dots, k$) can be defined by

$$V(M \geq M_1, M_2, \dots, M_k) = V[(M \geq M_1) \text{ and } (M \geq M_2) \text{ and } \dots \text{ and } (M \geq M_k)] \\ = \min V(M \geq M_i), \quad i = 1, 2, \dots, k$$

Assume that

$$d'(A_i) = \min V(S_i \geq S_k).$$

For $k = 1, 2, \dots, n; k \neq i$. Then the weight vector is given by

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n))^T$$

where A_i ($i = 1, 2, \dots, n$) are n elements.

Step 4: Via normalization, the normalized weight vectors are

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T$$

where W is a nonfuzzy number.

4. Proposed model implementation

4.1 Structuring the hierarchical model of the selection of the business strategy, including goal, assessment dimension, criteria, and alternatives

First, this study determines the goal as the selection of the most suitable business strategy by focus group discussion (FGD) with 8 experts. We decided on 12 criteria and classified them into three assessment dimensions: the relationship dimension, the tactic dimension and the specificity dimension. Also, considering Porter's generic strategies, selected three: differentiation strategy and focus strategies including

innovative focus strategy and market focus strategy as our business strategy alternatives.

The model for business strategy selection is proposed in Fig. 4-1..

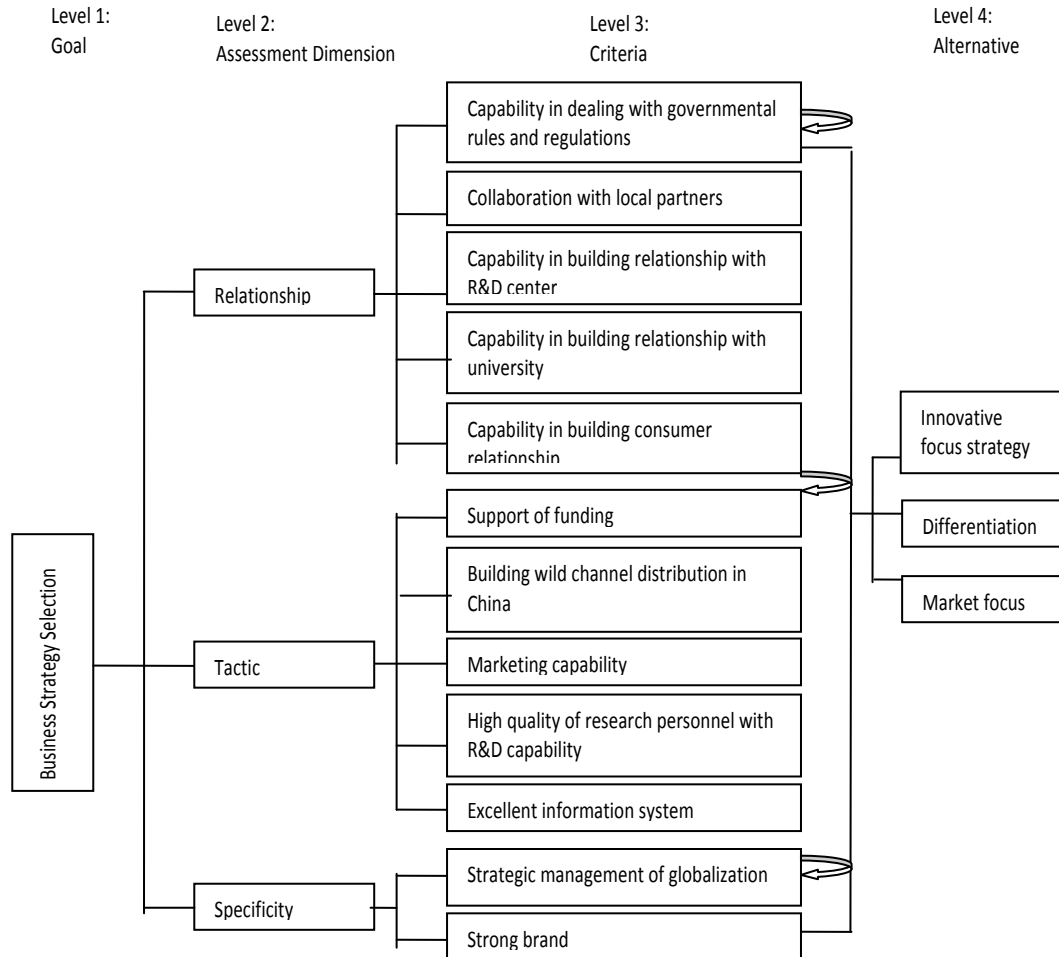


Fig. 4-1 The hierarchical model for business strategy selection

4.2 Calculating the local weights of assessment dimensions with respect to the goal

In this step, the pair-wise comparisons rest on FGD (with a scale ranging from 1 through 9). With fuzzy values, we obtain weights of each assessment dimension as shown in Table 4-1.

Table 4-1 Pair-wise comparison matrix and weights of assessment dimensions

Dimensions	D1	D2	D3	Weights
D1	(1,1,1)	(2.37,2.69,3.12)	(2.93,3.44,4.15)	0.52

D2	(1.79,2.35,2.75)	(1,1,1)	(2.65,3.37,3.99)	0.47
D3	(1.03,1.39,1.62)	(1.34,1.67,2.04)	(1,1,1)	0.01

4.3 Calculating the global weights of each criteria

In this step, criteria's local weights in each assessment dimension are determined in the same way, then the interdependent weights of the inner relationships among criteria are calculated. Finally, the global weight of each criterion is determined (see the last column in Table 4-2).

Table 4-2 The computed results for all criteria

Assessment Dimension	Criteria	Global Weight	Computed Result
Relationship (0.52)	C1	0.362	0.189
	C2	0.505	0.263
	C3	0.006	0.003
	C4	0.006	0.003
	C5	0.126	0.067
Tactic (0.47)	C6	0.039	0.018
	C7	0.227	0.106
	C8	0.257	0.120
	C9	0.445	0.209
	C10	0.032	0.015
Specificity (0.01)	C11	0.118	0.001
	C12	0.882	0.009

4.4 Comparing the business strategy alternatives with respect to criteria under each assessment dimension

Table 4-3 presents the fuzzy weights of the alternatives under each criterion.

Table 4-3 Fuzzy weights of the alternatives under each criterion

Criteria	Alternative		
	A1	A2	A3
C1	0.323	0.591	0.085
C2	0.447	0.155	0.398
C3	0.362	0.381	0.257
C4	0.482	0.409	0.109
C5	0.599	0.167	0.234
C6	0.043	0.529	0.428
C7	0.54	0.000	0.460

C8	0.691	0.083	0.226
C9	0.385	0.302	0.314
C10	0.440	0.088	0.472
C11	0.459	0.250	0.291
C12	0.586	0.407	0.007

4.5 Obtaining the best business strategy alternative

In this step, the final weights of “business strategy” alternatives are calculated. By multiplying the dimension weight with the global weight of each criterion, and with the values in Table 4-3, we obtain the priorities for the business strategy (Table 4-4).

Innovative strategy is the best business strategy with a 0.455 value.

Table 4-4 Results of business strategy alternatives

Dimension	Alternative		
	A1	A2	A3
D1	0.221	0.166	0.138
D2	0.228	0.084	0.156
D3	0.006	0.004	0.0004
Sum	0.455	0.254	0.294

5. Conclusions

In this study, we have sought to identify the most appropriate business strategy for multinational biotech pharmaceutical enterprises that which plan to invest, or have already invested in China. By harnessing an ANP technique that combines both qualitative and quantitative information, we proposed a hierarchical model for business strategy selection. With the help of interactions between criteria under relationship, tactic and specificity dimensions, the data reflects the reality in a better way. Furthermore, the current study accounts for vagueness, subjectivity, and imprecision by using fuzzy logic. This study’s use of fuzzy ANP has revealed that the most suitable business strategy for MNEs is innovative focus strategy, followed by differentiation strategy and market focus strategy.

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