A Product-oriented Power Taxonomy Framework

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Abstract. Power of partners in supply chain is an essential concept in collaboration, which can influence the decisions and behaviours of the focal company. Therefore, any company has to have a good understanding on the power of partners in order to determine the possible opportunities or threats in a potential collaboration. In this paper we present a product-oriented power taxonomy obtained from the analyses on two classes of power factors: the partner-independent power factors and the partner-dependent power ones. The former are related to the product and market while the latter are intrinsic ability factors of partner such as reputation, knowledge and performance. Then we analyse the different aspects of each type of power and corresponding determinants. Furthermore, we propose a method to assess those determinants.

Keywords: power, power taxonomy, power determinants

1 Introduction

Supply chain brings more profits but not all the members can benefits evenly, because sometimes members are in asymmetry positions [1][2]. The stronger parties may use their power to gain their own goals and outcomes by coercing others to do what they would be reluctant to do [3]. This paper reflects a consideration as perceived from focal company's point to analyse the power of its partners/potential partners, regarding the factors arising from the focal company itself and intrinsic factors of partners such as reputation, knowledge and performance. Here the focal company is a company on which the study is focused. As said by Sun Tzu, an ancient Chinese philosopher, "knowing the enemy and knowing yourself, you can fight a hundred battles without danger of defeat". Based on the analyses, the focal company can make its "pre-activation" evaluation on its potential partners before collaboration, i.e. a power-based partner selection strategy. On the other hand, the focal company can also conduct a "post-activation" estimation, i.e. to estimate the existing relationship between partners and to anticipate potential threat from other partners.

However, the sources of power come from various aspects [2][4][5], which results in a variety of power factors. In order to achieve a clear understanding, it is necessary to classify those factors. Most of the research considers the classification and analyses power from the perspectives of social science [2][6]. In this paper, we establish a power taxonomy from the engineering view so that it can help not only to understand

the sources and drivers of the power of partners but also to deploy a method to assess the power.

Section 2 reports on existing research works on power from its concepts to impact. In section 3, we introduce a systematic framework to elaborate power taxonomy and discuss about how to calculate the power value regarding the involvement of partners in the product development. In section 4 we provide an illustrative case and after some discussions we conclude in section 5.

2 Related Work

The general agreement on the definition of power is "the ability to evoke a change in another's behavior" [7][8]. When it is extended to apply in market fields, there are more precise definitions. Emerson defines power as "the ability of one firm (the source) to influence the intentions and actions of another firm (the target)" [9]. Yeung et al. provide a similar definition, i.e. "Power is one channel member's ability to influence the behaviour and decision of other members" [10]. Other researchers also mention several derivative concepts such as "relative power", "bargaining power", "customer power", "retailer power" and "organizational power" [11-16]. In essence, all these concepts focus on the ability of one party to influence the others.

Power sources from various aspects such as reputation, resource, knowledge and so on. French and Ravens [4], largely cited in scientific literature, classify power into five bases, i.e. reward power, referent power, legitimate power, coercive power and expert power. Based on this classification, Tedeschi et al. [17] summarize them into mediated power and non-mediated power. The mediated power including reward, coercive, and legal legitimate represents the strategies that the source will take to influence the target. On the contrary, the non-mediated power is more relational and positive [18] in orientation that includes referent power, expert power and legitimate power.

The theory of power applies in various aspects of supply chain such as supplier integration, partner selection, decision-making and so on. In [10], they argue that coercive power could lead to worse cooperation in western cultures but improve the supplier integration in China. Generally, company can use coercive power to enhance buyers' internal integration that may lead to supplier integration under a trust-based relationship. Zolghadri et al [19] introduce a method to select partners by comparing the power between the focal company and its potential partners in the mutual relationship. In [11] and [18], the authors conclude that the mediate power could throw negative influence on buyer-supplier relationship while the non-mediate power could retain positive effect on partnership. Zhao et al [20] present a more detailed discussion on the influence of each of the five bases power on the partnership in supply chain.

3 Power Taxonomy and Determinants

3.1 Power Taxonomy Framework

When considering the power of partner, it can be derived from two dimensions. One dimension is the power arising from the focal company instead of individual partner, which we called "partner-independent power". Take automobile manufacturing for example. There may be several candidates to supply engines. Though their promised price, quality and experience are different, the power of those candidates is on the same level in terms of the activity of supplying the module of engine. However when compared with the activity of supplying window glass to the automobile, to supply the module of engine could be considered more critical because engines play a more essential role to the end product. On the other hand, the marketing factors such as the available number of suppliers could also influence the decision or strategy of the focal company. Suppose there are three alternative suppliers in one solution and only one in another. Undoubtedly, the supplier in the latter will affect the focal company more than any supplier in the former situation regardless of the products provided. Therefore we examine partner-independent power from two dimensions: the demand of focal company to the final product (function-oriented power) and the market situation (market-oriented power).

The other dimensions is the power emerging from the partner, which is the ability closely related to a particular partner. We call it "partner-dependent power". We also subdivide this type of power into two dimensions regarding the partners' capability and performance on the product. One is product-independent power, a kind of power concerning the aspects of a partner itself like expertise, reputation and such capability issues except the concrete product related issues; the other is product-dependent power, which is the performance factors of a partner with regards to the demanded product.

In light of the above discussion, we propose a product-oriented power taxonomy framework, illustrated in figure 1.

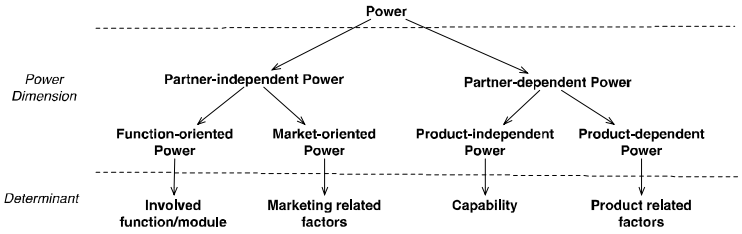

Fig.1. Power Taxonomy Framework

We adopt a two-level-criteria method to finalize the framework: the first level criteria is "partner dependent or not" that indicates the first two dimensions of power, i.e. partner-independent power and partner-dependent power; the second level criteria is "product dependent or not" that is used to apply on the first two dimensions. When considering the sub-dimensions of partner-independent power, the dependence on product indicates the function-oriented power and correspondingly no dependence

indicates market-oriented power. It is the same for the partner-dependent power. The following section introduces some determinants of each dimension.

3.2 Power determinants

3.1.1 Determinants of function-oriented power

Function-oriented power comes from the importance of modules. We evaluate the importance based on the functions the modules perform. In this way, it is possible to establish a mapping between functions and modules and rank the importance of modules by ranking the importance of function. To evaluate function-oriented power, the first step is to mapping modules into functions. There are several methods that can be used for this purpose. Take F.A.S.T. (Functional Analysis Systems Technique) methodology [21] for example, which is a method of developing and decomposing the system functions. We establish a matrix to illustrate this mapping (see figure 2).

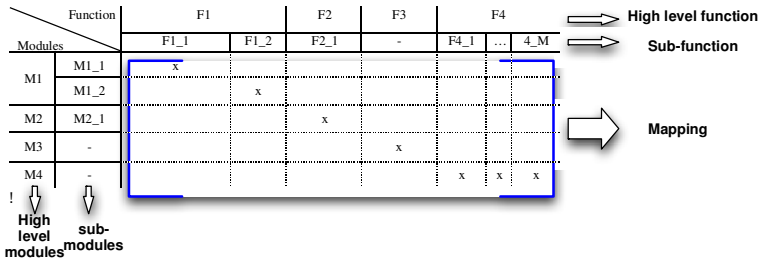

Fig. 2. Mapping modules into functions

The second step is to calculate the importance of the function. We adopt AHP technique [22] to rank the functions. To compare the two functions, the values v = {1, 2, …, 9} representing the preferences are assigned (see table 1) and the matrix of these pairwise preferences are deduced as illustrated in figure 3. High-level functions are compared first and then are the sub-functions inside. The weight of a high level function is the sums of all the weights of its sub-functions. To be noticed, for the case that function (like F4) contains its sub-functions (F4_1, …, F4_M) but finally is implemented by one module (M4), there is no necessity to compare the sub-functions inside.

	F1	F2	F3	F4	Weight
F1	1	x_{12}	x_{13}	x_{14}	x_1
F2	$1/x_{12}$	1	x_{23}	x_{24}	x_2
F3	$1/x_{13}$	$1/x_2$	1	x_{34}	x_3
F4	$1/x_{14}$	$1/x_{34}$	$1/x_{34}$	1	x_4

a. High level comparison

	F1_1	F1_2	Weight inside	Overall weight
F1_1	1	x_{12}'	x_{1_1}'	x_{1_1}
F1_2	$1/x_{12}'$	1	x_{1_2}'	x_{1_2}

b. Inside functions comparison

Fig. 3. Modules preference matrix

Table 1. Fundamental scale of relative importance

Intensity of Importance	Numerical assessment
Extreme importance	9
Very strong or demonstrated importance	7
Strong importance	5
Moderate importance	3
Equal importance	1
Intermediate values	2, 4, 6 and 8

The last step is to transform the weights of functions to the weight of modules based on the mapping matrix (see figure 4a). Therefore, the importance of supplying certain modules is deduced. When it comes to calculating the power of particular partners, we can relate the partners with modules and aggregate the weight values (see figure 4b and 4c).

Modules		Weight
M1	M1_1	x_{1_1}
	M1_2	x_{1_2}
M2	M2_1	x_2
M3	-	x_3
M4	-	x_4

a. Weights of modules

Modules / Suppliers	M1_1	M1_2	M2_1	M3	M4
S1	x		x		
S2		x		x	
S3					x

b. Mapping between partners into modules

Suppliers	S1	S2	S3
Power value	$x_{1\_1}+x_2$	$x_{1\_2}+x_3$	x_4

c. Weights of partners

Fig. 4. Retrieving modules weight and weights of partners

3.1.2 Determinants of market-oriented power, product-independent power and product-dependent power

Market-oriented power is determined by the factors related to market situation, i.e. availability of alternative partners and criticality of product. It is easy to understand that the more alternative partners exist, the more powerful the focal company is whereas the less power the partners own and vice versa. If the final product is critical to the focal company's business or its future performance in its trading area, the partners' power will be increased, whereas the focal company's power will be decreased. As we mentioned before, product-independent power is a kind of power related to partners' capability. The capability can be leveraged to the focal company's advantages in the long term [2323]. In order to assess this power, the factors of capability need to be determined in the first place such as volume of sales, switching cost and expertise knowledge. While product-dependent power is tightly associated with concrete product, including price, quality, deliver cycle time, technical support and fill rate.

All the factors mentioned above can be catalogued to two types according to their nature: quantitative factors (e.g. availability of alternative partners, volume of sales, price) and qualitative factors (e.g. criticality of product, expertise knowledge, quality). We propose a method to calculate the power value of each sub-dimension. The first step is to determine the weight of each factor by comparing every two factors, which stands for the criticality of every factor to the focal company. The second step is to

determine the level of each (potential) partner's activity upon each factor. We adopt a similar table as table 2, in which the numbers {1, 2, …, 9} represent the level of activity, i.e. 1 indicates lowest level and 9 indicates the highest. Finally, we obtain the power value by aggregating the factors values:

$$V(P)=\sum_{i=1}^{t}\alpha_i \cdot x_i \ , \qquad \sum_{i=1}^{t}\alpha_i = 1 \ . \tag{1}$$

In the formula, t is the number of factors in one sub-dimension while α_i is the weight. Table 2 shows an example completing the above calculation procedure.

Table 2. Calculation of power factors

Weights / Partners	Factor 1	Factor 2	Factor 3	Factor 4	Total
	0.35 (α_1)	0.2 (α_2)	0.3 (α_3)	0.15 (α_4)	(V(p))
P1	3	7	5	4	4.55
P2	6	4	2	4	4.1

4 Illustration and Analysis

In this section, our method is applied to a case study. Various initiatives exist all over the European territory to promote bicycle by public authorities in highly jammed traffic cities like Paris or Berlin. However, the use of bicycle remains difficult. A possible solution to extend the use of bicycle is to transform basic bicycles into electrical power-aided ones by assembling electrical power-assist kits. To simplify the case, suppose the electrical power-aided bicycle consists three modules fulfilling one function respectively: basic bicycle, electrical motor and high-charge batteries, and the bicycle manufacture intends to purchase electrical motors from other suppliers. By estimating the function importance, the modules weight is deduced and further the power value of providing modules are achieved (see figure 5).

	F(bicycle)	F(motor)	F(battery)	Weight
F(bicycle)	1	2	6	0.577
F(motor)	1/2	1	5	0.342
F(battery)	1/6	1/5	1	0.081

a. Function comparison

Modules	Weight
M(bicycle)	0.577
M(motor)	0.342
M(battery)	0.081

b. Module weight

Fig. 5. Deducing value of function-oriented power

Considering the factors of market-oriented power, suppose there are three potential suppliers (P1, P2 and P3) and the weights of each factor (availability and criticality) are 0.4 and 0.6 respectively. Because there are only three alternatives, we can consider this will highly increase the power of those potential partners. Moreover, this product could be the future trend, so it is important to the manufacture. Therefore the numbers representing the level of importance of the two factors are 5 and 3 respectively. The power value is calculated (see figure 6a). The calculation processes of the product-independent power value and the product-dependent value of each potential partner are similar to that of the market-oriented power value. The first is to decide the weights of each factor under the two dimensions. The second is to assign

numbers representing the level of activity and finally all the values will be aggregated. Based on those calculations, we can get a result like figure 6b.

	Availability	Criticality	Power value
Weights	0.4	0.6	
Levels	5	3	3.8

a. Value of market-oriented power

	F-O	M-O	P-I	P-D
P1	0.342	3.8	4.5	7.3
P2	0.342	3.8	3.1	6.9
P3	0.342	3.8	3.45	2.6

b. Final result with power values

F-O: function-oriented Power
M-O: market-oriented Power
P-I: prodcut-independent Power
P-D: prodcut-dependent Power

Fig. 6. Power values

In this case, partner 2 (P2) is the best choice. Dealing with P1 could be too risky because it is with a high value of partner-dependent power (11.8) that means P1 could restrain the manufacture, though this value could also indicate good performance and capability. Dealing with P3 could suffer least risk, however, the lower value of power could also means lower ability. Dealing with P2 could be less risky, and looking inside the partner-dependent power, it is not hard to find out the product-dependent power is close to that of P1. In general, on the premise of same value in partner-independent power, the focal company should choose partner with lower (not lowest) partner-dependent power value. If there are several candidates with close values, look inside the partner-dependent power and analyse its two sub-dimensions. This method can also assist the focal company to choose between two solutions in terms of partners. In this case, the values in the partner-independent power will be different. It is better to the solution with lower values of function-oriented power and market-oriented power but middle level value of partner-depended power.

5 Conclusion

This paper proposed a product-oriented power taxonomy with analyses of power determinants. When analyzing the power of partner, the focal company can first follow a top-down method to list all the determinants it concerns and then follow a bottom-up method to aggregate the power value of each dimension based on the weights of its determinants. This taxonomy can be applied not only to the companies in supply chain but also other types of alliances such as virtual enterprise. On one hand, this taxonomy can be used to assess the (potential) partners or solutions in terms of partners; on the other hand, it can also be used to analyses the focal company itself if it is a subcontractor. In the future, we will focus on refining the assessment method of power value and a further study on the analyses of the assessment results.

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