American Journal of Economics 2016, 6(6): 334-343
DOI: 10.5923/j.economics.20160606.04

An Application of AHPTOPSIS Model for Evaluating the Optimal Individual of Extending Loan in SCF Ecosystem

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Abstract The critical concept of supply chain finance (SCF) is looking for a core target in a supply chain and delivery of credit. Using the transaction records from the target to the members, the financier will be able to provide a higher level of cash flow to the ecosystem. However, financiers provide the SCF service can improve their profits, but there are many risks implied in SCF activities from the target to supply chain (SC) members. Therefore, this paper presents processes to evaluate the optimal individual of extending loan for financiers combining the analytic hierarchy process (AHP) and the technique for ordering preference by similarity to the ideal solution (TOPSIS). In the first place, construct the criteria and sub-criteria by modify Delphi method. In the second place, the AHP is used in obtaining the weights of criteria and sub-criteria. In the third place, the TOPSIS approach to rank the optimal individual of extending loan in terms of their overall on multiple evaluation criteria. Furthermore, this study applied a case study of smartphone industry SC to assess the optimal alternative. Importantly, the proposed model can provide academic support to the decision-makers in the financiers with a valuable objective guide for evaluating the individual of extending loan of smartphone industry SC programs to obtain optimal solution in their actual administration of SCF service practices.

Keywords Supply chain finance (SCF) ecosystem, Analytic hierarchy process (AHP), the technique for ordering preference by similarity to the ideal solution (TOPSIS), Smartphone industry supply chain, Individual of extending loan

1. Introduction

In recent years, the development of a globalized economy has led to intense competition in the market which has led to many industries implementing supply chain management (SCM). The SCM can reduce the propagation of unexpected/undesirable events through the network and can influence decisively the profitability of all the SC members and co-ordination of all the input/output flows (materials, information and finances) (Simchi-Levi et al. 2000; Guillen et al. 2007). SCM systems rely on financial flows in addition to manufacturing, logistics and marketing activities to coordinate the flow of goods, services and money between separate stages in the supply chain (Blackman, et al. 2013). The financial processes that can be seen are important to any industry when they have implemented the SC activities. Hence, finance institutions to look in a very zealous way for Small-Medium sized Enterprises (SMEs) and provide working capital or more credit (loan level) to them and then expand the market share. This concept is the basis of Supply Chain Finance (SCF) that can enhance the efficiency of finance flows in a SC activity. The idea of SCF was proposed in 2006 (Berger and Udell, 2006). Pfohl and Gomm (2009) proposed the details of the definition of SCF is the inter-company optimization of financing as well as the integration of financing processes with customers, suppliers, and service providers in order to increase the value of all participating companies. Randal and Farris (2009) found that SCF can strengthen the SC by collaborative management of cash-to-cash cycles and sharing the weighted average cost of capital.

The SCF services can create a financial win-win for the buyer, the seller and the financial intermediary (More and Basu, 2013). In the financiers' opinion, the biggest feature of SCF is to find an individual of extending loan in the SC, and improve the financial constitution based on this individual, which extends the good credit of individual to the upstream and downstream firms and lifts the lid on lending without taking on unacceptable risk (Wang et al. 2013; Liu, 2007). The three flows of typical SCM system (financial, goods and information) is shown in Figure 1 and then Figure 2 is shows the ecosystem of SCF. For instance, if the individual of extending loan is the manufacturer, SC members (upstream/downstream) can extend the individual of extending loan to improve the working capital efficiency then it can solve a problem that most SMEs face when they have low credit to loan funds. Therefore, the individual of extending loan in a SCF ecosystem is a critical actor when a bank or financial sector wants to provide these new financial

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Published online at http://journal.sapub.org/economics

services.

In this tough economic environment it is very difficult to access funds through traditional channels, and with banks tending to lend less; corporations are finding alternative ways to source funding. Lack of access to required financing has strained many buyer/supplier relationships (More and Basu, 2013). SCF ecosystem may solve this problem for SC members. The SCF ecosystem is a new type of financial service that can make the SC more efficient by providing the SMEs with a lower cost of credit. There are some studies about the benefits when banks provide SCF service in a SC that are enhancement of profitability, stronger more collaborative relationships with clients, increased reach and profile of trade and treasury organization and lending to an expanded need for banking service (Mazars, 2011; He and Tang, 2012).

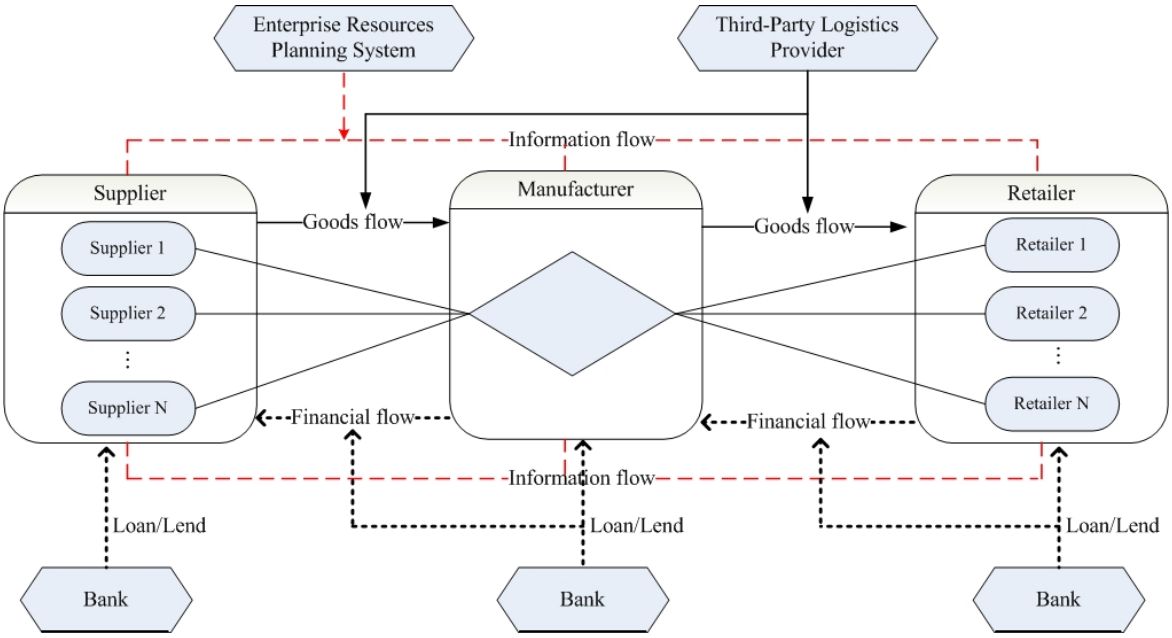

Figure 1. The three flows of the traditional SCM system

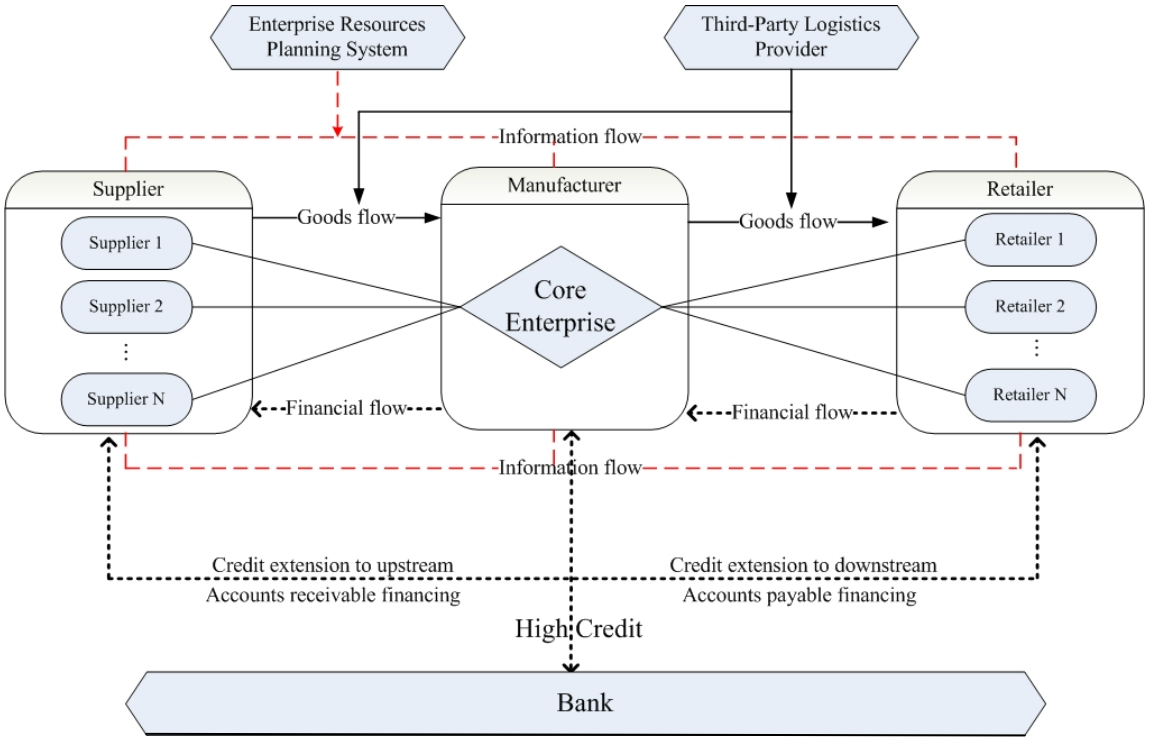

Figure 2. The ecosystem of SCF

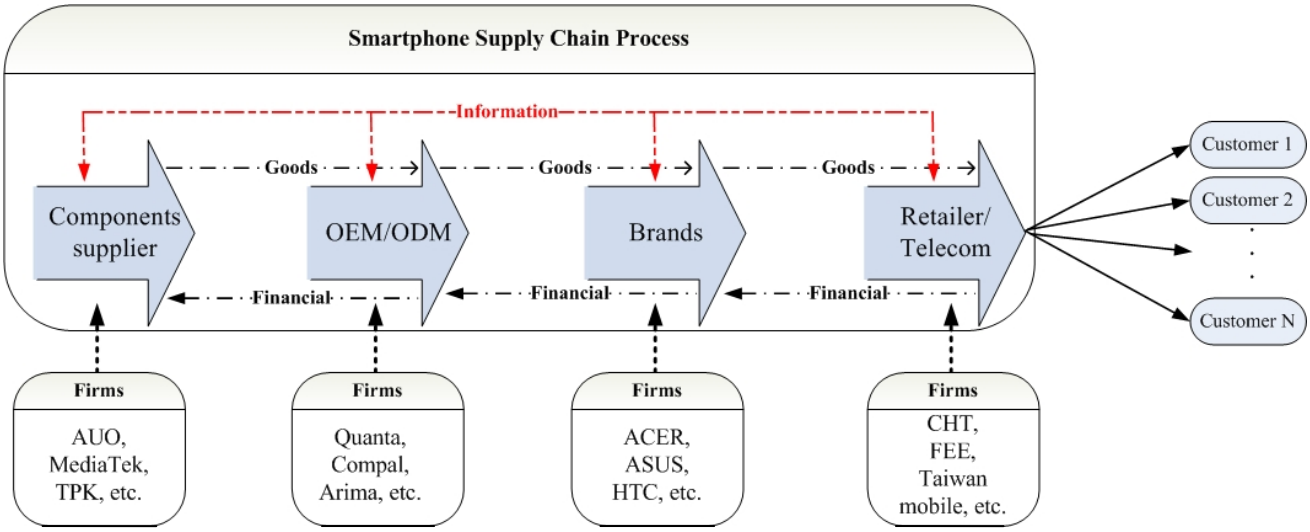

Figure 3. The Smartphone industry SC process. (Source: Ali-Yrkko et al., 2011; Linden, et al., 2009)

Simultaneously, SCF also inherit a lot of the risks through this individual of extending loan to upstream and downstream members. These risks include SC systematic risk, transaction risk, and bankruptcy risk and so on. Therefore, it is important in evaluating the optimal individual of extending loan when a bank would like to provide SCF service. To date, there is no research that has developed a comprehensive model about individual of extending loan evaluation in SCF. Hence, the purpose of this study is to present an integration model and a case study of smartphone industry SC to estimate which individual of extending loan is the optimal for a financier. The main process of the smartphone industry supply chain can be divided into the (1) Components supplier, (2) OEM/ODM, (3) Brands and (4) Retailer/Telecom (Ali-Yrkko et al., 2011; Linden, et al., 2009) as shown in Figure 3. The smartphone market was chosen for this case study because the SC is very complex, and finding the optimal individual of extending loan, and then within that the individual of extending loan, in this industry's SCF would allow for SMEs to increase their financial efficiency through lower borrowing costs and solve the loan barrier. In the smartphone industry supply chain, it can be difficult to find the optimal individual of extending loan because the optimal individual of extending loan is often not readily apparent. In many parts of the supply chain there are different sized firms, and the individual of extending loan cannot be found without comprehensive analysis. There is no easy rule to find the optimal individual of extending loan; it can be in any part of the supply chain. That is why a comprehensive model is needed to find the optimal individual of extending loan.

Although there are some of papers about SCF that cover concentrate coordination, working capital and optimal financial flow (Yan and Sun, 2013; Kristofik et al. 2012; Pfohl and Gomm, 2009) they have not solved the crucial problem of the core feature of SCF that is who exactly is the "optimal individual of extending loan" of a supply chain. Determining who constitutes the "optimal individual of extending loan" of the smartphone industry supply chain is critical to improving the efficiency of credit. The usual model of the SCF supply chain ecosystem is there is one large company surrounded on both sides by SMEs.

Currently, financial institutions lend separately to companies in every step of the supply chain. For example, the manufacturer has a slightly different method of obtaining credit: It will send product to the retailer and receive an account payable promissory note, this note will also be sent to the financial institution to allow it to obtain credit to pay the manufacturer for product. Finding the "optimal individual of extending loan" allows for a far more efficient model where every member of the supply chain can use the upstream and/or downstream transaction record to obtain credit from the manufacturer. Nevertheless, finding the optimal individual of extending loan in a supply chain ecosystem is an important question and the evaluation of optimal solution is a multi-criteria problem and ideal model requires suitable criteria and strict screening (Wu et al., 2007). In past research, there was few literature about SCF and smartphone industry that used multi-criteria decision-making (MCDM) concept to evaluate the optimal individual of extending loan of smartphone SC for a financier.

Optimal alternative evaluation first is an MCDM problem, and then the analytic hierarchy process (AHP) method is employed to prioritize the weights of each criteria and alternatives (Tsai, et al., 2010). Currently, there are many studies that have applied AHP to construct a hierarchy architecture which MCDM topics can be structured (Adhikary, et al., 2013; Ashis, 2013; Shahin and Pourhamidi, 2013; Yazdani-Chamzini, et al., 2013). Even though AHP is popular, this algorithm cannot adequately resolve the positive ideal solution and negative ideal solution problems in MCDM scenarios (Chen and Tzeng, 2004). Thus, this research integrated the TOPSIS model into the traditional AHP and then improves the evaluating efficiency. This study develops an AHPTOPSIS-based evaluation framework for

measuring the optimal individual of extending loan in smartphone industry SC. In addition to literature review and surveys of experts in the financial field, this study also utilize the modified Delphi method AHP and TOPSIS to construct an evaluation process that can estimate the optimal individual of extending loan of smartphone industry SC for a financier.

Accordingly, this study integrates the modify Delphi method, AHP and TOPSIS to evaluate the synthetic utility values of criteria and sub-criteria weights and then ranking optimal individual of extending loan by TOPSIS in smartphone industry SC from the opinion of experts employed in the financial field. The AHPTOPSIS based decision-making model is used to provide decision makers or administrators of bank or financial institution with a valuable reference for evaluating the optimal individual of extending loan when they will create the new financial service "SCF" for an industry SC.

2. Evaluation Processes

This study adopts the modify Delphi, AHP and TOPSIS method. The processes are show in Figure 4. The modify Delphi method is to collect experts' view and point out the determinants of the evaluation model, then calculation of the weighted criteria by AHP, finally ranking the optimal alternative through TOSIS. The AHPTOPSIS processes are follows.

2.1. Modify Delphi Method

The Delphi method collects and analyzes the results of anonymous experts who communicate by means of writing, discussion and feedback with respect to particular issues. Anonymous experts share knowledge, skills, expertise, and opinions until they achieve a mutual consensus (Sung, 2001). The procedure of Delphi as follows (Wu et al., 2007):

A. Select the anonymous experts.
B. Conduct the first round of the survey.
C. Conduct the second round of the questionnaire survey.
D. Conduct the third round of the questionnaire survey.
E. Integrate expert opinions and reach a consensus.

Steps C and D are normally repeated until a consensus is reached regarding a particular topic (Sung, 2001). The results of literature reviews and expert interviews can be applied to identify all common views expressed in the survey. Furthermore, step B is simplified in order to replace the conventionally adopted open style survey; when this is done it is commonly referred to as the modified Delphi method (Sung, 2001). This study develops a quality evaluation criterion for evaluating the CO in smartphone industry supply chain ecosystem by using the modified Delphi method, as well as by conducting interviews with nameless experts.

2.2. Calculating the Weights of Criteria by using AHP

Saaty (1980) proposed the AHP model to solve the complexity decision problem. As a decision-making method that deconstructs a complex multicriteria decision problem into a hierarchy. AHP incorporates the evaluations of all decision makers into a final decision, without having to elicit their utility functions on subjective and objective criteria, by pairwise comparisons of the alternatives (Saaty, 1990). The AHP steps are as follows.

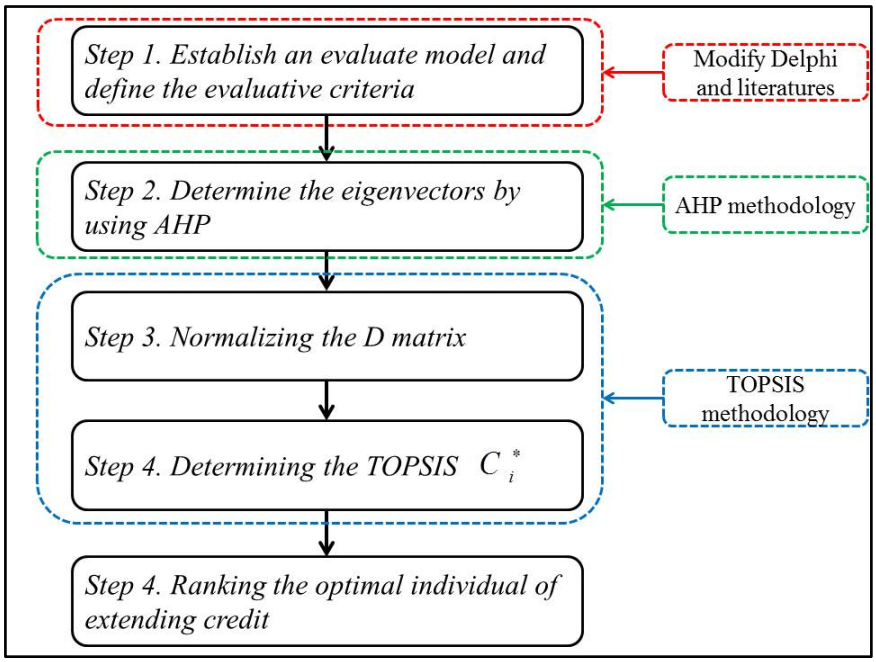

Figure 4. The evaluation processes of optimal individual of extending credit

Establishment of pairwise comparison matrix A. Let C_1, C_2, ..., C_n denote the set of elements, while *aij* represents a quantified judgment on a pair of elements C_i, C_j. The relative importance of two elements is rated using a scale with the values 1, 3, 5, 7 and 9, where 1 refers to 'equally important', 3 denotes 'slightly more important', 5 equals 'strongly more important', 7 represents 'demonstrably more important' and 9 denotes 'absolutely more important'. This yields an *n*-by-*n* matrix A as follows:

$$A=\left[a_{ij}\right]=\begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array}\begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{n2} & \cdots & 1 \end{bmatrix} \end{array} \quad (1)$$

where $a_{ij} = 1$ and $a_{ji} = 1/a_{ij}$, $i, j = 1, 2, ..., n$. In matrix A, the problem becomes one of assigning to the n elements C_1, C_2, ..., C_n a set of numerical weightss W_1, W_2, ..., W_n that reflect the recorded judgments. If A is a consistency matrix, the relation between weightss W_i and judgments a_{ij} are simply given by $W_i/W_j = a_{ij}$ (for $i, j = 1, 2, ..., n$) and

$$A=\begin{array}{c} \\ C_1 \\ C_2 \\ \vdots \\ C_n \end{array}\begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \cdots & C_n \end{array} \\ \begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \vdots & \vdots & \ddots & \vdots \\ w_n/w_1 & w_n/w_2 & \cdots & w_n/w_n \end{bmatrix} \end{array} \quad (2)$$

Saaty (1990) suggested that the largest eigenvalue λ max would be

$$\lambda_{\max}=\sum_{j=1}^{n} a_{ij}\frac{W_j}{Wi} \quad (3)$$

If A is a consistency matrix, eigenvector X can be calculated by

$$(A-\lambda_{\max}I)x=0 \quad (4)$$

Saaty (1990) proposed utilising Consistency Index (*CI*) and Consistency Ratio (*CR*) to verify the consistency of the comparison matrix. *CI* and Random Index (*RI*) are defined as follows:

$$CI=(\lambda_{\max}-n)/(n-1) \quad (5)$$

$$CR=CI/RI \quad (6)$$

where *RI* represents the average *CI* over numerous random entries of same order reciprocal matrices. If $CR \leq 0.1$, the estimate is accepted; otherwise, a new comparison matrix is solicited until $CR \leq 0.1$.

2.3. Ranking the Optimal Individual of Extending Loan by using TOPSIS

Saaty (1980) indicated that the hierarchy concept can be used to deconstruct a complex multi-criteria problem. The AHP is also an evaluation principle that prioritizes the hierarchy and consistency of judgmental data provided by a group of decision makers. There are many studies that have applied AHP to construct a hierarchy architecture within multi-criteria decision-making problem (Adhikary, et al., 2013; Ashis, 2013; Shahin and Pourhamidi, 2013; Yazdani-Chamzini, et al., 2013). However, the AHP method utilized on positive ideal solution and negative ideal solution problems are not effective. Thus, this research integrated the TOPSIS model into the traditional AHP and then improves the evaluating efficiency.

The TOPSIS was first proposed by Hwang and Yoon (1981). Shyur and Shih (2006) present an effective model using both ANP and modified TOPSIS techniques for strategic vendor selection. Chen and Tzeng (2004) applied TOPSIS to selecting an expatriate host country. TOPSIS has thus been successfully applied to a diverse array of problems. However, TOPSIS is thus ineffective when applied to ambiguous problem. The underlying logic of TOPSIS is to define the ideal solution and the negative ideal solution. The ideal solution is the solution that maximizes the benefit criteria and minimizes the cost criteria; whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria. The optimal alternative is the one, which is closest to the ideal solution and farthest to the negative ideal solution. The ranking of alternatives in TOPSIS is based on 'the relative similarity to the ideal solution', which avoids from the situation of having same similarity to both ideal and negative ideal solutions. The calculation processes of the method are as following:

I. Establish a decision (D) matrix for alternative

$$D=\begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_i \\ \vdots \\ A_m \end{array}\begin{array}{c} \begin{array}{cccccc} & & & & & \end{array} \\ \begin{bmatrix} X_{11} & X_{12} & \cdots & \cdots & X_{1j} & X_{1n} \\ X_{21} & X_{22} & \cdots & \cdots & X_{2j} & X_{2n} \\ \vdots & \vdots & \cdots & \vdots & \vdots & \vdots \\ X_{i1} & X_{i2} & \vdots & \vdots & X_{ij} & X_{in} \\ \vdots & \vdots & \cdots & \vdots & \vdots & \vdots \\ X_{m1} & X_{m2} & \cdots & \cdots & X_{mj} & X_{mn} \end{bmatrix} \end{array} \quad (7)$$

where A_i denotes the possible alternatives, $i = 1,. . . ,m$; X_j represents attributes or criteria relating to alternative performance, $j = 1,. . . ,n$; and X_{ij} is a crisp value indicating the performance rating of each alternative A_i with respect to each criterion X_j.

II. Normalizing the D matrix

Calculate the normalized decision matrix R (=[r_{ij}]). The normalized value r_{ij} is calculated as

$$r_{ij}=\frac{X_{ij}}{\sqrt{\sum_{j=1}^{n} X_{ij}^2}},\ j=1,\ ...,\ n;\ i=\ 1,\ ...,\ m. \quad (8)$$

where X_{ij} is the performance of attribute i to criterion j.

III. Create the weighted normalized matrix

A set of weights w= (w_1, w_2,…w_n), $\sum_{j=1}^{n} w_j = 1$, from the AHP is accommodated weight. This matrix can be calculated by multiplying each column of the R with its associated weight w_j. Therefore, the weighted normalized decision matrix V is equal to

$$V = \begin{bmatrix} V_{11} & V_{12} & \cdots & V_{1j} & \cdots & V_{1n} \\ \vdots & \vdots & & \vdots & & \vdots \\ V_{i1} & V_{i2} & \cdots & V_{ij} & \cdots & V_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ V_{m1} & V_{m2} & \cdots & V_{mj} & \cdots & V_{mn} \end{bmatrix} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \cdots & w_j r_{ij} & \cdots & w_n r_{1n} \\ \vdots & \vdots & & \vdots & & \vdots \\ w_1 r_{i1} & w_2 r_{i2} & \cdots & w_j r_{ij} & \cdots & w_n r_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ w_1 r_{m1} & w_2 r_{m2} & \cdots & w_j r_{mj} & \cdots & w_n r_{mn} \end{bmatrix} \quad (9)$$

IV. Determine the ideal solution and negative ideal solution

The ideal solution is computed based on the following equations:

$$A^* = \{(\max V_{ij} \mid j \in J),\ (\min V_{ij} \mid j \in J'),\ i = 1, 2, \ldots, m\}, \quad (10)$$

$$A^- = \{(\min V_{ij} \mid j \in J),\ (\max V_{ij} \mid j \in J'),\ i = 1, 2, \ldots, m\}, \quad (11)$$

where

$j = \{j = 1, 2, \ldots, n \mid j \text{ belongs to benefit criteria}\}$,

$j' = \{j = 1, 2, \ldots, n \mid j \text{ belongs to cost criteria}\}$.

V. Calculate the distance between idea solution and negative ideal solution for each alternative:

$$S_i^* = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^*)^2} \qquad i = 1, 2, \ldots, m \quad (12)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^-)^2} \qquad i = 1, 2, \ldots, m, \quad (13)$$

VI. Calculate the relative closeness to the ideal solution of each alternative

$$C_i^* = \frac{S_i^-}{S_i^* + S_i^-} \qquad i = 1, 2, \ldots, m, \quad (14)$$

where $0 \le C_i^* \le 1$ that is, an alternative i is closer to A^* as C_i^* approaches to 1.

VII. Rank the preference order

A set of alternatives can be preference ranked according to the descending order of C_i^*.

3. Case Implementation

This study constructed indicators to evaluate the optimal individual of extending loan in smartphone industry SC for financier and the research framework as shown in Figure 5. An evaluation model is constructed based on the modify Delphi method to assess the optimal individual of extending loan by using Expert Choice 2000 and Excel 2010. This framework for evaluating the optimal individual of extending loan comprises the following steps:

Step 1. Establish an evaluate model and define the evaluative criteria

According to the literatures, a general consensus among experts must be reached to construct a framework (Ali-Yrkko et al., 2011; Linden, et al., 2009). The final goal of evaluating the ideal individual of extending loan in smartphone industry SC for financial sector can be achieved, followed by three-evaluation criteria, eleven sub-criteria and final alternatives (Figure 5).

The evaluation criteria and sub-criteria used to determine the individual of extending loan are defined as follows:

1. Goods flow (GF) includes four sub-criteria, e.g. all of transaction volume, frequency of transaction, ratio of delay delivery and ratio of reject by customer.
   - Transaction volume (TV): The total amount of transactions completed and logged in a specific time period.
   - Frequency of transaction (FT): The number of occurrences of a transaction in a given time period.
   - Ratio of delay delivery (RDD): The number of transactions where delivery is delayed due to problems unrelated to logistics compared to the number of transactions where the delivery is completed in the agreed upon time frame
   - Ratio of reject by customer (RRC): The number of transactions where delivery is accepted by the customer compared to the number of transactions where the delivery is rejected by the customer.

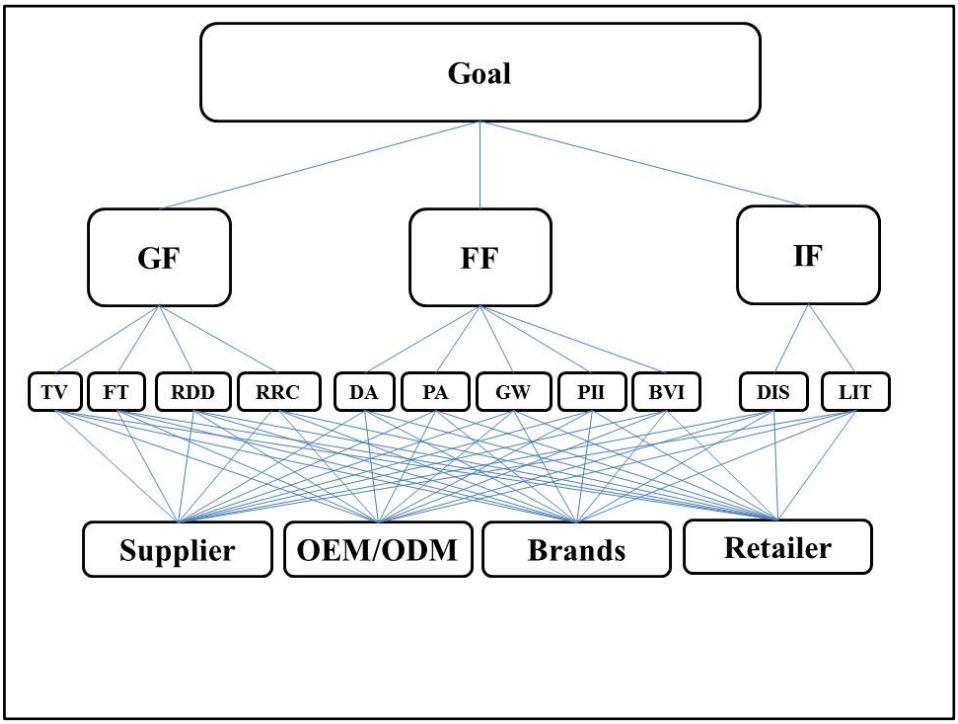

Figure 5. Research framework to evaluate the optimal individual extending credit

2. Financial flow (FF) includes five sub-criteria, e.g. debt-paying ability, profitability, goodwill, position in industry and brand value in industry.
   - Debt-paying ability (DA): The ability of the company to repay its debt obligations and remain liquid.
   - Profitability (PA): The company's income after input costs, expenses and other obligations are paid.
   - Goodwill (GW): A value the company has that's beyond its assets and liabilities.
   - Position in industry (PII): A qualitative assessment of where a company stands in the specific industry relative to other operations in the supply chain.
   - Brand value in industry (BVI): A qualitative assessment of a company's brand when compared to others in the industry.
3. Information flow (IF) includes three sub-criteria, e.g. degree of information sharing, level of information technology and degree of integrating in all of enterprise information systems (EIS).
   - Degree of information sharing (DIS): The level of sharing transaction records between all members of the supply chain.
   - Level of information technology (LIT): The degree to which a company integrates efficiency increasing computerized systems.
4. Individual of extending loan includes four operations, e.g. supplier, original equipment manufacturing/ original design manufacturer (OEM/ODM), Brands and Retailer.
   - Supplier: The individual of supplier in Taiwan smartphone industry SC, e.g. AUO, MediaTek, TPK, etc.
   - OEM/ODM: The individual of OEM/ODM in Taiwan smartphone industry SC, e.g. Quanta, Compal, Foxconn, Arima, etc.
   - Brands: The individual of Brands in Taiwan smartphone industry, e.g. ACER, ASUS, HTC, etc.
   - Retailer: The individual of Retailer in Taiwan smartphone industry, e.g. CHT, FET, Taiwan mobile, etc.

Step 2. Determine the eigenvectors by using AHP

The pair-wise comparisons of levels 2–4 are determined for 11 elements matching the above characteristics with each respondent making a pair-wise comparison of the decision elements and assigning them relative scores.

The relative scores provided by experts are aggregated with the geometric mean method. Table 1 lists the aggregate pair-wise comparison matrix for the level 2-4.

Step 3. Normalizing the D matrix

According to Table 1 establishing the *D* matrix, the weights of overall multiplied weights of level 4 is the *D* matrix as shown in Table 2, than normalizing the *D* matrix and create the weighted normalized the matrix using formulae (7) and (8). Table 3 summarizes the normalized results.

Table 1. The optimal individual of extending credit for financiers' eigenvectors (weights) for level 2-4

	Criteria	Weights	Sub-criteria	Global Weights	Individuals of extending credit			
					Supplier	OEM/ODM	Brands	Retailer
Goal	GF	0.363	TV	0.066	0.297	0.208	0.389	0.106
			FT	0.065	0.310	0.150	0.405	0.135
			RDD	0.120	0.279	0.315	0.179	0.226
			RRC	0.112	0.301	0.197	0.175	0.326
	FF	0.440	DA	0.070	0.320	0.192	0.236	0.252
			PA	0.146	0.229	0.241	0.378	0.152
			GW	0.065	0.175	0.176	0.494	0.155
			PII	0.055	0.259	0.451	0.198	0.091
			BVI	0.103	0.250	0.217	0.422	0.111
	IF	0.197	DIS	0.108	0.312	0.362	0.242	0.084
			LIT	0.089	0.235	0.433	0.231	0.101

Table 2. Decision matrix for individuals

	TV	FT	RDD	RRC	DA	PA	GW	PII	BVI	DIS	LIT
Supplier	0.297	0.310	0.279	0.302	0.320	0.229	0.175	0.259	0.250	0.312	0.235
OEM/ODM	0.208	0.150	0.316	0.197	0.192	0.241	0.176	0.452	0.217	0.362	0.433
Brands	0.389	0.405	0.179	0.175	0.236	0.378	0.494	0.198	0.422	0.242	0.231
Retailer	0.106	0.135	0.226	0.326	0.252	0.152	0.155	0.091	0.111	0.084	0.101

Table 3. Normalized the *D* matrix

	TV	FT	RDD	RRC	DA	PA	GW	PII	BVI	DIS	LIT
Supplier	0.020	0.020	0.033	0.034	0.022	0.033	0.011	0.014	0.026	0.034	0.021
OEM/ODM	0.014	0.010	0.038	0.022	0.013	0.035	0.011	0.025	0.022	0.039	0.039
Brands	0.026	0.026	0.021	0.020	0.017	0.055	0.032	0.011	0.043	0.026	0.021
Retailer	0.007	0.009	0.027	0.037	0.018	0.022	0.010	0.005	0.011	0.009	0.009

Step 4. Determining the TOPSIS C_i^*

First, determine the ideal solution and negative ideal solution using formulae (12) and (13).

$$S_i^* = \sqrt{(0.020-0.026)^2+(0.020-0.026)^2+(0.033-0.038)^2+...+(0.021-0.039)^2} = 0.042$$

$$S_i^- = \sqrt{(0.020-0.007)^2+(0.020-0.009)^2+(0.033-0.021)^2+...+(0.021-0.009)^2} = 0.043$$

Table 4 shows the S_i^* and S_i^-. Next calculate the relative closeness to the ideal solution of each alternative, C_i^*, using formulae (14) and rank the "Brands" performs the best (see Table 5).

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

	S_i^*	S_i^-
Supplier	0.042	0.043
OEM/ODM	0.044	0.081
Brands	0.036	0.092
Retailer	0.075	0.051

Table 5. Summary of the TOPSIS C_i^*

	C_i^*	Rank
Supplier	0.508	3
OEM/ODM	0.644	2
Brands	0.721	1
Retailer	0.405	4

Nevertheless, the sequential of these individual alternatives are Brands (0.721) > OEM/ODM (0.644) > Supplier (0.508) > Retailer (0.405) and the optimal individual of extending loan is "Brands" firm, which means when a potential financier would like to furnish the SCF services into smartphone industry SC, it should focus on the "Brands" company and then this individual can provide the purchase records to financier that would result in the delivery of credit, records in transaction or invoice and so on to their upstream (OEM/ODM and Supplier) firms.

On the other hand, the "Brands" individual also can provide shipment records to the financier that would result in the delivery of credit, records in transaction or invoice etc. to their downstream (Retailer). These activities not only can improve the accounts receivable financing efficiency for firms upstream of the individual of Brands and will also increase the accounts payable financing efficiency for firms downstream of the Brands company in smartphone industry SC ecosystem. It can upgrade the profits, operating scale, market share, services and innovation commodity etc. for the financier

However, implementation of the SCF concept can upgrade the financial efficiency in smartphone industry SC and improve the operations and income for the financier. But, the financier must consider the many risks in implementation. From the three flows of smartphone SCM and 11 sub-criteria, the optimal individual of extending loan is Brands.

Therefore, the results from the application of the AHPTOPSIS model demonstrates that the financier evaluate the optimal individual of extending loan in SCF services for smartphone industry SC is "Brands" when it plans to provide the SCF to smartphone industry SC.

4. Conclusions

The financial flows that can be seen are important to any industry when they have implemented the SC activities. SCF is new type of financial service that can be enhance the financial efficiency of an SC. The key concept of SCF is the delivery of credit. Using the transaction records from the individual of extending loan to the members, the financier will be able to provide a higher level of cash flow to the ecosystem. Financial sectors would be upgrading their operations and profits through SCF activities. Yet, SCF service can help the financial sectors to improve their operations, but there are many risks implied in SCF activities from individual of extending loan to relative members. Because various multi-criteria decision-making concerns are complex that have the characteristic of minimal costs and maximal benefits in evaluate the optimal individual of extending loan, the AHP method cannot solve this characteristics. Hence, this paper presents a method for applying a combination of the AHP and the TOPSIS in the decision-making process to evaluate the optimal individual of extending loan of smartphone industry SC. This will allow for more efficiency in the financial flow of smartphone industry SC.

AHP can combine quantitative and qualitative factors to handle different groups of factors, and to combine the opinions of many experts. TOPSIS can define the ideal solution and the negative ideal solution. The ideal solution is the solution that maximizes the benefit criteria and minimizes the cost criteria; whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria. The administrators of the financiers are often not equipped with objective decision-making processes or evaluation the criteria to determine the optimal individual of extending loan when they want to provide the new SCF services and the systematic risks in a SC are very high, combination of AHP and TOPSIS can solve the hierarchical and minimal costs and maxial benefits of all criteria becomes an effective tool for the administrators to obtain an accurate solution. Academically, the AHP-TOPSIS model can provide decision makers or administrators of the financiers with valuable guidance for measuring the optimal individual of extending loan of smartphone industry SC. Commercially, the proposed model can provide administrators with a useful instrument to assess the optimal individual of extending loan in smartphone industry SC for financier furnish the SCF services. Finally, the limitations of this study include 2 parts. First, the characteristic of decision factors are independent in research framework namely that is the method hypothesis of AHP. Second, this study applied the case of smartphone industry to assess the optimal individual of extending load in SCF ecosystem. Hence, the structure of SCF ecosystem is based on the smartphone industry supply chain. The future research would be focus on the evaluation of lending level from the optimal individual to their members and forecast the lending risks in a supply chain finance ecosystem.

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