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Choosing the Best Financing Source in a Supply Chain by PROMETHEE Approach

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Abstract
Issues related to structures of goods and information are frequently discussed in the logistics and Supply Chain Management (SCM) literature. But, only few contributions are exploring the financial structures associated with supply chains. This paper presents a framework to identify the appropriate financing source used for supply chain. It is extensively noticed that although various financing sources are available today; issue in choosing the proper one in order to decrease the cost of capital investment with the most effectiveness, still remain in supply chains. In this paper, the proposed framework includes three main developmental phases: (1) identification of financing sources, (2) determination of factors effective on choosing the best financing source in a supply chain, and (3) conducting a numerical study with a questionnaire survey by PROMETHEE approach in the supply chain of downstream oil industries in Iran to illustrate the applicability of the proposed method of the survey. Results show that financing through the capital market is the best choice in the supply chain of the survey.

Keywords: supply chain management, financial structure, financing sources.

Introduction

Senior executives of leading companies view supply chains as serious drivers of shareholder value and competitive differentiation. Yet 'reducing cost' (65%) and 'enhancing revenue' (25%) are still the pre-eminent driver of supply chain initiatives and relatively few companies know where to direct their supply chain investments to maximize business results and bottom line value (Avanzo et al. 2003). As Keebler (2000) mentioned, supply chain decisions affect the firm's capital structure, risk of decisions, cost structure, market value, and profitability. Therefore, supply chain management (SCM) is shifting from a tactical, back-office function to a driver of shareholder value. In turn, supply chain executives must speak the 'language of finance' to communicate the impact of supply chain performance on financial indicators (Keebler, 2000; Carter et al. 2005; Rudzki et al. 2005; Atkinson, 2008).

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For this purpose, selection of proper financing source is necessary to effective supply chain performance management (SCPM) which has become an important issue for organizations in order to pave the way to obtain and sustain competitiveness (Ramezankhani et al. 2018). It is extensively noticed that although various financing sources are available today; issue in choosing the proper one in order to decrease the cost of capital investment with the most effectiveness, still remain in supply chains. Furthermore, under conditions of competition for reducing the cost of capital investment, supply chains perceive the urgent necessity of choosing a proper financing source.

In this conceptual paper, aspects of finance theory and supply chain are applied to extract the factors effective on choosing the best financing source in a supply chain. To this purpose, a literature review of the connection between financing sources and supply chain is used to develop a framework of supply chain finance (SCF), and then the effective factors are identified. Then, the proposed method is tested in the supply chain of downstream oil industries. The paper ends with a discussion of its findings and offers suggestions for further research.

Literature Review

Supply Chain Finance

Supply chains have existed ever since business has been organized to bring products and services to customers (Kumar, 2001). Many differences are found in literature on the same theme when defining a supply chain. Studying the literature shows that there are two major views of supply chain.

One school takes the system view which can be found in Houlihan (1985), Stevens (1989), Scott and Westbrook (1991). This theme of thought believes that supply chain is a system of suppliers, manufacturers, retailers, distributors, and customers where materials flow downstream from suppliers to customers and information flows in both directions.

Other authors view supply chain as a network of organizations and their related activities that work together, usually in a sequential manner, to produce value for the consumer (Kumar, 2001).

Both views have exactly described the entities, activities, and missions of a supply chain from different views and each has its own emphasis. For the system view, it focuses on the processes of making from raw material to final products and how these products are handed to customers in an effective and efficient way, as well as how information is passed within this system to support those processes. While the network view aims to explain the supply chain through the inter-relations and inter-actions between each entity involved. These entities are highly interdependent when it comes to improving performance of the supply chain in terms of objectives such as on-time delivery, quality assurance, and cost minimization (Swaminathan et al. 1998).

In this way, SCM also has a different meaning. In the past, academic papers regarding SCM mainly dealt with the design and optimization of the flows of goods and information (Avanzo et al. 2003; Keebler, 2000; Pfohl et al. 2006; Pfohl et al. 2003; Stemmler and Seuring, 2003; Fettke, 2007). SCM is applied in today's business world to optimize not only the flows of goods, and information, but also the financial flows within and between companies by functional and cross-company integration (Franke et al. 2005; Hofmann and Elbert, 2004; Stemmler and Seuring, 2003; Weber et al. 2007; Ceccarello et al. 2002). Thus, SCM must focus on the 'finance' to communicate the impact of supply chain performance on financial indicators.

SCF is an effective method to lower financing costs and improve financing efficiency and effectiveness, and it has gained research momentum in recent years (Xu et al. 2018). "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". In the other words, the task of SCF is to save capital cost by means of better mutual adjustment or completely new financing concepts within the supply chain eventually in combination with a changed role or task sharing (Phol and Gomm, 2009). SCF aims to optimise financial flows through solutions implemented by financial institutions (Xu et al. 2018).

Stemmler and Seuring (2003) were amongst the first authors to use the term SCF. They speak of the control and optimization of financial flows induced by logistics. Logistically induced financial processes comprise inventory management, the handling of the logistically induced financial flows as well as the supporting processes with an immediate reference to logistics as, for example, the insurance management for stocks.

In line with the characterization presented here, a working definition of SCF can finally be put as follows: located at the intersection of logistics, SCM, collaboration, and finance, SCF is an approach for two or more organizations in a supply chain, including external service providers, to jointly create value through means of planning, steering, and controlling the flow of financial sources on an interorganizational level. While preserving their legal and economic independence, the collaboration partners are committed to share the relational sources, capabilities, information, and risk on a medium- to long-term contractual basis (Hofmann, 2005).

Financing Sources

One of the key decision areas for SCF is the question of how the companies in a supply chain finance their operations. If finance is not raised efficiently, the ability of the companies to accept desirable projects will be adversely affected and the profitability of their existing operations may suffer. The aims of an efficient financing policy will be to raise the appropriate level of funds, at the time they are needed, at the lowest possible cost (Watson and Head, 2007). In the other words, the main objective of a finance plan is to produce the lowest weighted average cost of capital consistent with the required equity return. This enables the lowest price to be offered in a competitive bid (Vinter, 2006).

There is clearly a link between the financing decisions made by a company's managers and the wealth of the company's shareholders. For a financing policy to be efficient, however, companies need to be aware of the sources of financing available to them portfolios.

Sources of financing are divided into internal and external categories. By internal finance we mean cash generated by a company which is not needed to meet operating costs, interest payments, tax liabilities, cash dividends or fixed asset replacement. This surplus of cash is called retained earnings in corporate finance. Another internal source of financing that is often overlooked is the saving generated by more efficient management of working capital. This is the capital associated with short-term assets and liabilities.

There is a multitude of different types of external finance available which can be split broadly into debt and equity finance (Watson and Head, 2007).

Equity is defined as any financing vehicle that has a residual claim on the firm, does not create a tax advantage from its payment, has an infinite life, does not have priority in bankruptcy, and provides management control to the owner. Conversely, debt is defined as any financing vehicle that has a contractual claim on the firm's cash flows and assets, creates tax deductible payments, has a fixed life, and has priority claims on the cash flows in both operating periods and bankruptcy (Damodaran, 2001). The debt financing opportunities of a company are mainly influenced by the company's credit rating, the securities, and the willingness of the lender (Hofmann, 2005).

The equity claim can take different forms, depending on whether the firm is privately owned or publicly traded, and on the firm's growth and risk characteristics. Private firms have fewer choices available when it comes to equity than do publicly traded firms, since they cannot issue stock to the public to raise equity. The main choice of equity financing for private firms is owner's equity (Damodaran, 2001).

Publicly traded firms have a number of alternatives for raising equity, including common stock (Finnerty, 2016), warrants, contingent value rights, and other equity innovations (Damodaran, 2001).

The conventional way for a publicly traded firm to raise equity capital is to issue common stock at a price the market is willing to pay. For a firm that is being publicly traded for the first time, this price is estimated by an investment banker and is called the offering price; for an existing company, it is based on the current market price.

With warrants, holders receive the right to buy shares in the company at a fixed price in the future, in return for paying for the warrants today. Since the value of the warrant is derived from the price of the underlying common stock, warrants have to be traded another form of equity.

Contingent value rights (Taussig ang Delios, 2014) provide investors with the right to sell stocks for a fixed price and thus derive their value from the volatility of the stock and the investors' desire to protect themselves against losses.

The alternative to use equity, which is residual claim, is to borrow money. Debt creates a fixed obligation to make cash flow payments and provides the lender with prior claims if the firm is in financial trouble.

Totally, debt financing is divided into two categories: internal and external. Internal options include loans, stocks, bonds, etc., which can be done by banks or capital markets and external options include borrowing and investment methods.

Besides being a source of both long-term borrowing for firms, banks also often offer them a flexible option to meet anticipated or seasonal financing needs. This option is a line of credit, which the firm can draw on only if it needs financing. In most cases, a line of credit specifies an amount the firm can borrow and links the interest rate on the borrowing to a market rate, such as the prime rate or treasury rates. The advantage of having a line of credit is that it provides the firm with access to the funds without having to pay interest costs if the funds remain unused. Thus, it is a useful type of financing for firms with volatile working capital needs (Damodaran, 2001).

Totally, methods of financing by banks can be divided into bank credit and facility. Credit includes letter of credit (LC) and bank guarantee. LC is an instrument that is commonly used to facilitate payments in business transactions between buyers and sellers, and can be used either locally or across borders (CheHashim and Mahdzan, 2014). Also, a bank guarantee is a guarantee from a lending institution ensuring the liabilities of a debtor will be met. In other words, if the debtor fails to settle a debt, the bank covers it. A bank guarantee enables the customer, or debtor, to acquire goods, buy equipment or draw down loans, and thereby expand business activity (http://www.investopedia.com).

For large publicly traded firms, an alternative to bank debt is to use capital markets. Capital markets are markets for trading long-term financial securities. These securities are ordinary shares, long-term debt securities such as debentures, unsecured loan stock and convertible bonds, and, to a much lesser extent, preference shares.

Capital markets have two main functions. First, they are a place where long-term funds can be raised by companies from those with funds to invest, such as financial institutions and private investors. In fulfilling this function, they are primary markets for new issues of equity and debt.

Second, capital markets allow investors to sell their shares and bonds, or buy new ones to increase their portfolios (Watson and Head, 2007).

As mentioned before in debt financing, external options include borrowing and investment methods. Borrowing methods include finance, usance, line of credit, and international loans.

Finance is a contract with the use of foreign medium-term credit facilities to fund the project, purchase equipment and technical and engineering services.

Usance is a contract with an allowable period of time (often from two weeks to two months) for paying a bill of exchange in foreign commerce (Millani and Esmailli, 2010).

Also, investment methods are divided into three categories: direct investment, indirect investment, and counter trade.

Direct investment includes ownership, joint venture, and contribution to production, profit, and time. A joint venture is a business entity created by two or more parties, generally characterized by shared ownership, shared returns and risks, and shared governance.

Indirect investment includes BOT (Build- Operate- Transfer), BOO (Build- Operate- Ownership), BLT (Build- Lease- Transfer), BLO (Build- Lease- Operate), DBOM (Design- Build- Operate- Maintenance), ROT (Resuscitation- Operate- Transfer), and ROO (Resuscitation- Operate- Ownership).

Counter trade which is a reciprocal form of international trade in which goods or services is exchanged for other goods or services, rather than for hard currency (Welch and Luostarinen, 1988). Counter trade includes barter, counter purchase, offset, buy back, and compensation trade.

Barter is a contract to exchange (goods or services) for other goods or services without using money. Counter Purchase is an arrangement where one company agrees to sell products to a foreign purchaser for cash, but also simultaneously agrees to purchase specified products or services from the foreign partner. An offset involves assuming an opposite position in regards to the original opening position. Additionally, to offset is to liquidate a futures position by entering an equivalent but opposite transaction that eliminates the delivery obligation. The goal of offsetting is to reduce an investor's net position in an investment to zero so that no further gains or losses are experienced from that position. A buy back, known as a repurchase, is the purchase by a company of its outstanding shares that reduces the number of its shares on the open market. Companies buy back shares for a number of reasons, such as to increase the value of shares still available by reducing the supply of them or eliminate any threats by shareholders who may be looking for a controlling stake. Compensation trade is a form of barter in which one of the flows is partly in goods and partly in hard currency (Table 1).

Table 1. Sources of financing category

Equity Base	Cash Guaranteed By The Company/ Saving/Owner's Equity	
Debt Base	Internal	By Bank (Facility, Credit)
		By Capital Market (Ordinary Shares/Long- Term Debt Securities/Preference Shares)
	External	Borrowing Methods (Finance, Usance, Line of Credit, International Loans)
		Direct Investment (Ownership, Joint Venture, Contribution) Indirect Investment (BOT/BOO/BLT/BLO/DBOM/ROT/ROO) Counter Trade (Barter, Counter Purchase, Offset, Buy Back, Compensation Trade)

Selected indicators effective on choosing the best financing method

As previously stated, there are some financing methods in a supply chain that choosing the best one is a key decision. Reviewing various articles shows that some indicators are effective on choosing a suitable financing method in a supply chain. These indicators can be related to the elements of the chain builder or the communication between them.

Some of the most important of these factors are identified through articles and research literature, which will continue to provide explanations for each one.

- Optimal capital structure

As Keebler (2000) mentioned, supply chain decisions affect the firm's capital structure. The best financing source in a supply chain is the method that makes optimal the capital structure.

Since the flow of material is still at the heart of SCM, the basis for SCF is a true understanding of the internal cause–effect relationships in logistics including the effect on financials. Companies must analyze their logistics systems and processes and link the operational drivers to top level financial, economic, and chain indicators. As Lambert and Burduroglu (2000) mentioned, the economic value – added (EVA) method (Dunbar, 2013) can be used for this purpose. Costs and quality of service as classic logistics management figures can easily be included in the EVA as shown in Fig. 1.

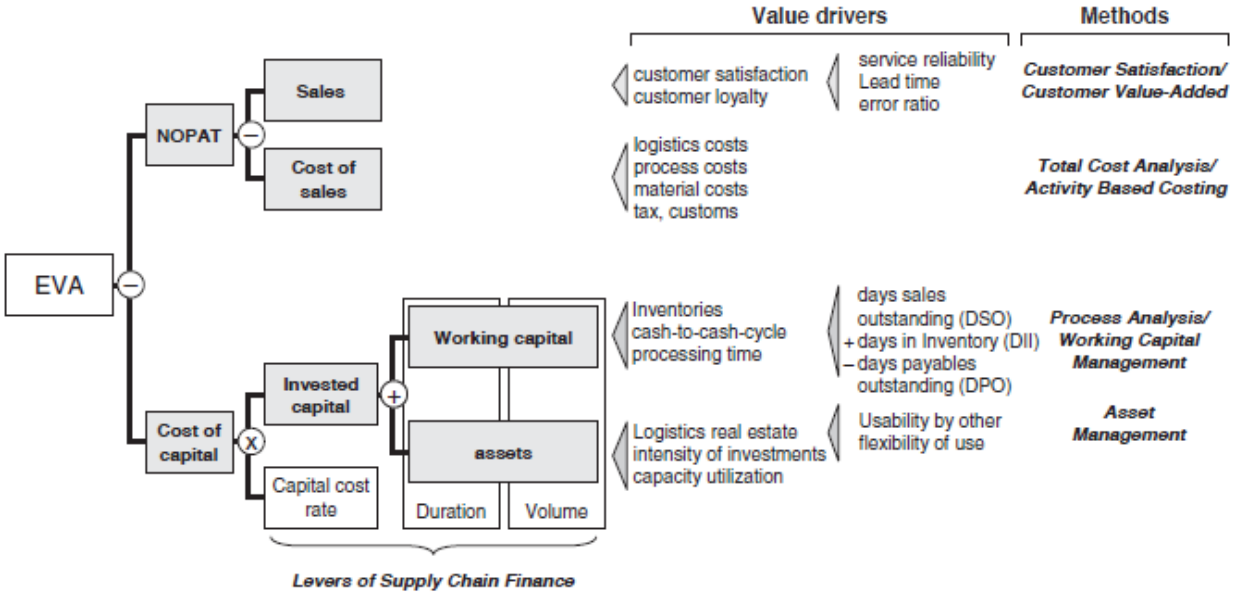

Figure 1. EVA value-driver hierarchy and levers of SCF (Gomm, 2009)

As shown in the EVA method, the three main components of the supply chain financing process are the order cycle management, working capital management, and the fixed assets management. Order cycle management includes all related ordering, billing, and payment-related processes that have a profound connection with IT systems (Pfaff et al. 2003).

The goal of working capital management is also to reduce fixed assets, such as declining goods and inventories. This type of management also seeks to optimize the transfer time, payments, and payment deadlines by developing and improving communication between the flow of materials and information. Also, optimizing the transaction ordering time, debts and debt management (for

example, the cash-to-cash cycle time[1]) are in this category (Hofmann, 2005; Supply Chain Council, 2014).

The cash-to-cash cycle time is the time that takes for an investment to go back to the company after spending the necessary materials. For services, this time represents the time from which a company is charged for the cost of a service until the customer receives payment from the customer for the service (Pavlis et al. 2018). Finally, financing of fixed assets also seeks to optimize fixed assets such as property, assets and machinery (Bowersox et al. 1999; Hofmann, 2005).

On the other hand, the capital invested in fixed assets encompasses logistics real estate such as warehouses as well as movable assets such as trucks, material handling equipment, IT systems, containers, and so on. Here, the question should be asked whether it is worth owning these assets or whether they should be outsource to third party service providers. There are a variety of special service providers focusing, for example, on the financing of logistics real estate. Important aspects for improving the fixed assets are the company specific intensity of investments and the capacity utilization. If either of them is low, items can be outsourced or sold if the fixed assets are usable by others and/or if the use by the company is flexible (Gomm, 2009).

Regarding the volume of investment, it is also important to note that each financing source is able to finance a specific volume of resources and invest in that particular project. Financial managers should pay attention to the amount of capital or resources required for the project, and choose the source of financing in proportion to the resources needed. For example, if they want to absorb a large amount of funding sources, they should do it through a bank or capital market, and they cannot finance large projects with personal capital.

In general, the volume of investment is greatest when it comes to financing through the capital market. Financing through banks and personal capital is at a later stage (Botshekan and Saifuddini, 2010).

Also, each financing source has a specific financing period. For example, when a company with a shortage of working capital faces a shortage of its current assets, it should choose a short-term financing source, and it should not be funded through the capital market to resolve its problem.

Investigations show that the investment period is the most when it comes to financing through personal capital. Funding through the stock market and then the banks are in the next level (Fadaivahed and Miley, 2014).

- Sales costs

One of the main leverages of supply chain finance is the sale cost optimization, which aims to reduce its constructive costs, such as logistics costs, process costs, material costs, financing costs, taxes, and customs. The main method of reducing sales costs is to analyze the total costs as well as operating costs (Gomm, 2009).

Some financial sources have a much smoother, less costly process, and more efficiently, such as commercial bonds, while some other sources impose a higher cost of financing because of the complex processes and institutions involved. In the process of financing through these sources, many institutions engage and have a longer process. In this way, financing through these resources costs a lot (Brealey et al. 2001).

If the goal is considering the green supply chain management (GSCM), process costs will rise. Academicians and practitioners are proposing the concept of GSCM as a potential solution for improving environmental performance. Handfield et al. (1997) mentioned the application of environmental management principles to the entire set of activities across the whole customer order

[1] It has three components: day's sales outstanding, days in inventory, and day's payable outstanding.

cycle. Sarkis et al. (2011) defined GSCM as integrating environmental concerns into the inter-organizational practices of sustainable supply chain management, including reverse logistics.
Some of the most aspects of GSCM are reverse logistics, green information, technology and systems, supplier and customer environmental collaboration, green processing (design, purchasing, manufacturing, and packaging), and green logistic (Islam et al. 2017).

- Economic indexes

As previously stated, some criteria which effects in choosing the best financing source, can be related to the elements of the chain builder such as the expected return on investment, and risk adjustment (Ross et al. 2009).

Each project has a certain rate of return or profit. The expected return rate for each source of financing is determined by the risk that it accept. According to existing literature, the expected rate of return is expected to be highest when it comes to financing through personal capital. Financing through the capital market and banks are in the next level (Botshekan and Saifuddini, 2010).

- Chain indexes

Chain indexes includes three related influential factors which are the mechanism of profit sharing, credit score for supply chain companies (Ross et al. 2009), and the market orientation (Gomm, 2009). Market orientation is an indicator that compares the performance of a company or project with other companies and projects in a specific market.

Material and Methods

Based on the literature review, the proposed indicators of the model are presented in Table 2.

Table 2. The proposed indicators

Criteria	Related influential factors	Reference
Working Capital Management	Inventories	Pfaff et al. (2004) and Gomm (2009)
	Cash-To-Cash Cycle Time	Pfaff et al. (2004) and Gomm (2009)
	Processing Time	Pfaff et al. (2004) and Gomm (2009)
Asset Management	Logistics Real State	Lambert and Burduroglu (2000) and Gomm (2009)
	Intensity/Volume of Investment	Lambert and Burduroglu (2000) and Gomm (2009)
	Investment Duration	Lambert and Burduroglu (2000) and Gomm (2009)
	Capacity Utilization	Lambert and Burduroglu (2000) and Gomm (2009)
Cost Analysis	Logistics Costs	Gomm (2009)
	Process Costs	Gomm (2009)
	Material Costs	Gomm (2009)
	Cost of Financing	Gomm (2009)
	Tax, Customs	Gomm (2009)
Economic Indexes	The Expected Return On Investment	Ross et al. (2009)
	Risk Adjustment	Ross et al. (2009)
Chain Indexes	The Mechanism of Profit Sharing	Ross et al. (2009)
	Credit Score of Chain Companies	Ross et al. (2009) and Hofmann (2005)
	Market Orientation of Chain Companies	Gomm (2009)

As mentioned before, POROMETHEE[2] II approach is used to rank the financial methods of the supply chain of downstream oil industries. The main progressive phases are listed below:

Phase I: conceptual model
As it can be seen in Fig. 2, this phase includes the indication of effective indicators as well as the financial sources.

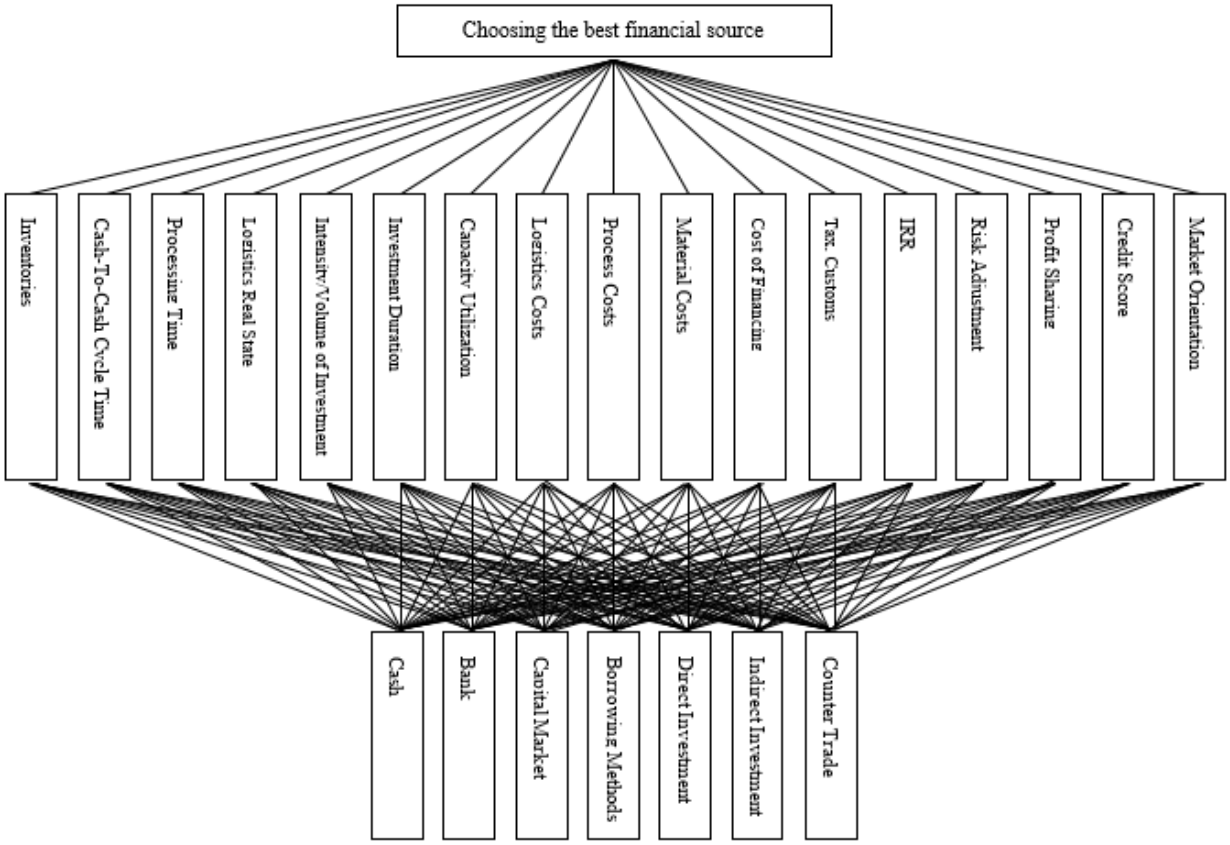

Figure 2. The conceptual model

Phase II: Questionnaire setup
The selected indicators were scheduled and confirmed regarding to the comments of the experts, using CVR[3] index.

As the indicators were selected from the supply chain of downstream oil industries, experts with related backgrounds were chosen for confirmation test. The selection was itself included four criteria:

- At least, 20 years of related experiences in downstream oil industries;
- Academic degree of MSc or higher;
- Experiences as vice-president or manager;
- Covering knowledge of finance.

[2] Preference Ranking Organisation MeTHod for Enrichment Evaluations
[3] Content Validity Ratio

Since the CVR indexes for all the indicators were quantified higher than 0.66, the validity of the conceptual model was finally confirmed.

Phase III: The evaluation table setup
In this table, the alternatives (financing sources) are evaluated on the different criteria. These evaluations involve the decision-makers preferences, which he/she uses when comparing the contribution of the alternatives in terms of each separate criterion (paired comparison analysis[4] is used in this study).

Phase IV: the weights of the indicators
In this study, entropy method is used to weight the indicators. The result is presented in Table 3.

Table 3. The weights of indicators

Related influential factors	Weight
Inventories	0.06
Cash-To-Cash Cycle Time	0.06
Processing Time	0.06
Logistics Real State	0.05
Intensity/Volume of Investment	0.03
Investment Duration	0.05
Capacity Utilization	0.06
Logistics Costs	0.07
Process Costs	0.06
Material Costs	0.06
Cost of Financing	0.03
Tax, Customs	0.05
The Expected Return On Investment	0.08
Risk Adjustment	0.08
The Mechanism of Profit Sharing	0.12
Credit Score of Chain Companies	0.06
Market Orientation of Chain Companies	0.02

Phase V: Ranking the financing sources
As mentioned before, the PROMETHEE II approach which is developed by Brans (1982) and further extended by Brans and Vincke (1985); Brans and Mareschal (1994), is used to rank the financing sources based on selected indicators.

The preference function (Pj) translates the difference between the evaluations (i.e., scores) obtained by two alternatives (a and b) in terms of a particular criterion, into a preference degree ranging from 0 to 1.
Let

(1) $Pj\ (a,b) = Gj\ [fj\ (a) - fj\ (b)]$,
(2) $0 \leq Pj\ (a,b) \leq 1$,

be the preference function associated to the criterion, fj (0) where G_j is a nondecreasing function of the observed deviation (d) between fj (a) and fj (b).

[4] The scores in this analysis are: 1 (Equal preferred), 3 (Moderately preferred), 5 (Strongly preferred), 7 (Very strongly preferred), 9 (Extremely preferred), 2, 4, 6, 8 (Interstitial states).

PROMETHEE permits the computation of the following quantities for each stakeholder r (r = 1, … ,R) and alternatives a and b:

$\Pi_r (a,b) = \sum P_j(a,b)w_{rj}$

$Phi^+ (a) = \sum \Pi_r (x,a)$

$Phi^- (a) = \sum \Pi_r (a,x)$

$Phi (a) = Phi^+ (a) - Phi^- (a)$

For each alternative a, belonging to the set A of alternatives, π (a,b) is an overall preference index of a over b, taking into account all the criteria, Phi^+ (a) and Phi^- (a). These measure respectively the strength and the weakness of a vis-a-vis the other alternatives. Phi (a) represents a value function, whereby a higher value reflects a higher attractiveness of alternative a. We call Phi (a) the net flow of alternative a for stakeholder k (Macharis et al., 2004; Paula et al. 2018). The result of using PROMETHEE approach is presented in next part.

Findings

The purpose of this study was to select the best financing source in a supply chain. To this end, financing sources and related indicators were identified by literature review. In the following, a conceptual model was drawn. After confirmation the validity of the model, the best financing source in the supply chain of downstream oil industries was selected by PROMETHEE approach. In the following, the results are presented in Table 4.

Table 4. PROMETHEE flow

Rank	Action	Phi	Phi $^+$	Phi $^-$
1	Capital Market	0.1714	0.2629	0.0915
2	Bank (Credit)	0.0754	0.1594	0.0840
3	Line of Credit	0.0729	0.1575	0.0846
4	Finance	0.0688	0.1499	0.0811
5	Usance	0.0597	0.1480	0.0884
6	Bank (Facility)	0.0581	0.1291	0.0710
7	Barter	0.0470	0.1843	0.1373
8	Counter Purchase	0.0470	0.1843	0.1373
9	Compensate Trade	0.0432	0.1843	0.1411
10	International Loans	0.0354	0.1064	0.0710
11	Contribution	0.0155	0.1989	0.1834
12	Indirect Investment	-0.0073	0.1427	0.1499
13	Joint Venture	-0.0426	0.2320	0.2746
14	Buy Back	-0.0802	0.0581	0.1383
15	Offset	-0.1553	0.0436	0.1989
16	Ownership	-0.1903	0.1149	0.3052
17	Cash (Equity)	-0.2188	0.1544	0.3731

The results showed that three main financing sources including financing through capital markets, banks, and borrowing methods will result in better outcomes (Phi>=0.0500). As can be seen in the table, the score of financing through the capital market is the highest. Therefore, financing through the capital market has the highest rank among the financing sources, and is the

best financing source in the supply chain of downstream oil industries in order to decrease the cost of capital investment with the most effectiveness.

Also as it can be seen in Fig.3, the final ranking of financing sources is shown through the PRIMETHEE network. In this figure, financing methods are ranked from top to bottom.

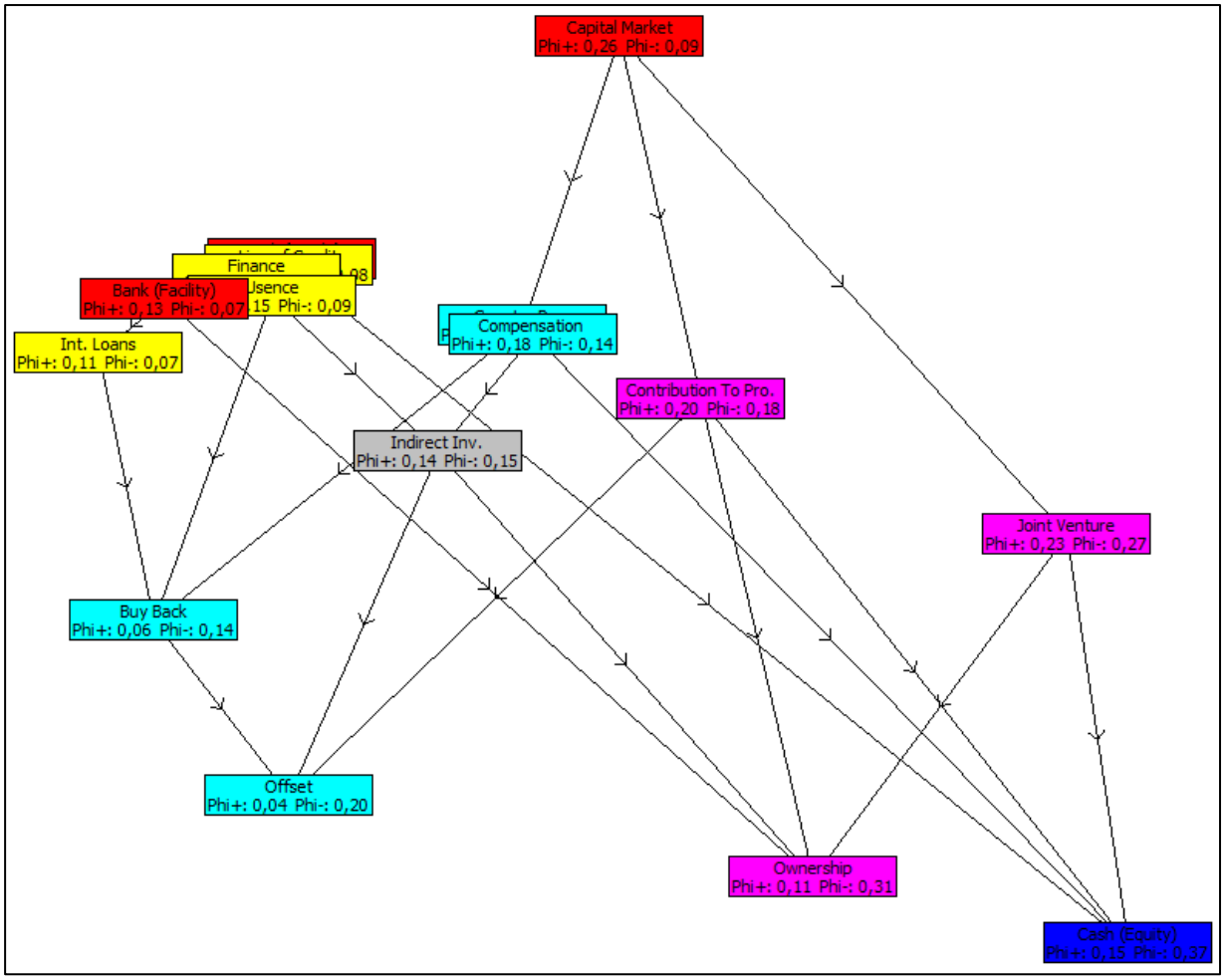

Figure 3. PROMETHEE Network

As it is shown in Fig.3, financing through the capital market with the Phi of 0.1714 is at the highest level of the PROMETHEE network. Financing through the bank (credit) with the Phi of 0.0754 is at the second level, and financing through the line of credit which is a type of borrowing methods, with the Phi of 0.0729 is at the third level.

Conclusion

This paper is a study to develop a collection of indicators effective on choosing the best financing source in a supply chain. The architecture of the proposed methodology involves three main development phases, including (1) identification of financing sources, (2) determination of factors effective in choosing the financing source in a supply chain, and (3) testing the indicators in a selective supply chain to choose the best one.

The corresponding analytical results revealed that five main categories are the key criteria in determining the appropriate financing source for a supply chain. The categories include working capital management, asset management, cost analysis, economic indexes, and chain indexes.

Results indicated that financing through the capital markets has earned the most point. On one hand, it is confirmed that the capital markets are favorable long-term funding source for companies in the supply chain of oil industry. On the other hand, capital markets promote these companies to sell their shares and bonds, or buy new ones to increase their portfolios.

Also, banks often offer firms a flexible option to meet anticipated or seasonal financing needs. This option is a line of credit, which the supply chain of oil industry can draw on only if it needs financing. The main advantage of the credit lines in the supply chain of downstream oil industries, is the accessibility of the funds without having to pay interest costs if the funds remain unused. Thus, it is a useful type of financing for this supply chain with volatile working capital needs.

Results showed that other borrowing methods include finance, and usance have earned good points between the financing sources of a supply chain and can be used as an acceptable and appropriate methods in the supply chain of downstream oil industry.

Nevertheless, the methodology proposed in this study is expected to stimulate more research in the related fields. In addition, the authors hope that this study may help developing logic rules and analytical skills for practical use in addressing issues regarding the uncertainty and complexity of financing the supply chains. Extension and modification of the proposed model for other industries and operational cases may also warrant more research. Further effort in training the proposed model with more valid data is also needed for practical applications.

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