Cost-benefit Analysis of a Blockchain-based Supply Chain Finance Solution

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Summary: This thesis explores the net value of implementing blockchain technology in supply chain finance arrangement by using cost-benefit analysis. A new cost-benefit model and the operating processes of traditional and blockchain-based supply chain finance solutions are proposed. The thesis applies the cost-benefit model to a real-world case study of supply chain arrangement in Thailand to evaluate and estimate the net value of implementing blockchain technology for involved parties.

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KEY INSIGHTS

1. Blockchain technology increases the total net benefit among involved parties participating in the supply chain finance arrangement as a result of improved efficiency of invoice processing
2. Suppliers would benefit from blockchain-based supply chain finance if the benefit from the unlocked working capital outweighs the cost of the platform fee
3. Buyers do not benefit from the technology in terms of unlocked working capital

Introduction

In a business world, companies, especially buyers, tend to use trade credit as a tool for financial growth. While the buyer gains benefit from the extended due date, the supplier is affected by a negative working capital situation from the delayed payment. To mitigate this situation, supply chain finance (SCF) becomes a useful financial tool not just for suppliers but also for buyers for enhancing working capital.

Meanwhile, digital transformation has disrupted different industries and transformed businesses and societies over the past decade including SCF. During the past few years, blockchain technology has shown great potential to disrupt existing supply chain finance solutions, as it could increase the efficiency of invoice processing and provide a more transparent and secure transactions. Although the benefits of applying blockchain technology in SCF is obvious, many businesses are reluctant to adopt the blockchain technology in SCF. One of the most prominent ongoing questions for applying blockchain technology in SCF is whether it is cost-effective for involved parties to use the technology instead of the traditional SCF using a paper-based invoice or traditional platforms. Since research on the topic is scare, the answer for this question is still unclear.

From this, the research question of the thesis is "what is the net value of implementing a blockchain-based SCF solution for involved parties". This thesis contributes to research on SCF both theoretically and practically. The thesis not only is the first academic paper to propose a cost-benefit model for evaluating the net value of blockchain-based SCF solution, but it also applied the model to a real-world use case.

Methodology

Overall, this research develops a cost-benefit analysis of blockchain-based supply chain financing solutions. To conduct the analysis, a cost-benefit model to quantify the net value of blockchain-based SCF and the operating processes of the traditional and blockchain-based SCF was proposed. Then the model and the processes were applied in a real-world case study.

To elaborate, to develop the new cost-benefit model to quantify the value of blockchain-based SCF, a review of relevant quantitative academic literature in areas of traditional SCF was conducted to find a cost-benefit model as a base-case model. Since an application of blockchain in SCF has been considered a novel concept in recent years, there is a paucity of academic literature on quantifying costs and benefits of blockchain-based SCF. Interviews with practitioners were therefore necessary to revise the base-case model and produce an appropriate cost-benefit model with fixed and variable parameters for blockchain-based SCF.

Once the new model was completed, the next step was to map out operating processes for traditional and blockchain-based SCF solution, to get best-estimated parameters to plug in the model. The thesis analyzes the operating processes in 3 scenarios:

(1) Traditional SCF solution without blockchain technology,

(2) Blockchain-based SCF solution using smart contract, and

(3) Blockchain-based SCF solution using internet-of-things (IoT) & blockchain system.

We then applied the cost-benefit model and the operating processes in 3 scenarios to a real-world case study. We use assumptions and parameters from actual financial terms among the involved parties in the SCF arrangement. We also estimated variable parameters from the proposed operating processes in scenario 2 and 3. In the end, the thesis summarizes the key findings and the net value of applying blockchain technology in SCF for the case study.

The cost-benefit model

We use the cost-benefit model proposed by Dello Iacono, Reindorp, and Dellaert (2015), which is shown below, as a base model.

$$Benefit_{\text{buyer}} = A * R_{\text{b}} * (\frac{T_{\text{ext}}}{365})$$

$$Benefit_{\text{supplier}} = A * (R_{\text{s}} - R_{\text{scf}}) * \left(\frac{T_{\text{scf}}}{365}\right)$$

$$Benefit_{\text{funder}} = A * (R_{\text{scf}} - R_{\text{f}}) * (\frac{T_{\text{scf}}}{365})$$

However, according to the interview with industry experts, the base model does not provide realistic benefits since the SCF solution in actual business cases has different arrangement and contains some parameters other than what the models provides as explained in three points below.

First, the base model assumes that the duration of supply chain finance solution provided by the funder, during which the supplier gains benefit, is T_{scf}, which is based on the extended credit term that the buyer agrees on with the funder. However, one popular arrangement of SCF is that the funder allows the supplier the early funding with the original payment period.

Second, the base-case model assumes that the funder agrees to provide early funding for full amount of the invoice. However, according to the interviews with subjects no. 3 and 7, a funder typically does not allow the supplier the full amount of invoice for early funding, but the discounted amount based on credibility of the buyer and the supplier.

Finally, the base model assumes that there is no service fee charged for using the platform. The assumption is valid in case the SCF activities are done via an internal platform developed and operated by the funder. However, in case the blockchain-based SCF provided by a third-party platform provider, the supplier usually has to pay a platform service fee (F_i) charged by the platform provider.

From these, we adjusted the based model and proposed the new cost-benefit model as shown below.

$$Benefit_{\text{buyer,i}} = A * R_{\text{b}} * (\frac{T_{\text{ext}}}{365})$$

$$Benefit_{\text{supplier,i}} = D * A * (R_{\text{s}} - R_{\text{scf}} - F_{\text{i}}) * \left(\frac{T_{\text{ini}} - T_{\text{i}}}{365}\right)$$

$$Benefit_{\text{funder,i}} = D * A * (R_{\text{scf}} - R_{\text{f}}) * (\frac{T_{\text{ini}} - T_{\text{i}}}{365})$$

$$Benefit_{\text{platform,i}} = D * A * (F_{\text{i}}) * (\frac{T_{\text{ini}} - T_{\text{i}}}{365})$$

The variables used in the model are described in the Table 1.

Table 1: Variable explanations

Variable	Unit	Description
A	$	Amount of the invoice
$\mathbf{R_s}$	% / year	Supplier's interest rate
$\mathbf{R_b}$	% / year	Buyer's interest rate
$\mathbf{R_f}$	% / year	Funder's cost of funding
$\mathbf{R_{scf}}$	% / year	Interest rate of SCF
i	-	Number of scenarios
$\mathbf{T_{ini}}$	Days	Original payment term
$\mathbf{T_{ext}}$	Days	Extended payment term
$\mathbf{F_i}$	% / Transaction	Service fee charged by the platform provider
$\mathbf{T_i}$	Days	Period from invoice approval to early payment receipt

The three scenarios

1st Scenario: Traditional SCF Solution

2nd Scenario: Blockchain-based SCF Solution using Smart Contract

3rd Scenario: Blockchain-based SCF solution using IoT Technology

We present three scenarios in comparable to a base-case scenario as shown in Figure 1. The base case scenario is the case when the buyer and the supplier do not participate in the SCF program and decide to pursue the original trade credit term. The tangible benefit to a supplier from participating in the

SCF program is the unlocked working capital from early payment. The unlocked working capital for supplier increases inversely proportional to T_i, which is the period from invoice approval to early payment receipt by the supplier. As a result of increased efficiency by blockchain technology, the processing time required from the first day that the supplier submits the invoice (Day 0) to the day that the supplier is able to get early funding (Day T_i) decreases from scenario 1,2 and 3 respectively, meaning that T1 > T2 > T3. Therefore, considering only the unlocked working capital perspective, the supplier's tangible benefit from unlocked working capital is more in scenario 3 than in scenario 2 and 1 respectively, and that of the buyer is the same among three scenarios.

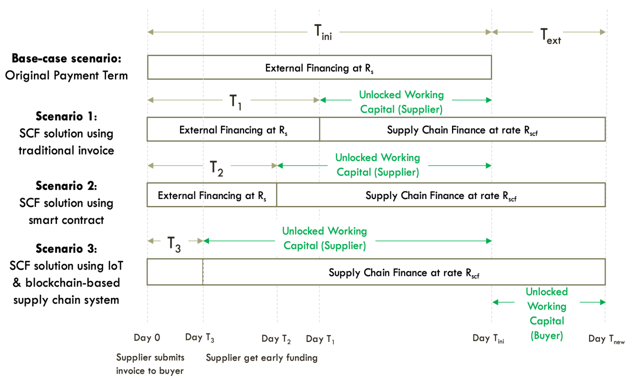

Figure 1: Overview of three scenarios

The case study

The case study used in the thesis is real-world data from one of the leading commercial banks in Thailand ("the funder"). The raw data includes the operating processes and financial arrangement of SCF solutions among the bank and its customer ("the buyer") in the hypermarket industry, while the supplier is The supplier in the case study sells foods and beverages to the buyer with the credit term and utilize the SCF scheme provided by the funder to improve working capital. Due to the non-disclosure agreement, this thesis does not disclose the organization names of the involved parties and keep them anonymous.

In order to clearly evaluate the tangible benefits of blockchain technology in SCF, we apply the same data from SCF arrangement among the supplier, the buyer, and the funder in all three scenarios. While the 1st scenario or the traditional SCF arrangement is the real-world case that they implement, the 2nd and 3rd scenarios are created based on the assumptions as explained in section 5. Given that the same financial terms and financial conditions of involved parties are applied, the set of the fixed parameters for each scenario is similar, while the control parameters vary from scenario to scenario. The fixed parameters include A, D, R_s, R_b, R_{scf}, T_{ini}, and T_{ext}, and the control parameters include T_i and F_i. Among the raw data, we extracted only the necessary data of fixed parameters for the cost-benefit model. For control parameters, we estimate control parameters based on the operating processes proposed in white papers and interviews with experts. In summary, the parameters for all three scenarios are shown in Table 2.

Table 2: Fixed and control parameters for 3 scenarios

Parameters	Unit	Scenario 1	Scenario 2	Scenario 3
A	$	302,114	302,114	302,114
D	%	95%	95%	95%
R_s	% / year	7.159%	7.159%	7.159%
R_b	% / year	4.659%	4.659%	4.659%
R_f	% / year	1.750%	1.750%	1.750%
R_{scf}	% / year	4.659%	4.659%	4.659%
T_{ini}	Days	30	30	30
T_{ext}	Days	20	20	20
T_i	Days	10	5	1
F_i	% / Transaction	-	0.699%	0.699%

Result and discussion

We then applied these parameters in 3 different scenarios in our proposed cost-benefit model to see determine what is the net value of implementing blockchain-based SCF solution. There are four key findings.

To begin, the first key finding from the analysis is that blockchain technology increases the total net benefits of SCF solution. The individual and total net benefits are shown in Table 3. To illustrate this in the real-world situation, if involved parties converted from the SCF solution using a traditional invoice (scenario 1) to the SCF solution using smart contract (scenario 2) and to SCF solution using blockchain-based & IoT platform (scenario 3), the total net benefits for involved parties would increase $210.88 or 13% and $391.15 or 24% respectively.

Table 3: Benefits to involved parties

Result	Scenario 1		Scenario 2		Scenario 3	
Benefit to Supplier	$	393.16	$	354.09	$	410.74
Benefit to Buyer	$	771.19	$	771.19	$	771.19

Benefit to Funder	$ 457.42	$ 571.77	$ 663.25
Benefit to Platform	$ -	$ 144.60	$ 167.73
Total net benefit	$ 1,621.77	$ 1,841.65	$ 2,012.92

The second key finding is that the benefit allocation of supplier and the buyer decreases, while that of funder and platform provider increases from blockchain technology. The summary of benefit allocation among involved parties in each scenario is shown in Table 4.

Table 3: Benefit allocation

Result	Scenario 1	Scenario 2	Scenario 3
%Supplier	24.24%	19.23%	20.41%
%Buyer	47.55%	41.88%	38.31%
%Funder	28.20%	31.05%	32.95%
%Platform	0.00%	7.85%	8.33%
Total net benefit	100.00%	100.00%	100.00%

The third key finding is that, unlike other parties, the supplier is the only party whose net benefit might be either positive or negative. This is because the platform fee that they have to pay might outweighs the benefit they earn in terms of unlocked working capital. We calculated the break-even platform fee (F_i) given each T_i as shown in Figure 2.

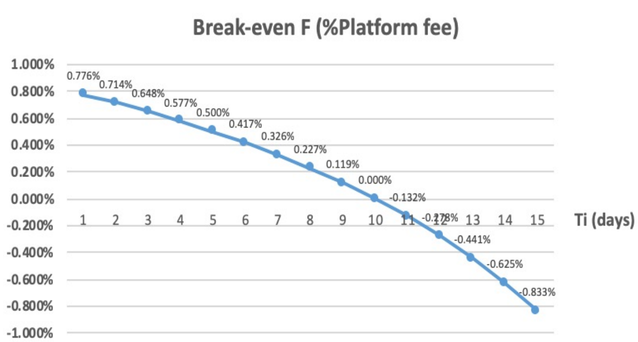

Figure 2: Breakeven platform fee

The fourth key finding is that the buyer does not gain benefits from unlocked working capital from faster processes through blockchain technology. To elaborate, with blockchain technology in scenario 2 and 3, the duration between the day that the invoice is created and the day that the supplier gets the funding is reduced. However, the duration does not affect the benefit to the buyer, which instead depends on the extended due date for the buyer to pay the invoice.

Conclusion

Understanding the costs and benefits of implementing blockchain-based SCF solution is crucial for businesses. We developed a cost-benefit model to quantify a net value of implementing blockchain-based SCF solution and proposed operating processes for analyzing the parameters used in the model in 3 scenarios. We also applied the real-world case study to showcase the calculation from our cost-benefit model. The results presented in this thesis suggest that blockchain technology might increase the total net benefit of involved parties in SCF as a result of improved efficiency of invoice processing.

Considering the supplier's point of view, they would enjoy the benefit if the amount that they pay for the platform fee is less than the benefit from unlocked working capital that they earn. Therefore, the supplier needs to carefully consider the platform fee that they have to pay, whether the net benefit that they gain makes sense financially.

From the buyer's point of view, they do not directly benefit from unlocked working capital through blockchain technology. As the buyer is the important party in the SCF arrangement who usually initiates and facilitate the SCF deal between the supplier and the funder, the buyer might use bargaining power to negotiate the extended due date with the funder, so that they can earn benefits from switching from the traditional to blockchain-based SCF solution.

From the funder's perspective, given that the financial conditions with the supplier and the buyer is similar among scenarios, they gain more money from a longer duration of financing due to shorter processing time from blockchain technology. I

Regarding the blockchain-based platform provider perspective, they directly benefit from the platform fee paid by the supplier. Given that the supplier is able to calculate the benefits arise from blockchain technology and the break-even point as shown in this thesis, the platform provider might consider setting the platform fee at a lower value than the break-even point to attract the supplier to use the blockchain-based SCF platform.