

## Factors Affecting Supply Chain Finance Decision for Actors in Agro-food Industry: A Study on Bangladesh Economy

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### Abstract

Supply chain finance (SCF) refers short-term loans, selling inventories, or technological assistance from internal or external actors of a chain. SCF is used to optimize financial flows and strategic co-operation among actors. The objective of the study is to identify factors that affect supply chain finance decisions in the agro-food industry of Bangladesh. Theoretically, this study intensively explains global supply chain finance of agro-food industry from three perspectives: in the context of time of operations, actors' involvement, and through financial derivatives. In this regard, the transformation of SCF instruments into financial derivatives is a new dimension in the agro-food chain. For quantitative analysis, this study explains supply chain finance is a dependent variable. The primary data of twenty-one variables and 120 actors of agro-food industry are randomly collected from five big divisions of Bangladesh. This study uses a multiple regression model to identify the significant factors of selecting supply chain finance strategies. The finding of this study has a mixed outcome and in most cases, are aligned with previous studies. The results of this study infer that sixteen variables have a significant effect on selecting supply chain finance decisions of chain actors, e.g. legal form of business, family employment, price challenges, societal challenges and entrepreneurial challenges, and food science training. To accomplish the objective, all the analysis are done through descriptive statistics and multiple regression model using statistical package 'R' (version 3.6.1) through car and fit package. This study covers only supply chain finance instruments of chain actors for agro-food industry and from demand perspective. Consequently, this result is irrespective of general and other actors' strategies and their individual decision-making.

**Keywords:** Supply chain finance, Agro-food industry, Derivatives in agro-food chain.

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### I. Introduction

Supply chain finance (SCF) refers short term loans, selling inventories or technological assistances from internal or external actors of a chain. SCF is used to optimise financial flows and strategic co-operation among actors. It helps to continue operations, productions, sales and distributions within a chain. SCF is important in food-retailers because generating profit and finance flows in food chain take a long time. During this time, actors need SCF to manage working capital and to survive in financial instability (EU, 2017). Moreover, SCF from chain actors has become an important solution after the economic crisis of 2008, because conventional loan of financial institutions receded drastically (Blome & Schoenherr, 2011). Globally agro-food value chain had total value of \$5.5 trillion and contributed to total profit pool of \$ 700 billion in 2018 (KPMG International, 2018) but financial constraints remain pervasive within limited sources (World Bank, 2018). In developing countries perspective, agro-food value chain is an ultimate instrument for poverty reduction (World Bank, 2008) and a source of self-sustaining income for farmers and traders (Chauffour & Malouche, 2011). In 2011, organic food scandal in Italy (Whitfill & Net, 2011), horsemeat scandal in 2013 (Barnard & O'Connor, 2017) and ongoing concern of food certification authority (e.g. EFSA), agro-food value chains are looking for more transparency and superiority (Trienekens et al., 2012). Furthermore, SCF is quite essential in different food industries due to uneven market power in the chain (Isakson, 2014). All the food-agents do not have same creditworthiness getting formal commercial loan from banks. Sometimes, they use internal SCF instruments to protect them from market failure and imperfection in the market mechanism (fi-compass, 2014). In fact, interconnected supply chain finance ensures tight coordination among actors (Lee & Whang, 2000) and a factor of enterprise's profitability (Mithas et al., 2012). In case of Bangladesh, agro-food industry is account for 20 percent of gross domestic product (GDP). Moreover, the agro-food processing industry contributes about 8% to manufacturing output and 1.7% of GDP. In fact, the agro-processing sector in Bangladesh stood at \$ 2.2 bn in

2016, averaging a growth rate of 7.7%. However, the prevailing supply chain finance is complex and faces many challenges including logistic issues, transparency and security (Trienekens et al., 2012). In this process, managing supply chain finance is a determinant of investment decision, financing decision and efficiency (Ding, S., Guariglia, A., & Knight, J. (2013) and Guariglia & Knight, 2011). This is also important for financial performance, value enhancing component (Aktas, Croci & Petmezas, 2015) and profitability of a company (Anna Bieniasz & Zbigniew Golaś, 2011; García-Teruel & Martínez-Solano, 2007). In a conventional agro-food chain, each actor allied with one or more financial institutions to ensure efficient working capital management but each actor suffers from individual working capital cost, multiple risk, lead time and documentation cost. However, there are limited studies on the factors associated with taking supply chain finance decision in chain perspective. As such, this study addresses the determinants of selecting supply chain finance for chain actors.

## II. Literature review

A value chain is a strategic partnership between inter-dependent actors and is regarded as a source of collective competitive advantage (Christopher, 2016). It involves a reciprocal co-operation to create value for consumers and to capture value for all actors (Klibi, Martel & Guitouni, 2010; Stabell & Fjeldstad, 1998). The general purpose of value chains is to scrutinize all activities and grasp how actors are related to each other (Porter, 1985). Generally the scope of a value chain is the entire system of production, processing and marketing of a particular product from inception to finished product (Miller & Jones, 2010). Moreover, the scope may also include information and finance flows (Scholten et al., 2016). With regard to agro-food value chains, the collaboration refers to e.g. processing agents, trade intermediaries, food service companies, retailers and supporting groups such as banks or technology providers. It allows integration of various actors for instance similar scopes or similar purposes (Muiruri, 2007). The characteristics of agro-food value chain are broadly three types besides common features of a chain such as planning, innovation, governance and networking. According to Sterling et al. (2013), there are three distinctive features of agro-food value chain; i.e., Volatility, Complexity, and Scrutiny. Moreover, the study leans value chain features into supply chain finance (SCF). Though supply chain finance is a well discussed theme in research, it has no common definition (Hofmann & Johnson, 2016). All studies define supply chain finance on contextual perspectives such as timing of financing, liquidity of financing, organizational involvement (bank/NBFI) and financial engineering perspective. Definitions of supply chain finance from several studies are stated in the following table.

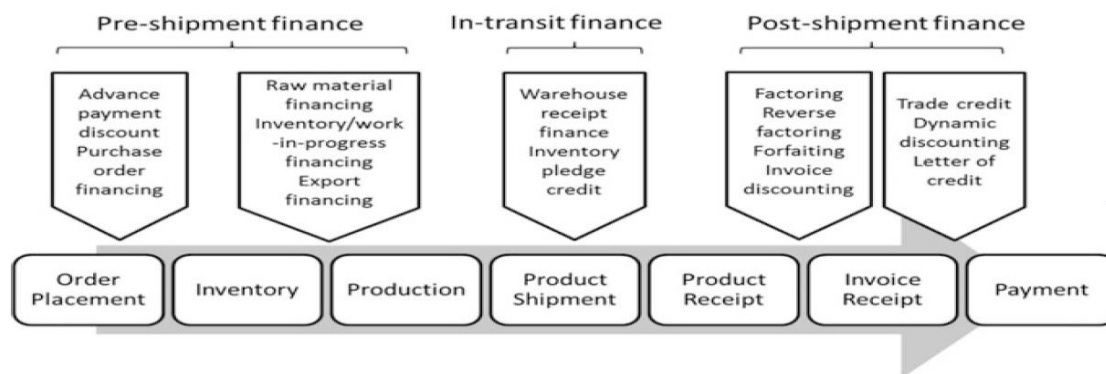
**TABLE 1: AN OVERVIEW OF DEFINITIONS OF SCF AND INVOLVEMENT OF FINANCIAL INSTITUTIONS**

Reference	Description of supply chain finance	Involvement of financial institutions
Hofmann & Belin (2011)	“This study views SC namely that financial flows are in contrast to physical flows and their related information flow along the Cash 2 Cash cycle. Thus, the optimization of company’s SCF can be considered equivalent to working capital optimization.”	Yes
Caniato et al. (2016)	A source of short term financing used to optimise financial flows in an inter organisational level through solution executed by financial institutions or technology providers where benefits rely on the cooperation among players of a supply chain.	Yes
Steeleman (2014)	“Financial used in collaboration by at least two supply chain partners and facilitated by the focal company with the aim of improving the overall financial performance and mitigating the overall risk of the supply chain.”	Yes
Euro Banking Association (2014)	The use of financial instruments, practices and technologies to optimise management of working capital and liquidity tied up in supply chain processes for collaborating business partners.	Differs on the basis of instruments

Most of these studies underline optimization of financial flows and efficient working capital management including factoring, trade credit or short term bank loans. All these instruments can be classified in terms of *time periods of operations, assets and liabilities, speed of liquidity and financial derivatives*.

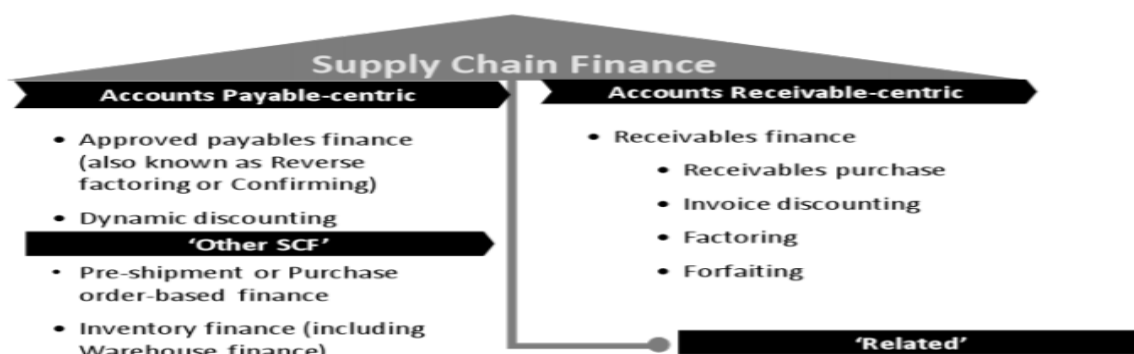
### Supply chain finance in context of time of operations

SCF is needed for any time of operations e.g. before production, during production and after production. There are various schemes of SCF and cost of these schemes also differ in terms of time. According to Zhao & Huchzermeier (2018) supply chain finance can be broadly classified in terms of time period of operations phase along supply chain finance as revealed in the following figure.



**Figure 1 :** Classification of SCF in context of time period of operations phase Source: Zhao & Huchzermeier (2018)

In figure 1, Zhao & Huchzermeier (2018) has identified three main time periods for supply chain finance i.e. pre-shipment finance, in-transit finance and post-shipment finance. These financing instruments are related to cash, invoice, inventories and account receivables. whereas the Euro Banking Association (2014) explained same instruments of supply chain finance in terms of current assets and current liabilities.

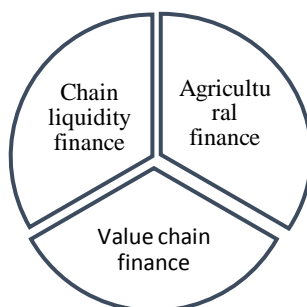


**Figure 2:** Classification of SCF in context of assets and liabilities Source: EBA (2014)

Figure 2 shows that supply chain finance are related to inventories, accounts receivables and accounts payables and these instruments (factoring, trade credit and bank loans) are used at a discount or at a cost of short term financing.

### Supply chain finance in context of actors' involvement

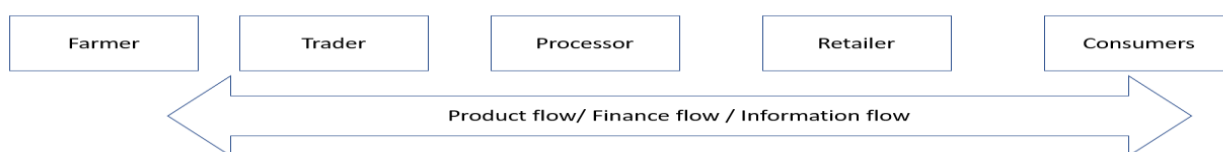
There are some SCF instruments which are similar to short term bank loans, a few are direct financing between two actors of a chain and a few are related to indirect involvement of two actors through third party. The literature of KIT & IIRR (2010) separates supply chain finance into three categories.



**Figure 3:** SCF in agro-food supply chain in context of actors' involvement source: KIT & IIRR (2010)

*Chain liquidity:* facilitates short term loan from upstream or downstream actors in a chain. These are named trade credit, chain credit or pre-finance for cultivation or harvesting (De Klerk, 2008) and bidirectional sources of SCF. Active actors of a chain take part in chain liquidity financing. It is a low cost source of SCF and ensures

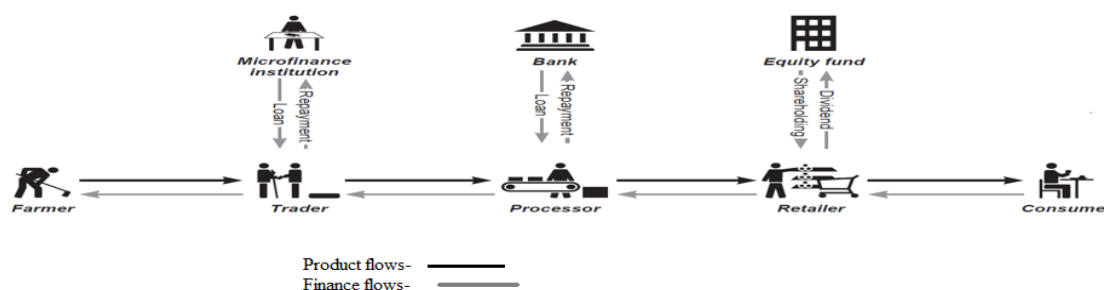
tailor-made chain efficiency (KIT & IIRR, 2010) but has a danger of dependency. Following figure is a typical chain liquidity of agro-food industry.



**Figure 4:** Example of a typical chain liquidity finance as a source of supply chain finance

In practice, actors use many financial instruments for chain liquidity. Most of these are related to operational working capital (Knauer & Wohrmann, 2013). A chain liquidity instruments of SCF are trade credit, pre-finance credit purchase order) and factoring.

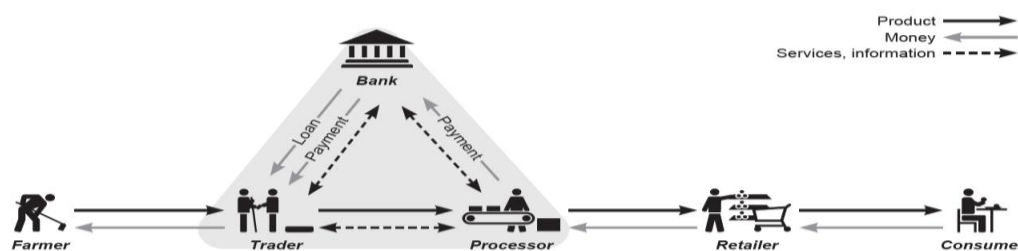
*Agricultural finance:* refers to formal and informal loans from commercial banks, nonbank financial institutions, NGOs and micro finance organizations except direct actors of a value chain. It designates external financing sources in a form of cash loans, advances, deposits or insurance (Swamy & Dharani, 2016). It has high transaction cost and less flexibility in loan agreement. Most of the actors of a chain have limited access to agricultural finance. An example of agricultural finance flow in context of developing countries is stated in following figure.



**Figure 5:** Agricultural financing flows as a source of SCF Source: <http://www.fao.org/sustainable-food-value-chains/library/details/en/c/267120/>

Figure 5 explains agricultural finance as a financial agreement between actors and financial institutions at different levels of a value chain. Though all actors have access to financial institutions, the required capital, time of financing and interest of financing are different. The common agricultural supply chain financial instruments are loans and advance, line of credit, and revolving credits.

*Value chain finance:* designates financing opportunity through one or more financial institutions using business relationship between buyers and sellers. It facilitates benefits and liquidity for all actors in a chain (Frohling, 2011). The examples of value chain finance are warehouse receipts, repurchase agreement, private equity, leasing, and reverse factoring. Moreover value chain finance consists of a few advanced financial schemes formed by trust and connected to financial institutions. KIT & IIRR (2010) figured out value chain financing process that stated in figure



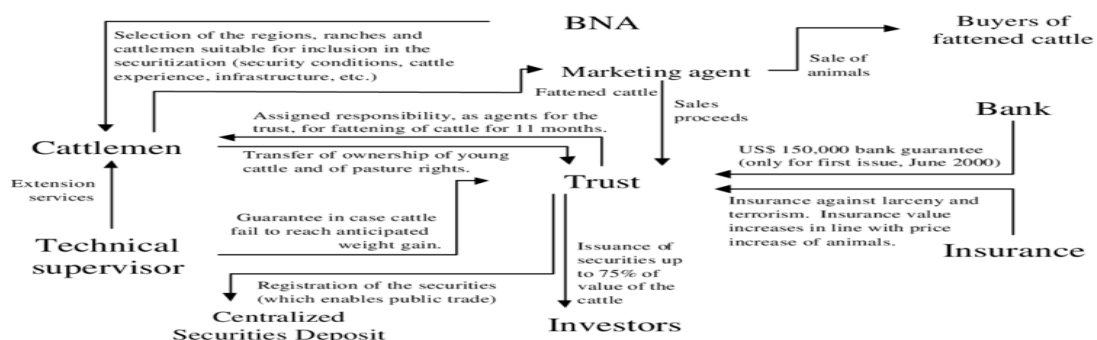
**Figure 6:** Value chain financing process as a source of SCF Source: KIT & IIRR (2010)

In figure 6, financial institution is connected to two actors in a value chain and bank incorporates the flows of finance and information but products are transferred within active actors. Common practising value chain financing instruments are reverse factoring, dynamic discounting and vendor managed inventory.

**Supply chain finance through financial derivatives**

Financial derivatives refer to a formal contractual agreement among two or more parties and value is agreed upon on a underlying financial assets or set of assets. Many financial derivatives are used as instruments of supply chain finance in different countries. A few practical example of financial derivatives are explained.

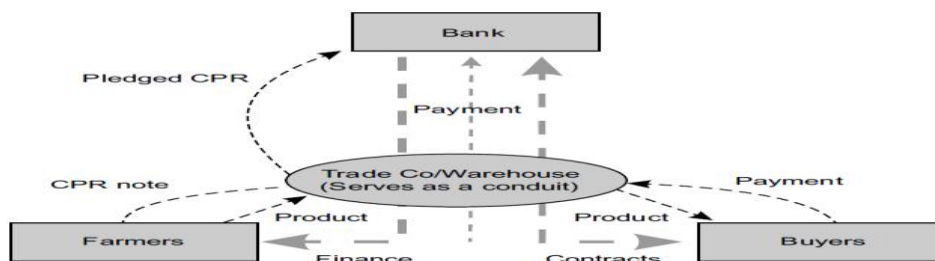
*Securitization:* Securitization is a process of pooling assets and transforming these assets into a security. It is a contractual debt obligation and a structured financing technique where cash flows are pooled and sold in capital market to potential investors (Millar & Jones 2010). National Agriculture and Livestock Exchange (BNA) of Colombia established a securitization scheme where securities of cattle are able to be registered and traded in national Stock Exchanges where actors have chance of excessive leveraging opportunity at minimum regulations for securitization. As such, securitization has the potential as a supply chain financing source in agriculture. In the following figure securitization process for Colombian cattle is explained.



**Figure 7:** Securitization process of livestock goods at BNA (National Agriculture and Livestock Exchange), Colombia Source: UNCTAD secretariat (2002)

*Insurance and Hedging:* Production risk, price risk and credit risk are three considerable risks in supply chain finance (Miller & Jones, 2010). To reduce production risk, smooth production system and access to working capital finance are very important in agriculture and to manage yield variability crop insurance, rain insurance and weather insurance are used as supply chain finance tools at specific terms and business models (Agrawal, 2007). Price hedging is also used as a tool of risk management (Aimin, 2010). In India, ICICI bank has innovated many insurance policies for farmers to cover price and credit risks and to provide immediate financing in agriculture.

*Futures and Forward Contracts:* A forward contract is a contractual apparatus to guard price variability in commodity exchange market. It is a customized contract to buy and sell a specific good or asset on a known date at a specific price between two parties (Hirsa & Neftci, 2012). Forward contracts are traded in Over The Counter (OTC) markets. In contrast, a futures contract is a standardized contract, traded on a futures exchange to buy or sell a certain underlying instrument. Futures contracts are traded in quoted stock exchange markets at low counterparty risk compared to forward contracts. In agriculture both futures and forward contracts are being used as supply chain finance and used to mitigate price risk (Mukherjee, 2011). In Brazil, a forward contract financing has been developed in agriculture as a source of supply chain finance. The following figure shows the transaction process of Brazilian forward contract in agriculture.



- > Farmer signs a CPR (a note pledging the future crop), personal guarantees and/or land in order to finance the crop production.
- > Trade Company (Co) takes the CPR and lends to the farmer against it at a discounted rate.
- > If the Trade Co is borrowing funds from banks, it will pledge the CPR to those banks.
- > Trade Co replaces the CPR with warehouse receipts in order to keep loans with banks.
- > When the crop is harvested, the farmer delivers it to the Trade Co which in turn returns the CPR to the farmer.
- > Banks perform collateral audits as needed.
- > Trade Co sells product to the market and pays the banks.

Figure 8: Forward contract process in Brazilian agriculture Source: Miller & Jones (2010)

*Loan Guarantee:* Loan guarantee is very common source of supply chain finance in agriculture. In this scheme a certain guarantee is provided by a third party to enhance financing opportunity and to mitigate lending risk. It is a conjunction of other financial instruments. In Mexico, FIRA a second tier agricultural bank provides loan guarantee to support farmers and rural investors (Chávez, 2006). FIRA is a para-financing agent which ensures formal financing for marginal farmers and investors. In the following figure transaction process of loan guarantee is explained.

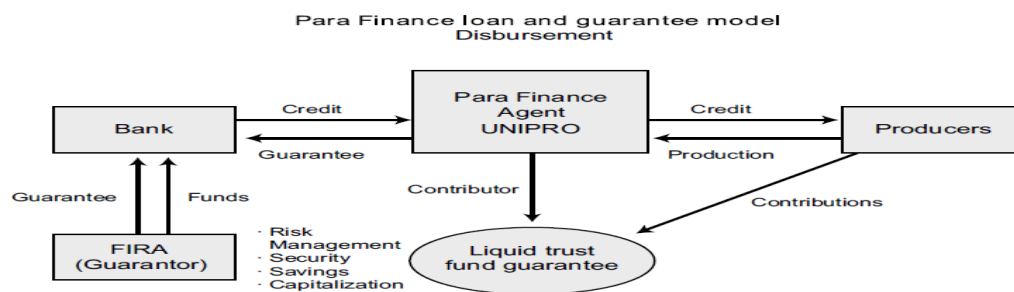


Figure 9: Loan guarantee process as a source of SCF in Mexico, Source: Chávez (2006)

*Joint Venture:* In Africa, the Actis Africa fund involve in joint venturing in agriculture. They participated across value chain and got success in value addition, market led, fund investment and decision making process (Actis, 2007). In Thailand and Indonesia, it is used as contract farming (Cahyadi & Waibel, 2015) with private and public ownership. Moreover, all these sources of short term financing are components of working capital for a value chain but have the issues of transparency, data frauds, integrity and privacy disclosure in a value chain (Ge & Brewster, 2016). In a traditional value chain, all compliances and data are monitored and audited by third parties through central database system. Value chain actors face value chain challenges to ensure their supply chain finance (Emerick et al., 2016). Potential price variation also affect desired supply chain finance for actors (Velandia et al., 2009). From previous literatures it is also evident that, financial challenges (Meuwissen, Huirne & Hardaker, 2001), production challenges (Barry & Robison, 2001), Personal and personnel challenges (Binswanger, Khandker & Rosenzweig, 1993), Institutional challenges (Nadezda, Dusan & Stefania, 2017) and Social challenges (Nick, 2004), expectation for succession (Larson et al., 2015) have significant affect on supply chain finance decision of many chain actors.

### III. Materials and Methods

This study is consist of primary data. The respondents are the chain actors of agro-food in Bangladesh. Data are collected through a structured questionnaire. The questionnaire consist of open-ended and closed-ended questions. It had two sections of data. We gathered information on demographic factors of chain actors, risk perceptions and attitudes, financial challenges related to supply chain finance. The total number of respondents are 120 actors in the Bangladesh. The data are collected during 2019 from five divisions in Bangladesh. 120 actors consist of 35 respondents from Chittagong, 32 from Dhaka, 21 from Rajshahi, 16 from Sylhet, and

remaining 16 from Khulna. The data of each division has randomly selected. The representative data sample of the study is stated in figure 10 as bar chart according to divisions.

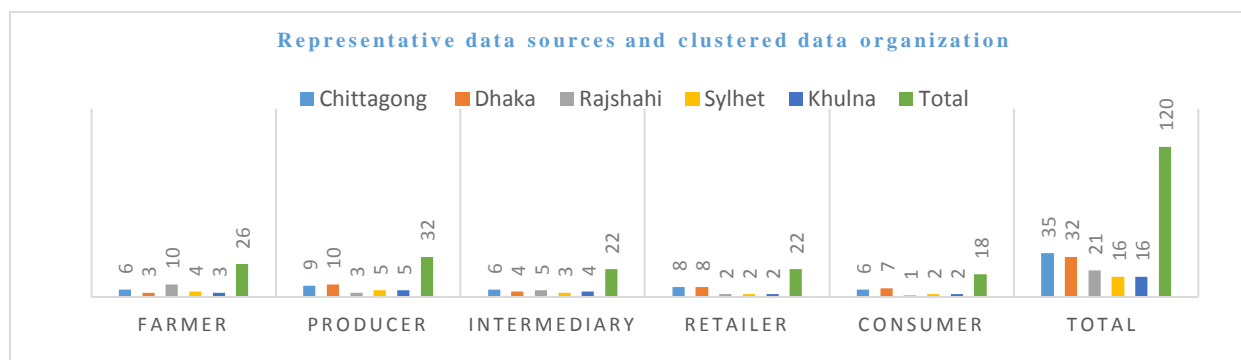


Figure 10: Representative Bar chart of collected data from Five divisions

*Data management, cleaning and organization:* This study uses self-collected dataset. The data set was consist of 21 explained variables of 150 respondents. The selection of twenty one variables is based on the literature and research design. Moreover these variables are grouped into three broad domain (i.e., actors personal characteristics, business' characteristics, financial aspect of actors). The dataset was formed on survey questionnaires with a random sampling method from mentioned five divisions. There are variety of respondents regarding size of business, types of business, ownership and their specialization. We reframed this raw dataset according to our research objectives. Firstly we derive few variables from collected data through literature and simple calculation.

*Data cleaning, Outlier and Strange observations:* Most of the explained variables of supply chain finance aspect are measured in terms of seven point Likert scale. The variables of personal characteristics and business characteristics are measured in simple numerical value and mostly are categorical variables. To identify any strange data, we detect outlier with the help of following statistical formula of outlier and the graphical identification through boxplot of the respective variables.

$$IQ \text{ (Inter Quartile)} = 3^{rd}Q - 1^{st}Q$$

$$\text{Upper fence} = \{3^{rd}Q + (1.5 * IQ)\}$$

Therefore any value greater than "Upper fence" is considered as outlier for this variable. Finally we have done the analysis from 120 respondents dataset.

*Descriptive statistics of the explained variables:* The explanatory variables that potentially influence to the supply chain finance are defined as the age, gender, education level, and other challenges faces by chain actors. The descriptive statistics independent variables of the survey questionnaire is presented in the following table.

Length of Business	Legal Forms of Ownership	Family Employment	Hired Employment	Price challenges
Min. : 1.000	Min. :1.000	Min. :0.000	Min. : 5.00	Min. :3.000
1st Qu.: 2.000	1st Qu.:1.000	1st Qu.:0.000	1st Qu.: 7.00	1st Qu.:5.000
Median : 4.000	Median :2.000	Median :0.000	Median :11.00	Median :6.000
Mean : 6.925	Mean :1.508	Mean :0.525	Mean :18.65	Mean :5.525
3rd Qu.:11.000	3rd Qu.:2.000	3rd Qu.:1.000	3rd Qu.:18.00	3rd Qu.:6.000
Max. :26.000	Max. :2.000	Max. :2.000	Max. :110.00	Max. :7.000
Value chain challenges	Financial Challenges	Production Challenges	Personal and Personnel challenges	
Min. :1.000	Min. :1.000	Min. :1.00	Min. :1.00	
1st Qu.:3.000	1st Qu.:2.000	1st Qu.:2.00	1st Qu.:3.00	
Median :4.000	Median :3.000	Median :3.00	Median :5.00	
Mean :3.767	Mean :3.892	Mean :3.55	Mean :4.45	
3rd Qu.:5.000	3rd Qu.:5.250	3rd Qu.:6.00	3rd Qu.:6.00	
Max. :7.000	Max. :7.000	Max. :7.00	Max. :7.00	
Institutional Challenges	Societal Challenges	Entrepreneurial Challenges	Technological Challenges	Regulatory Challenges
Min. :1.000	Min. :1.000	Min. :3.000	Min. :3.000	Min. :3.000
1st Qu.:2.000	1st Qu.:2.000	1st Qu.:6.000	1st Qu.:5.000	1st Qu.:4.000
Median :3.000	Median :5.000	Median :7.000	Median :6.000	Median :5.000
Mean :3.725	Mean :3.908	Mean :6.958	Mean :5.592	Mean :5.308
3rd Qu.:5.000	3rd Qu.:6.000	3rd Qu.:8.000	3rd Qu.:6.000	3rd Qu.:6.000
Max. :7.000	Max. :7.000	Max. :10.000	Max. :7.000	Max. :7.000
Business Challenges	Cultural Challenges	Gender	Expectation for the Succession	General Education
Min. :1.00	Min. :1.000	Min. :1.0	Min. :1.000	Min. :2.000
1st Qu.:3.00	1st Qu.:4.000	1st Qu.:1.0	1st Qu.:2.000	1st Qu.:4.000
Median :5.00	Median :6.000	Median :1.0	Median :2.000	Median :4.000
Mean :4.25	Mean :5.042	Mean :1.1	Mean :2.142	Mean :4.158
3rd Qu.:5.00	3rd Qu.:6.000	3rd Qu.:1.0	3rd Qu.:2.000	3rd Qu.:5.000
Max. :7.00	Max. :7.000	Max. :2.0	Max. :5.000	Max. :5.000
Food science Training	Age			
Min. :1.000	Min. :20.00			
1st Qu.:2.000	1st Qu.:31.00			
Median :2.000	Median :37.00			
Mean :1.942	Mean :37.07			
3rd Qu.:2.000	3rd Qu.:41.25			
Max. :2.000	Max. :67.00			

Figure 11: Descriptive summary of twenty one explained variables

**Multi-collinearity test:** Before doing final multiple regression model by the selected twenty one variables, we check the co-relation coefficient of all these variables. A condition index was used to detect correlation (Belsley, Kuh & Welsch 1980). We could not find any strong positive or negative co-relation among the explanatory variables. The co-relation coefficient matrix of the explanatory variables are within,  $r = 0.1$  to  $0.5$ . Moreover, we also identify the Variation Inflation Factor (VIF) for each explanatory variables of this study.in the figure 12 Contrarily by the suggestion of Menapace, Colson & Raffaelli (2013) and van Winsen et al. (2014). We presume that if the value of VIF is  $> 10$  than we decide, there is multi-collinearity among the explanatory variables. In this dataset all the value of VIF is,  $< 7.5$ .

```

> car::vif(fit)
Supply_Chain_Finance$`Length of Business`      2.516965
Supply_Chain_Finance$`Family Employment`      2.847578
Supply_Chain_Finance$`Price challenges`        3.521714
Supply_Chain_Finance$`Financial Challenges`    3.320564
Supply_Chain_Finance$`Personal and Personnel challenges` 6.705614
Supply_Chain_Finance$`Societal Challenges`    7.313218
Supply_Chain_Finance$`Technological Challenges` 3.952151
Supply_Chain_Finance$`Business Challenges`    3.961047
Supply_Chain_Finance$`Gender`                 1.816328
Supply_Chain_Finance$`General Education`      3.058808
Supply_Chain_Finance$`Age`                   1.925136
Supply_Chain_Finance$`Legal Forms of Ownership` 3.059723
Supply_Chain_Finance$`Hired Employment`      4.333583
Supply_Chain_Finance$`value Chain Challenges` 2.054460
Supply_Chain_Finance$`Production Challenges`  2.936695
Supply_Chain_Finance$`Institutional Challenges` 3.105383
Supply_Chain_Finance$`Entrepreneurial Challenges` 2.249609
Supply_Chain_Finance$`Regulatory Challenges`  2.427899
Supply_Chain_Finance$`Cultural Challenges`    5.995669
Supply_Chain_Finance$`Expectation for the succession` 2.042961
Supply_Chain_Finance$`Food science Training`  2.088767
    
```

Figure 12: Summary of Variation Inflated Factor of twenty one independent variables

### Empirical model and Result

The proposed methodology derive insight on the actor's personal characteristics, socio-economic challenges that lead to the decision of supply chain finance. For the derivation of insight, empirically the following model can be specified;

$$\left\{ Y_i = \alpha + \beta X + \epsilon_{i1} \right\} \quad \left[ 1 \right]$$



$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + \beta_{17} X_{17} + \beta_{18} X_{18} + \beta_{19} X_{19} + \beta_{20} X_{20} + \beta_{21} X_{21} + U_i$$

Where, Y= Supply Chain Finance,  $\alpha$ =Intercept,  $\beta$ =Regression coefficient,  $X_1$  = Length of business,  $X_2$  = Legal form of ownership,  $X_3$  = Family employment,  $X_4$  = Hired employment,  $X_5$  = Price challenge,  $X_6$  = Value chain challenge,  $X_7$  = Financial challenge,  $X_8$  = Production challenge,  $X_9$  = Personal and Personnel Challenge,  $X_{10}$  = Institutional challenge,  $X_{11}$  = Societal challenge,  $X_{12}$  = Entrepreneurial challenge,  $X_{13}$  = Technological challenge,  $X_{14}$  = Regulatory challenge,  $X_{15}$  = Business challenge,  $X_{16}$  = Cultural challenge,  $X_{17}$  = Gender,  $X_{18}$  = Expectation for the succession,  $X_{19}$  = General education,  $X_{20}$  = Food science training,  $X_{21}$  = Age,  $U_i$  and  $\epsilon$  = is the error term. The hypothesis can be tested by running an independent multiple regression models by assuming that the unknown parameters that to be estimated and  $\epsilon_{ij}$  is the unobserved error term. Assuming the error terms across supply chain finance decision of a chain actors are normally distributed with mean equal to zero. We estimate the model using in R (version 3.6.1) through car and fit package. The final outcome of the model has been displayed in the figure 13 and detailed R code of each analysis is stated in the appendix.

```

Coefficients:
(Intercept)                -17.701415  2.719480  -6.509 3.23e-09 ***
Supply_Chain_Finance$`Length of Business`    0.010702  0.022232  0.481 0.631305
Supply_Chain_Finance$`Legal Forms of Ownership` -0.778760  0.301376  -2.584 0.011241 *
Supply_Chain_Finance$`Family Employment`      0.721166  0.178100  4.049 0.000103 ***
Supply_Chain_Finance$`Hired Employment`       0.044296  0.008695  5.094 1.70e-06 ***
Supply_Chain_Finance$`Price challenges`       0.774097  0.140019  5.529 2.68e-07 ***
Supply_Chain_Finance$`Value chain Challenges`  0.028016  0.077893  0.360 0.719863
Supply_Chain_Finance$`Financial Challenges`   -0.450681  0.086013  -5.240 9.23e-07 ***
Supply_Chain_Finance$`Production Challenges` -0.193863  0.077112  -2.514 0.013564 **
Supply_Chain_Finance$`Personal and Personnel challenges` 0.595637  0.116522  5.112 1.58e-06 ***
Supply_Chain_Finance$`Institutional Challenges` -0.413937  0.087161  -4.749 6.98e-06 ***
Supply_Chain_Finance$`Societal Challenges`    0.468441  0.105409  4.444 2.33e-05 ***
Supply_Chain_Finance$`Entrepreneurial Challenges` 0.207337  0.081872  2.532 0.012915 *
Supply_Chain_Finance$`Technological Challenges` 0.748059  0.159108  4.702 8.45e-06 ***
Supply_Chain_Finance$`Regulatory Challenges` -0.054744  0.134441  -0.407 0.684753
Supply_Chain_Finance$`Business Challenges`   -0.749266  0.110946  -6.753 1.03e-09 ***
Supply_Chain_Finance$`Cultural Challenges`    0.114514  0.125894  0.910 0.365262
Supply_Chain_Finance$Gender                  1.469498  0.386949  3.798 0.000253 ***
Supply_Chain_Finance$`Expectation for the Succession` 0.737003  0.165268  4.459 2.19e-05 ***
Supply_Chain_Finance$`General Education`     1.021608  0.166706  6.128 1.86e-08 ***
Supply_Chain_Finance$`Food science Training` 1.997534  0.531148  3.761 0.000288 ***
Supply_Chain_Finance$Age                    0.034429  0.014647  2.351 0.020745 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.9436 on 98 degrees of freedom
Multiple R-squared:  0.7594,    Adjusted R-squared:  0.7078
F-statistic: 14.73 on 21 and 98 DF,  p-value: < 2.2e-16
    
```

Figure 13: The final output of the regression model through statistical package R

Figure 13 reports estimated marginal effects on the probabilities of each variable. For continuous independent variables, marginal effect measures the change of probability given a one unit change of independent variable, holding all other variables remain constant. From this analysis, it is clearly evident that, the selected explained variables represent 70% variation of the dependent variable; supply chain finance. Therefore, almost all the explained variables have significant effect on selecting supply chain finance decision for agro-food chain actors, except; cultural challenges, regulatory challenges, value chain challenges, and length of business and so on. As personal characteristics age, food science training and gender have significant positive effect on supply chain finance. For example, under, 'food science training', the estimate of 1.99 for supply chain finance' suggests that for one unit increase in food science training' score, the multiple logistic coefficient for supply chain finance decision will increase by that amount; 1.99. In other words, if food science training increases one unit, the chance of using supply chain finance are high. In other way around, Meraner & Finger (2019) explained food science training are more likely to focus on on-farm risk management tools not on supply chain finance decision. The result of general education and training of this study is align with the finding by Meraner & Finger (2019) and they explained the effect of training on on-farm risk management strategies and investment decision of actors. However, the findings of this study is not into line with the findings by Velandia et al. (2009). In case of entrepreneurial challenges, it has significant positive impact on supply chain finance. However, production challenge has significant negative effect of selecting supply chain finance decision for chain actors; that means the supply chain financing for sole proprietorship, partnership and other forms are not similar to all. This finding also confirms findings by Meuwissen, Huirne & Hardaker (2001), Winsen et al. (2016), Flaten et al., (2005), Saqib et al., (2016) but it was only on farm level supply chain finance decision.

#### IV. Discussion and Conclusion

This study describes supply chain finance (SCF) in a holistic way because it designates SCF not only as a short-term financial instrument but also describes features, cost, relationship, and bottlenecks of each supply

chain finance (details in appendix 2). The literature review section has deliberated intensively supply chain explains supply chain finance of agro-food chain from three perspectives: in the context of time of operations, actors' involvement and through financial derivatives. The transformation of SCF instruments into financial derivatives is a new dimension in agro-food chain. Financial derivatives of agro-food chain are traded as enlisted stocks in many stock exchanges (e.g. forward contract in Brazil, securitization in Serbia and loan guarantee in Mexico). However, the effectiveness of these stocks is challenging due to proper regulation, oversight, and excessive leveraging. SCF design can be classified into two categories; internal SCF (i.e. account receivables, account payables, and inventories financing) and external SCF (i.e. direct bank payment obligation). In this regards, the quantitative aspect of the model concludes that most of the explained variable plays role in selecting supply chain finance decision. As the value of the adjusted r-square is more than 0.25, we can say that the fitted model largely explains the selected variables from social science perspective. Besides, this study covers only 120 respondents which are not appropriate sample against total population of agro-food industry. However, selected 120 respondents are from main cities of the country; Bangladesh. Finally, Further research is needed to get comprehensive results on the decision of selecting supply chain finance through a dynamic model. This study describes various SCF instruments but does not suggest any specific supply chain finance source as the best instrument, because the managerial decision of the actors decides the appropriate instrument for them. This study also infers that the actors of agro-food chain need to pay attention to manage these factors. However, it has been professed that outcomes of the scenarios are not the rigid outcomes for all situations as illustrated by this study. These outcomes prevail whenever subjective risk factors, risk attitudes of chain actors are not affecting supply chain finance decision. There might have different outcomes and scenarios whenever actors adopt other assumptions.

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[worldbank.org](http://worldbank.org)

**Appendix 1: Analysis of Variance table**

```
> anova(fit)
Analysis of Variance Table

Response: Supply_Chain_Finance$`Supply Chain Finance`

Df Sum Sq Mean Sq F value Pr(>F)
Supply_Chain_Finance$`Length of Business` 1 55.025 55.025 61.8053 5.000e-12 ***
Supply_Chain_Finance$`Legal Forms of Ownership` 1 2.296 2.296 2.5790 0.1115103
Supply_Chain_Finance$`Family Employment` 1 6.517 6.517 7.3200 0.0080433 **
Supply_Chain_Finance$`Hired Employment` 1 11.468 11.468 12.8814 0.0005203 ***
Supply_Chain_Finance$`Price challenges` 1 0.351 0.351 0.3941 0.5316227
Supply_Chain_Finance$`value Chain challenges` 1 3.471 3.471 3.8986 0.0511416 .
Supply_Chain_Finance$`Financial challenges` 1 63.983 63.983 71.8668 2.405e-13 ***
Supply_Chain_Finance$`Production Challenges` 1 4.004 4.004 4.4974 0.0364703 *
Supply_Chain_Finance$`Personal and Personnel challenges` 1 0.084 0.084 0.0939 0.7598666
Supply_Chain_Finance$`Institutional challenges` 1 34.787 34.787 39.0735 1.064e-08 ***
Supply_Chain_Finance$`Societal challenges` 1 5.987 5.987 6.7244 0.0109662 *
Supply_Chain_Finance$`Entrepreneurial challenges` 1 0.594 0.594 0.6674 0.4159398
Supply_Chain_Finance$`Technological Challenges` 1 0.262 0.262 0.2942 0.5887702
Supply_Chain_Finance$`Regulatory Challenges` 1 0.021 0.021 0.0234 0.8787330
Supply_Chain_Finance$`Business Challenges` 1 22.476 22.476 25.2451 2.272e-06 ***
Supply_Chain_Finance$`Cultural Challenges` 1 13.515 13.515 15.1806 0.0001787 ***
Supply_Chain_Finance$Gender 1 6.327 6.327 7.1063 0.0089854 **
Supply_Chain_Finance$Expectation for the succession` 1 6.920 6.920 7.7727 0.0063719 **
Supply_Chain_Finance$General Education` 1 21.658 21.658 24.3261 3.323e-06 ***
Supply_Chain_Finance$Food science Training` 1 10.677 10.677 11.9931 0.0007932 ***
Supply_Chain_Finance$Age 1 4.919 4.919 5.5255 0.0207451 *
Residuals 98 87.249 0.890

---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

**Appendix 2: Details classifications of supply chain finance from previous studies**

a)

TABLE 1. INSTRUMENTS OF CHAIN LIQUIDITY AS A SOURCE OF SUPPLY CHAIN FINANCE

Reference	Instrument	Description	Bottleneck	Cost	Relationship	Benefits
Swamy & Dharani (2016), Wuttke, Blome & Henke (2013) and Wu & Zhao (2016)	Trade credit	An arrangement of deferred payment between seller and buyer where deferred payment is allowed by seller in order to increase sales and profits which in turn having default risk (Grau & Reij, 2018)	<ul style="list-style-type: none"> <li>High default risk</li> <li>Overdue and bad debts</li> </ul>	<ul style="list-style-type: none"> <li>Financial transaction cost in a form of trade discount</li> </ul>	<ul style="list-style-type: none"> <li>Need long term trade relationship between buyer and seller</li> </ul>	<ul style="list-style-type: none"> <li>Easy transaction at the door steps for actors</li> <li>Traditionally accepted and well known by all actors of a chain</li> </ul>
De Boer et al. (2015), European Union Accounting rule 5 (2015) and EBA (2014)	Pre-finance credit (Purchase Order)	A cash in advance or a payment intended to provide to a supplier with a float. Pre-finance credit manages working capital needed for suppliers	<ul style="list-style-type: none"> <li>Depend on buyer’s willingness</li> </ul>	<ul style="list-style-type: none"> <li>Weighted Average Cost of Capital (Hofmann &amp; Kotzab, 2010; Steeman, 2014)</li> </ul>	<ul style="list-style-type: none"> <li>Buyer’s and seller’s trade relationship</li> </ul>	<ul style="list-style-type: none"> <li>Low transaction cost</li> <li>No third party commission</li> <li>More assured</li> </ul>
Chauffour & Malouche (2011) and Michalski (2008)	Factoring	A financial service of trading invoice or account receivables at a discounted price. Factoring is used to manage liquidity and to mitigate the risk of default	<ul style="list-style-type: none"> <li>High discount rate</li> <li>Seller centric</li> <li>Less customer bond</li> </ul>	<ul style="list-style-type: none"> <li>2%-5% of turnover</li> </ul>	<ul style="list-style-type: none"> <li>Buyer-Factor-seller relationship with recourse or without recourse (Zhao &amp; Huchzermeier, 2018)</li> </ul>	<ul style="list-style-type: none"> <li>Reduce cost of collection from account receivables</li> </ul>

b)

TABLE 3: INSTRUMENTS OF AGRICULTURAL FINANCE AS A SOURCE OF SCF

Reference	Instrument	Description	Bottleneck	Cost	Relationship	Benefits
Ekka, Wenner & Campion (2010) and Miller & Jones (2010)	Loans and advances	A formal loan disbursement by financial institutions in a form of cash or others at specified interest rate as a term loan which is backed by collateral or security	<ul style="list-style-type: none"> <li>Not easy access for marginal farmers or traders</li> <li>More formalities and demonstrating documents</li> </ul>	<ul style="list-style-type: none"> <li>High interest rate compare to chain liquidity (Miller &amp; Jones, 2010)</li> </ul>	<ul style="list-style-type: none"> <li>Lender and borrower relationship through a formal agreement</li> </ul>	<ul style="list-style-type: none"> <li>Uses as start-up capital</li> <li>Low flotation cost and high speed of loan transaction (Brigham &amp; Houston, 2013)</li> </ul>
Brigham & Houston (2013), Demiroglu & James (2010) and Lins, Servaes & Tufano (2010)	Line of credit	An informal financial arrangement of a customer and a bank in where bank honour maximum amount of loan a client can borrow which is secured, unsecured or demand basis	<ul style="list-style-type: none"> <li>Limited to premium customers</li> <li>Informal agreement (Brigham &amp; Houston, 2014)</li> </ul>	<ul style="list-style-type: none"> <li>Flexible interest rate in terms of relationship and designated period</li> </ul>	<ul style="list-style-type: none"> <li>Long term client-bank relationship</li> </ul>	<ul style="list-style-type: none"> <li>Dominant source of liquidity</li> <li>Lower interest rate and less formalities</li> </ul>
Sanchez-Barrios et al. (2016) and Vijaykumar et al. (2016)	Revolving credit	A special types of line of credit committed by bank where client need to pay commitment fee for unused loan and is charged interest on used loan	<ul style="list-style-type: none"> <li>Only for large firms which have huge cash inflows and outflows</li> </ul>	<ul style="list-style-type: none"> <li>Interest and a certain commitment fee</li> </ul>	<ul style="list-style-type: none"> <li>Continues transactional relationship between corporate firm and bank</li> </ul>	<ul style="list-style-type: none"> <li>Continues liquidity for firm by a legal obligation for a bank to honour funds (Hofmann &amp; Belin, 2011)</li> </ul>

c)

TABLE 4: INSTRUMENTS OF VALUE CHAIN FINANCE AS A SOURCE OF SCF

Reference	Instrument	Description	Bottleneck	Cost	Relationship	Benefits
Liebl et al. (2016), Seifert & Seifert (2011) and Wuttke et al. (2013)	Reverse factoring	An arrangement where buyer provides/manages a discounted financing from third party for supplier by grounding buyer's credibility instead of supplier's creditworthiness. Reverse factoring guarantees longer payment term without affecting long-term relationship between actors	<ul style="list-style-type: none"> <li>Depend on credibility of buyer</li> </ul>	<ul style="list-style-type: none"> <li>Average discount is 6% (Lekkakos &amp; Serrano, 2016)</li> <li>Different tax regulations</li> </ul>	<ul style="list-style-type: none"> <li>Buyer initiated relationship among buyer-bank-seller</li> </ul>	<ul style="list-style-type: none"> <li>Short cash conversion cycle</li> <li>Extra financing source for supplier</li> </ul>
Gelsomino et al. (2016) and Handayati, Simatupang & Perdana (2015)	Dynamic discounting (daily discount)	An elastic discounted financing source where buyer pays early using his excess cash in return the supplier charge overall lower cost of product or provide goods at a discounted price. This discount rate is not static for entire credit term	<ul style="list-style-type: none"> <li>Used only in post shipment financing</li> <li>Discount rate depends on supplier (Zhao &amp; Huchzermeie, 2018)</li> </ul>	<ul style="list-style-type: none"> <li>Discount = face value - trade/market value</li> </ul>	<ul style="list-style-type: none"> <li>Simple buyer-seller relationship</li> </ul>	<ul style="list-style-type: none"> <li>Early recovery for seller and short CCC</li> <li>Reduced price or higher discount for buyer by early payment</li> </ul>
Marquès et al. (2010) and Mangiaracina, Melacini & Perego (2012)	Vendor managed inventory (VMI)	A collaborative arrangement in where a supplier makes inventory replenishment decisions for its buyer, monitoring its inventory levels and making periodic resupply decisions regarding order quantities, shipping and timing (Caniato et al., 2016; Waller et al., 1999)	<ul style="list-style-type: none"> <li>Lead time based delivery</li> <li>Market demand variability</li> </ul>	<ul style="list-style-type: none"> <li>Vendor bears retailer's ordering cost while retailer bears holding cost (Bazan et al., 2014)</li> </ul>	<ul style="list-style-type: none"> <li>Trust and power based buyer-supplier's close partnership (Ragunathan &amp; Yeh, 2001)</li> <li>Relationships of consignment</li> </ul>	<ul style="list-style-type: none"> <li>Lower inventories cost</li> <li>Higher customer services</li> <li>Common replenishment period</li> </ul>

Appendix 3: Graphical display of data for theoretical distribution such as a Normal distribution

