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**A BLOCKCHAIN APPLICATION:
HOW THIS TECHNOLOGY MITIGATES INEFFICIENCIES IN THE
IMPLEMENTATION OF SUPPLY CHAIN FINANCE PROGRAMS**

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ABSTRACT

The Blockchain Technology (BCT) has become one of the most investigated technological paradigm within a broad range of industries such as financial services, healthcare and transportation. Several business-related disciplines showed their interest towards this technology, including supply chain management.

The multiple uses and configurations of BCT, are bringing experts to be more and more interested in the topic, trying to understand if this revolutionary distributed network will actually lead to a new level of security, transparency and trust.

The main purpose of this research project, issued by Supply Chain Finance (SCF) "Observatory" of Politecnico di Milano, is to spot BCT potential applications in order to improve the management, planning, control and optimization of all transaction activities and processes concerning financial flows among supply chain actors.

This study aims to answer research questions coming from literature gaps. Firstly, a theoretical study of how BCT features can mitigate inefficiencies in the implementation of SCF programs has been carried out. Then, a catalogue of innovative blockchain-based and SCF (bSCF) oriented use-cases was studied in order to understand the state-of-art of this potentially highly attractive market. Finally, the use-case analysis played an important role to confirm and validate the findings.

The research work proposes a comprehensive framework, taking advantages of both theoretical considerations and practical examples, to properly identify the uncovered connections between SCF programs and BCT features. This framework's uniqueness consists in its ability to show how the under-investigated BCT features can provide substantial value by addressing SCF programs inefficiencies.

Specifically, the ultimate goal of this thesis is to deepen the bSCF ecosystem, not only by understanding the "as-is" blockchain-based solutions, but also by providing insights about how different technology characteristics can be exploited to lower SCF barriers.

SOMMARIO

La Blockchain Technology (BCT) sta progressivamente diventando uno dei paradigmi tecnologici più studiati per via del al suo alto grado di innovazione e del suo potenziale. Diversi settori aziendali, in particolare Supply Chain Management, hanno mostrato il loro interesse nei confronti di questa tecnologia.

Grazie alla molteplicità di applicazioni e configurazioni di BCT, gli esperti hanno sviluppato un crescente interesse sull'argomento, cercando di capire se questa rivoluzionaria rete distribuita sarà effetivamente in grado di condurre ad un nuovo livello di sicurezza, trasparenza e fiducia.

Questo progetto, inserito all'interno della ricerca dell'Osservatorio Supply Chain Finance (SCF) del Politecnico di Milano, è stato realizzato per individuare le potenziali applicazioni di BCT al fine di migliorare la gestione, la pianificazione, il controllo e l'ottimizzazione di tutte le attività ed i processi di transazione relativi ai flussi finanziari tra attori della Supply Chain.

Lo studio si propone di rispondere alle domande di ricerca emerse dalle lacune della letteratura attuale riguardo l'argomento trattato. In primo luogo, è stato effettuato un attento studio teorico su come le funzionalità di BCT possono attenuare le inefficienze nell'implementazione e nell'esecuzione dei programmi SCF. Quindi, è stato raccolto un database di casi d'uso innovativi basati su blockchain e SCF (bSCF) al fine di comprendere lo stato dell'arte di questo mercato. Infine, tramite l'analisi del database i risultati sono sati confermati e convalidati.

Il lavoro di ricerca propone un quadro completo, che trae vantaggio sia da considerazioni teoriche sia da esempi pratici, per identificare correttamente le connessioni scoperte tra i programmi SCF e le funzionalità di BCT. L'unicità di questo framework consiste nella sua capacità di mostrare come le nuove applicazioni BCT, che vanno oltre lo scopo primordiale delle Cryptocurrencies, possano apportare un valore sostanziale le inefficienze delle soluzioni di SCF. Nello specifico, l'obiettivo finale di questa tesi è di approfondire l'ecosistema bSCF, non solo comprendendo le

soluzioni attualmente offerte sul mercato, ma fornendo linee guida su come le diverse caratteristiche tecnologiche possono essere sfruttate per ridurre le barriere SCF.

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1. INTRODUCTION

Digital technologies are becoming more and more important and are modifying the way people communicate with their surroundings. These emerging technological evolutions are reshaping every business, leading industrial manufacturing to a radical change. Digital industrial technology, known as Industry 4.0, is a transformation that empowers businesses to gather and analyse data improving processes, enabling faster and efficient decision making with one eye firmly focused on costs and quality performances. Supply chain is no exception.

The **data swarm** generated by supply chains is bigger than ever before and supply chain **collaborative management** will increasingly look at suppliers for innovation in processes and products and to partner on areas of mutual benefit. These inflection points represent an opportunity to drive progress in a forward-thinking supply chain and to integrate it with key forces of digital revolution. It allows SC specialists to interpret information flows in order to shape the **supply chain of the future**.

During the last decade, Supply Chain Finance became one of the major trend topics in the business environment. Born as a branch of the Supply Chain Management, it has quickly established as a self-sustained discipline, with its own and independent practices, players and researches.

Supply Chain Finance consists in a set of solutions which can be harnessed to manage financial flows, one in particular, working capital. It focused on the contribution towards enhancing enterprise value leveraging not only on company's specific business lines but also on the role it covers along the supply chain.

Nowadays it is still hard to find a uniquely recognised definition of SCF or clearly point out the boundaries of this discipline, but a general principle can still be identified:

"SCF solution are all those solutions which aim to increase the working capital along the whole supply chain".

The pace of innovation today affects every industry and shareholders needing to make profits and increase enterprise value. If properly investigated, the supply chain may distinguish fundamental information that could prove the state of health of the companies constituting the SC.

Hand-in-hand with the digitalization of operational activities, the flow of goods, information and finance are no more isolated streams across different functions and parties. The relevance of Working Capital utilization and Cost of Capital reduction is highlighted by an increasing adoption of **supply chain finance solutions**. More practically, SCF should result in the ability to create win-win solutions for both buyers and suppliers by improving liquidity and cost allocation along the value chain. Last but not least, transparency and disclosure are now a matter of common knowledge and therefore supply chains have to strengthen their business practice in order to guarantee supportive collaboration, higher performances in the global trade and higher flexibility when dealing with regulatory requirements. The initial concept provides here a foundation to close the gap between vague assumptions and practical contributions. The need of supply chains to improve transparency, accountability and trust is the input of the research. The potential value of one of the most promising and disruptive technologies, the so called Blockchain Technology (BCT), is deeply investigated to develop a solution in practical value for SCF.

2.LITERATURE REVIEW

The first step of the research is the review of the academic literature in order to get acknowledgement on the present state of art on the theme. Only after a deep learning of the present situation is possible to get a clear view of what has done and subsequently identify possible gaps on which base the objective of the dissertation. Since the broader purpose of this thesis is to join together two different fields as the Blockchain and Supply Chain finance, they are analyzed at first as two separate silos. Only in a second moment the arguments are joined together to give a first and general overlook of what are the theoretical benefits.

2.1 SUPPLY CHAIN FINANCE

2.1.1 Introduction to Supply Chain Finance

The Supply Chain Finance (SCF) is a relatively new concept, born as a branch of the Supply Chain Management. More precisely the world SCF was coined at the beginning of the 21th century when "new inter-functional and inter-organizational tasks at the intersection of logistics and finance open new supply chain opportunities" (Hofmann, 2005). In particular, after the word economic crisis of 2008, liquidity problems emerged in the majority of the business organizations, which reacted at a macro-level by looking for internal source of financing, *not so much as pure cost cutting but, rather, as recovery of flow of a typical financial nature that can help overcome the current difficult conditions created by the economic conjuncture"* (Camerinelli, 2008). In this context SCF quickly established as a stand-alone discipline with its own independent players and researches, which results in a framework of new practices broadly applicable in different industries and contexts.

The most distinguished scholar in the field agree on identifying four main pillars behind the importance of the adoption of a SCF program:

- FINACIAL REASONS: as mentioned above the word economic crisis occurred in 2008 forced basically every industry in the word to increase the efficiency and rationalize the spending in order to survive (Hofmann & Belin, 2012). Nowadays, ten years since the beginning of the crisis, the traditional financing paradigm based on letter of credit (L/C) to Open Account (O/A) appears as inadequate and financial institutions started looking at SCF solutions as new business opportunities (Hofmann and Belin, 2012).

- STRATEGICAL REASONS: the progressive importance of the supply chain in building and sustaining the competitive advantage of a firm, a phenomenon of such importance which often moved the competition from firm vs firm to supply chain vs supply chain (or value chain vs value chain). (Hofmann and Belin, 2012). Other relevant phenomenon are the dramatic reduction of the product lifecycle and the request for more product variety from the market resulting in the so call 'mass customization' practices which pushes companies in rise their flexibility levels (Seuring, 2008)

- TECHNOLOGICAL REASONS: the 4th industrial revolution, consequent to the development of new sensors, higher computational power and a general democratization of the cost of technological solution, facilitated the internal digitalization of the processes and the external sharing of information Hofmann and Belin, 2012). Electronic invoicing and payment, digital signature and web application brings major advancement in fostering transparency and collaboration, necessary to adopt a SCF program (Shafer, 2005).

- REGULATORY REASONS: regulators continuously pushes company to update their reporting practice in order to rise transparency. SCF solutions brings embedded benefits in reporting due to the standardization of the flows from buyers and supplier and, in the most innovative cases and thanks to the use of technology, easier reconciliation of the physical and information flows (Hofmann and Belin, 2012).

2.1.2 Supply Chain Finance Definition

There is a lack of a unique and unequivocal recognized definition of SCF in the academic literature (Caniato, Gelsomino, Perego, & Ronchi, 2016). Scholars provide their personal interpretation according to the perspective they assume and the aspect they wants to highlight in their papers, although a common flow and a wide set of commons principles are widely accepted and used to identify this discipline. In this paragraph different definitions are presented and analyzed in order to provide a clear idea of what IS and what IS NOT the Supply Chain Finance.

> *"Located at the intersection of logistics, supply chain management, collaboration, and finance, Supply Chain Finance 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 resources on an inter-organizational level."* (Hofmann, 2005).

This is probably the first attempt to define the SCF; Hoffman underline the necessity of a systemic approach to the discipline and put the emphasis on joint management of financial flows between two firms in order to optimize the flows at a SC level rather than at a local level.

> *"SupplyChainFinance is the inter-company optimization of financing as well as the integration of financing process with customers, suppliers, and service provider, in order to increase the value of all participating companies."* (Pfohl & Gomm, 2009)

Pfohl and Gomm underline the need for commitment of all the party involved in a transaction, in a common and canalized effort in order to have mutual benefits.

"Managing, planning and controlling all the transaction activities and processes related to the flow of cash among SC stakeholders in order to improve their working capital." (Dileep More, 2012)

More and Basu introduced in an explicit way the key role of SCF in the Working Capital optimization.

"SCF deals with financial arrangements used in collaboration by at least two supply chain partners with the aim of improving the overall financial performance and mitigating the overall risks of the supply chain" (Caniato et al., 2016)

"Mix of models, solutions, and services aiming to both optimize the financial performance and control working capital within a supply chain, exploiting a deep knowledge of supply chain relations and dynamics."
(de Boer, Steeman, Gelsomino, & Perego, 2015)

One of the latest definitions, provided by de Boer, join the statement of the previous authors: in his view strategic collaboration along the SC and WC optimization are interconnected and reciprocally affect each others. SCF assume a comprehensive role with multi-beneficial effects at inter- and intra-organizational levels.

The different perspective can be resumed in a framework that highlights SCF under three different perspectives. Each perspective differs from the others due to their focus. As a result, the first point of view is "finance oriented". It aims at improving financing performances of the companies in order to be able to sustain day-to-day activities and financial health. Secondly, the so-called buyer-driven perspective focuses its attention to C2C reduction leveraging inditcators as DSO and DPO.

Last but not least, the third phase Supply-Chain oriented, that focuses on Supply Chain C2C cycle optimization by working on all its three components: DSO, DPO and DIH.

Perspective	Focus	Reference Authors
Finance oriented	Firm financial position and capability to run the operative business; Financial institution as main intermediaries	Camerinelli; Lamoureaux and Evans;
Buyer-Driven	C2C cycle reduction with particular emphasis on DSO and DPO	Wuttke and colleagues;
Supply- Chain Oriented	C2C cycle reduction including working DSO, DPO and DIH;	Pfohl and Gomm; Hofmann and Belin; Gelsomino,Mangiaracina, Perego and Tumino

Finally, a recent and comprehensive definition has been provided by the Osservatorio of Supply Chain Finance, which is the one this dissertation proudly focus on:

"SCF can be defined as a mix of models, solutions, and services aiming to both optimise the financial performance and control working capital within a supply chain, exploiting a deep knowledge of supply chain relations and dynamics."

-Gelsomino

Once defined widely accepted definitions, here is a focus on what IS NOT field of this thesis, introducing the concept of Financial Supply Chain and Supply Chain Management, often confused with the SCF, trying to highlight the major differences:

- FINANCIAL SUPPLY CHAIN MANAGEMENT: *"is the set of the processes and information that determines the value of liquidity, the accounts and the company's working capital"* (Camerinelli E. , 2008). The focus here is on the financial flows and the set of tools used consist in software which recognise and analysis interrelated events impacting on the WC with the aim to get an efficiency increase (Rouse, 2018)

- SUPPLY CHAIN MANAGEMENT: "through SCM companies better manage their supply chain through the improved collaboration of internal departments and external trading partners" (Mentzer, 2001). This disciplines aims at increase the efficiency by improving forecast and adopting inventory reduction techniques (Hofmann and Berlin, 2011, pag 21).

Both the disciplines lack an holistic view on the whole SC adopting and internal perspective with a focus, mostly, on just one flow, the material flow in the case of SCM and the financial in the case of FSCM.

2.1.3 Supply Chain Finance Concept and Framework

2.1.3.1 Relevant flows in the Supply Chain

"When approaching the topic of SCF, the general term ''supply chain'' first needs to be specified. A supply chain is a network of partners that supplies raw materials, assembles, manufactures products and then distributes them via single or multiple distribution channels to end customers. Along this supply chain, there are three parallel flows: goods and services, information and financial" (Lambert, 2000).

Figure 1- The physical and financial Supply Chain

- MATERIAL FLOW: the flow include both products and services which are transferred along the supply chain. The main concerning of the latest years studies focused on improving the efficiency in transferring the material flow from an actor to another, empathizing the importance of synchronize the physical supply chain with the relative information and financial flows (Hofmann and Belin, 2012).

- INFORMATION FLOW: the flows include all the information related to the physical supply chain, fundable in a series of documents. Purchase orders (POs), inventory documents, confirmations and invoices have the purpose to initiate the both the material and financial flows. Digitalization and automation lead to drastic increments in the efficency of the processes, sometimes allowing for a unification of this flow with the financial one (Hofmann and Belin, 2012).

- FINANCIAL FLOW: *"The financial flows in a supply chain consist of invoices, credit notes and payments. Financial flows in a typical supply chain encompass a multitude of invoices and payments between the market participants."* (Hofmann and Belin, 2012).

In order to better contextualize the supply chain finance discipline, a framework has been created including three examined dimensions. The assets that within the supply chian has to be financed, the actors involved in the financing process and the agreements terms, known also as levers.

Figure 2- Supply Chain Finance Framework

2.1.3.2 Supply Chain Finance Objects

For what concerns the dimension objects, it includes both those fixed assets, that constitute the basis of business operating activities, and the working capital management which is connected with day-to-day operations. (Pfohl and Goom 2009) The term working capital includes all items that can be converted into liquidity assets that are involve in the cash flow circulation in the short-term.

The role of Cash2Cash cycle and Working Capital

C2C cycle = Day of Inventory Holding + Days of Sales Outstanding – Days of Payables Outstanding

Figure 3- The Cash to Cash cycle an its components

An indicators introduced for the first time by (Richards, 1980) *"indicates the time between the cash outlay and cash recovery of a company"* (Hofmann and Belin, 2012).
It is the temporal translation of the WC and it is considered among the most important indicators of efficiency along the Supply Chain (Hofmann and Belin, 2012).
The closest the value is to zero, the better are the performances of the company, able to reinvest earlier its liquidity (Weiss, 2012). Its reduction along the supply chain is mainly possible due to *"integration and automation of the material, information and financial flows"* (Camerinelli, 2008).
 "SCF offers new opportunities to members allowing free extra cash which could be reinvested by companies without requiring external financing, resulting in a better creditworthiness due

to a greater perceived financial independence, which leads to a better credit rating and lower WACC" (Hofmann and Belin, 2012).

For this reasons, the cash-to-cah-cycle is a key figure to ensure a dynamic and deterministic treatment of net working capital performances.

Working capital*= current assets − current liabilities = Account Recivables + Inventory − Account Payable*

Figure 4- The elements of woring capital

"The Working Capital (WC) is a financial metric representing the operating liquidity of a firm, comprising all those current asset items that turn into cash within one production cycle, usually coinciding with one solar year" (Manatsa, 2008).

Differently from C2C there are no target value of WC which indicates better overall performance of a firm (Hofmann and Belin, 2011) but should be carefully kept between a certain range:

- positive values increase liquidity *"since these current assets are easily convertible into cash (..) mitigating risks, but harms overall profitability because of a large capital commitment, leading to higher inventory and financing costs"*

- negative values contributes to rise profitability due to *lower funding costs"* (Hofmann and Belin, 2012) but *"harm creditworthiness and hinder refinancing"*

(Hofmann and Belin, 2012) due to lower liquidity, which lead to higher risk of stockout and loss of production.

Considering this, studies sets an optimal amount of WC as positive values very close the zero (Shulman, 1985).

Evidences shows a link between WC and the operating and financial performances of a firm. In particular Howorth and Westhead first and García-Teruel and Martínez-Solano later proved a negative correlation between C2C cycle (WC temporal translation) and the Enterprise value of a firm (Garcia-Appendini, 2013).

"According to observations, a 25% reduction in the C2C cycle of the average manufacturing company leads to an increase in the enterprise value of approximately 7.5%" (Hofmann and Belin, 2012).

Deploying the Enterprise value in its major component, it is possible to find more specific relations:

- Empirical studies confirm a link between *"a shorter C2C cycle and a higher present value of net cash flows generated by assets"* (Shin, 1998);

- *"As a company manages to shorten its C2C cycle, the release of originally locked up and idle capital increases free cash flow and thereby improves a company's internal funding ability, which facilitates sales revenue growth"* (Moss, 1993);

- C2C reduction enables *"lower costs of capital, which lead to higher returns on invested capital (direct impact) and increased operating income (indirect impact) because of lower production and operating expenses"* (Jose et al., 1996);

- Positive values of WC close to zero lead to *"better creditworthiness due to a greater perceived financial independence, leading to a better credit rating and lower WACC"* (Hofmann & Kotzab, 2010);

Figure 5- Link betwen Working Capital Management and EVA

Traditional method to improve WC can be classified in:

- methods aiming to reduce Account Receivables;

- methods aiming to extend Account Payables;

-just in time techniques aiming to reduce the amount of stock;

Exempt for the latest, the other traditional methods achieve results only at a local level, worsening the general Suppy Chain's WC conditions (Hofmann and Belin, 2012). SCF techniques instead overcome this perspective, moving the emphasis from a local level to a holistic levels, in which a reduction of WC at a SC level bring greater benefits on the single firm than an internal optimization. This theme will be analyzed in depth later on.

2.1.3.3 Supply Chain Finance Actors

According to Lambert et al, the actors involved in supply chains with a clear inclusion in the financing activities have been identified. Actors are categorized under two different group of participants: "primary members", referring to the focal company

and its corresponding suppliers and customers, and "supporting members", namely financial institutions and logistic providers. (Lambert et al)

Differently by the traditional SC domain, characterized by a waterfall sequence of Supplier – Customer relationship, the SCF environment necessary include the figure of the intermediaries (Rhian Silvestro, 2013), which differs in nature, financial – technological - operational (Hofmann & Belin, 2012) and scope. This section is dedicated to illustrate typical actors active in a SCF program and their role:

Figure 6- The market players of a SCF solution

- FOCAL COMPANY, SUPPLIERS AND CUSTOMERS: the principal beneficiaries of the SCF solutions are the companies forming the SC. In most cases, once identified a focal company, it is not enough limit the analysis to its direct customers/suppliers, but it is appropriate to involve into the solution also 2nd and 3rd tier suppliers/customers in order to extract the maximum value from the financing solution, despite an increase in the complexity of the analysis (Caniato et al., 2016).

  Any firms can be assumed as a focal company, even thought, scholars tend to identify it in their study with the larger organization in the SC, the one with a complex galaxy of supplier and international trade deals (Kristofik, 2012), due to the significance it can give to the study.

- TRADITIONAL FINANCIAL INTERMEDIARIES: banks, funds and factoring firms represent nowadays, as well in the past, the source of credit, those actors to which the firms ask for financing (Caniato et al., 2016).. But the new needs of focal firms willing to adopt a SCF program require an update in the service offered by those institutions (Camerinelli E. , 2008): Silvestro and Lustrato recognize banks as the real enablers of SCF solutions, being in contact with both customers and suppliers, playing central role in the reconciliation of documents (Rhian Silvestro, 2013); beyond this, financial institution experience and capabilities allow them to be more than a simple funder, according to Fairchild they should provide a wider spectrum of value-added service, assuming the role of ADVISORY, helping them in *"selecting the adequate solution, managing the accounting structure choosing the most convenient tax scheme and managing other delicate issues by leveraging their expertise and specialized services"* (Fairchild, 2005). Only by innovating their business models those incumbents will be able survive in this market against new innovative actors.

- ICT PROVIDERS: they play a fundamental role in the industry, enabling innovative solutions by connecting clients and supplier through digital platforms. They are represented both by traditional ICT providers with the will to penetrate a new market or completely new actors specialized in the industry. (Caniato et al., 2016). Fundamental service they provide in a SCF program includes: process of reconciliation, exchanging Purchase Orders, invoices, credit notes, payments and information, credit risk management services and legal infrastructure (D, 2009).

- LOGISTIC OPERATORS: increasingly important in the actual scenario, for the capabilities and the amount and quality of information they have to manage (Caniato et al., 2016). In some cases they directly offer solution of financing as the inventory finance (Seifert, 2011) and, according to scholars, they may assume a key role in the near future of the industry, *"expanding their scope beyond*

the pure logistic services" (Reindorp, 2014). Despite this some operators are still skeptical about enter the SCF market.

- HYBRID INTERMEDIARIES: are those actors able to provide both the infrastructure and the financial services, proposing themselves as a HUNIQUE INTERFACE for a firm, or even for an entire SC(Caniato et al., 2016). Their extremely flexible and innovative solutions are reason of interest at first for those organizations (and SC) characterized by the absence of 'big players', in which typically the access to credit is limited or absent throught the traditional financial institutions (Yan, 2013). Potentially disruptive for the industry this new actor will represents a threat for traditional actors, being specialized in the industry and facilitating the whole process for the adoption of a SCF solution. (Caniato et al., 2016).

2.1.3.4 Supply Chain Finance Levers

As mentioned before, the third dimension, called "levers" is related to the financing process and includes three different aspect: the volume of financing, the duration and the cost of capital rate. (Pfohl and Goom 2009)

Figure 7- Supply Chain Finance Cube

The model shows how the capital tied up in the delivery of a SCF solution is made of three differents components. Volume of Financing, Duration of financing and Cost of

capital rate if multiplied together would show the total cost of capital by the investment.

$$Capital\ costs\ (€)=Volume\ (€)*Duration\ (time)*Capital\ Cost\ Rate\ (\%time)$$

SCF solutions are supposed to bring a consistent advantage to the cost of capital dimension (Gomm, 2010) . When considering a supply chain as a whole, the refinements points, with higher potential, are trade finance activities and the cost of capital. Furthermore, according to Wagner, the adoption of SCF programs, being able to affect both information and material flows, would allow to lower the financing costs for all the primary actors involved (Wagner, 2008).

Nowadays, companies tend to finance inventories and asset through credit lines whose interest rates are calculated in accordance to the credit risk rating of each single company involved. (Hofmann and Belin). Due to the fact that the risk calculation is based on the general condition of the company, without taking into account the real potential of different assets, interests rate may result as overestimated. By contrast, assets should be profiled according to their corresponding risk profiles trying to identify their real business value (Swink, 2007).

In order to better understand the problem, Lee has explained that usually financial providers are not fully aware of supply chain dynamics, so they assess risk without all the information required to get a proper picture of firms which are part of the supply chain (Lee, 2010). This, futher demonstrates that the financing process for supply chain is negatively affected by information asymmetry and that financial providers should improve their risk evaluation procedures and reduce the principle agent problem. (Buzacott, 2004). The problem is related to the fact that the only actor that can leverage on the information can assess the right interest rate. The principal agent problem, through the adoption of SCF solutions can be reduced by sharing the relevant informantion with different supply chain players, trying to enhance collaborative data

sharing. A result, when considering supply chains, internal financing should be provided by the player (usually the focal company) with the lower interest rate thus, all the other actors involved would benefits a significant decrease of in the cost of capital. As a consequence, as highlighted by Caniato, supply chains can experience a better financing conditions thanks to the intermediation of the focal company the financial institutions. (Caniato et al., 2015).

2.1.4 Supply Chain Finance Solutions

Although the literature review has been developed mostly focusing the attention to the conceptual SCF ecosystem a set of alternative financing options over time has been identified by the tal "SCF solution".

In this section, the existing supply chain finance solutions will be investigated according to the classifications provided by different experts. Among the expert that have contributed to this literature review, some of them have enlarged their researches in order to design or better understand SCF solutions and programs (Wuttke, Blome, Foerstl, & Henke, 2013). The following classifications are focused on different dimensions and extremely differ each other (Osservatorio Supply Chain Finance, 2016).

The first framework has been created by Hofmann and Belin and classifies SCF solutions already available on the market according to 4 different variables: geographical boundaries, payments methods, actors involved and type of platform used. (Hoffman, Belin).

Geographic boundaries	Payment methods	Market players	Platform types
▪ Domestic ▪ Cross-border	▪ Letter of credit ▪ Open account	▪ Focal compay ▪ Supplier / buyer ▪ Funder / risk taker ▪ SCF service provider	▪ L/C & O/A platforms ▪ Risk mgmt systems ▪ Third-party financing platorms

Figure 8- Segmentation criteria of SCF solutions

A second classification has been mad by Lamoureaux and Evans, in which three dimensions have been identified: pre-shipment financing, in-transit financing and post-shipment financing.

Pre-shipment Financing: Raw Material Financing Purchase-order Financing

In-Transit Financing: VMI Financing In-Bound & Out-Bound Inventory Financing

Post-shipment Financing: Receivables Financing Early-Payment Discount Programs

Figure 9- : Classification of SCF solutions (Lamoureaux & Evans, 2011)

Pre-shipment financing: it includes solutions usually required by suppliers. These solutions, focus on purchase orders as guarantors of refunding and not using invoices. As a result, this programs are also known as purchase-order financing activities. The solution accuracy is related to reliability of all the actors composing the supply chain, including banks, suppliers and financial institutions (Camerinelli E. , 2008) (More, 2013) (Silvestro & Lustrato, 2014).

In transit inventory financing: these SCF programs allow firms to access financing through the exploitation of inventories that behave as a collateral. In-transit inventory financing activities are really innovative and require advanced collaboration among

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actors to work as excpected. This group of solutions includes VMI and inventory financing are designed to sustain in-bound and out-bound activities (Lamoureaux & Evans, 2011). This group also comprises initiatives in which, initially, collaterals might be in possess of third party (financial institutions or logistic providers). (Silvestro & Lustrato, 2014).

Post-shipment financing: This group includes the most adopted solutions. Sometimes, in this solutions the buyer pays back the debt. Post-shipment financing practices are designed and delivered through a ICT platform able to automatize records and transactions. Due to the high number of actors involved and to the recurrent nature of such practice, cash exchanges can be automated as well. Receivable financing and Reverse Factoring are included in this group. (Silvestro & Lustrato, 2014) (Lamoureaux & Evans, 2011).

The third framework, presented by Osservatiorio of Supply Chain Finance– PoliMi shows different solutions of SCF considering 3 main dimensions: the impact on working capital considering the actors involved, the degree of digitalization required, and the level of innovation.

Figure 10-Classification of the SCF solutions

The vertical axis dimension shows on which components of the WC the solution have an impact, in particular it is possible to recognize two main blocks:

- BALANCING OF ACCOUNT PAYABLE AND ACCOUNT RECIVABLES: are solutions which aim at optimizing the amount of WC along the SC and decrease the cash-to-cash cycle. Some studies show that through this optimization is possible to reduce the overall level of working capital in the supply chain. Among those solutions a further classification is possible among thosesolution carried out by traditional financial intermediaries and those innovative solution provided by New Comers;

- INVENTORY REDUCTION: solutions which aim at optimizing the stock level rising the collaboration and the information sharing in the relation customer/supplier;

The horizontal axis account for two different dimension directly related among each other, the INNOVATION LEVEL and the RESORT TO DIGITALIZATION:

- TRADITIONAL SOLUTIONS: powered by financial intermediaries, are all those solutions offered on the market by years and widely known and used by organizations. The role of technology is not determinant, but it helps in rising the performance and for this reason the processes behind this solutions have been adapted over the years to include a wider use of technological interfaces;

- INNOVATIVE SOLUTIONS: powered by new actors and often provided through a platform, includes a spectrum of emerging and already established solutions which overcome the traditional ones in terms of time, cost and managerial effort. In these cases the resort to technology is the real enabling factor, without whom would be impossible to adopt this solutions.

Given the novelty a unique definition, along with a standardized provision of the service, lack

Supply chain finance solution are many and different, since is not possible, nor useful, to define every one of them, this phase focus on the most popular, adopted and useful among both traditional and innovative solution

2.1.4.1 Factoring

- FACTORING is one of the most popular and mature solution, typically used to finance ordinary goods. An enterprise signs a contract with the 'Factor', typically a bank, to sell it its account receivable in exchange for immediate liquidity (Camerinelli, 2008) corresponding to the amount of the invoice deducted by a certain fee (80- 90% of the invoice nominal value). The Factor assume the credit risk of the debtor and "receive cash as debtor decides to settle its account payable" (Rhian Silvestro, 2013) and discount applied on invoice' s value represent the remuneration for the service provided. In particular two type of factoring can be recognized: 'with recourse' which, in case the customer does not fulfill its account payable, allow the factor to ask the payment of the invoice to the supplier, and 'without recourse' in which of course the services delivered have an higher cost due to the higher risks it incur in.

  It' s popularity is given by the easiness of the solution, nevertheless the digitalization of the process can reduce the costs (and so the fees), the lead time and, most important, the risks for the bank, opening the solution to smaller enterprises with no credit access until now (Di, Rapporto, & Rapporti, 2015).

- REVERSE FACTORING: it is used in the situation of a big clients with a large portfolio of small suppliers (Di et al., 2015) In this case the entity which sign the contract with the bank is the client, which use its credit rating, reasonably lower than the one of its suppliers, to finance its orders (Pezza, 2011) .In this way, the

smaller entities are allowed to finance expensive orders at a lower cost, relying on to the reputation and the securities guaranteed by their client, while the client can benefit of higher service levels, in terms of quality and lead time, and increase its free cash flow useful to finance, for example, a new established division.

The popularity of this solution is fast growing, since it is offered directly by both banks and specialist providers (Williams, 2010).

- ADVANCED REVERSE FACTORING: It is an innovative form of reverse factoring which include in the solution an intensive use of technology, typically sensors and a platform supporting the supply chain processes, in order to extract data from the relation supplier/customer. In this way, the amount of information available can be increased and consequently the financing can be released at a lower risk and at a lower cost.

As mentioned the need for technology is fundamental for implementation of this solution, so the relation between the parties have to be long-term oriented in order to make profitable an investment in that sense.

There are different configuration of this solution involving different actors: as sad a platform provider is necessary along with a financial provider, typically a bank. A particular case is when the platform provider assumes also the role of factoring, managing the financial flow to the suppliers.

A further evolution reckons on a financial institute different by the bank as a factor; in this case this actor act as the guarantor of the transaction, managing the financial flow to the suppliers and dividing it in tranche in order to work as compensation chamber. This entity requires full visibility on the processes of the SC (Di et al., 2015).

2.1.4.2 Inventory Finance

Inventory Finance is a form of financing using the actual stock as collateral and performed by a logistic operator in partnership with a financial institution. The operator gets the ownership of the goods transported from the suppliers and maintain this ownership till the shipment to the customers. Presented by Silvestro and Lustrato (2014), this solution is thought as an enabler for the SME's to financial credit access, overcoming the traditional approach in which the collaterals are based on fixed assed (Rhian Silvestro, 2013).

DYNAMIC ADVANCED PAYMENT: is an extension of the traditional discount made on early payments. Through the use of a platform, these kinds of discounts can be switched from a DISCRETE logic to a CONTINUOS one. The supplier can set a percentual level of discount per time unit, typically days, and the customer can decide when fulfill the payment.

A further evolution, possible when the number of supplier and customers is high, is the automatization of the platform which on a daily basis match the offer side(the invoice and the level of discount set by suppliers) with the demand side (the number of pieces requested and the attended returns of the customers) (Di et al., 2015).

BUSINESS CREDIT CARD: is a solution proposed by big player in the consumer market such American Express. "It is associated with ad-hoc supplier expenditure and allows to consolidate many small suppliers into one single invoice" (Williams, 2010), for this reason it is particularly useful for manage all those low unitary cost / high volume transactions, ensuring convinience and speed in the payment process.

One of the early adopters in the Italian market is Peroni which largely use this tool to finance its suppliers.

INVOCE AUCTION: a solution based on a digital platform and a peer-to-peer logic, which open the market of order financing also to private investors. The assignment process of each order works as a traditional online auction and each invoice is assigned to the investors who offer the lower financing rate. The platform owner deduct its service fee from the nominal value of the invoice (Di et al., 2015). It allow suppliers to decide optimize their financing cost by selecting which order put on auction.

SUPPLY CHAIN VISIBILITY: through the use of information technologies and information sharing between supply partners about inventories, material consumption and production capacity allow to improve to facilitate production planning and shipping for suppliers and stock levels for customers.

VENDOR MANAGEMENT INVENTORY: in this model, the supplier has full visibility on the stock of the client and can autonomously decide the replenishment logic, within the contract terms (Di et al., 2015).

COLLABORATIVE PLANNING, FORECASTING AND REPLENISHMENT: based on total visibility and information sharing along the SC, consist in a jointly planning on production in the medium-long term, aimed at reduce as much as possible the bullwhip effect along the SC. The more the actor involved and the planning agreed, the more is the efficiency of the solution (Di et al., 2015).

2.1.5 Benefits of Supply Chain Finance

Once introduced and described SCF in its forms and solutions, a list of general benefits embedded in the adoption of a SCF program is presented at conclusion of this chapter. In the face of important starting investment required and an expected increased organizational complexity (Wuttke, Blome, Foerstl, & Henke, 2013) SCF programs represent a win-win situation for the actors in a supply chain (Dileep More, 2012),able

to bring benefits in a double perspective of Enterprise Value and Supply Chain efficiency.

As already mentioned, in fact, the truly distinctive aspect of this discipline is the holistic view adopted, with the objective to optimize the WC and C2C cycle at a SC level rather than a local optimization. Only in this way is it possible to satisfy both the objective of Enterprise value and SC effciency on a long-term basis, rather than putting the twos in trade-off to obtain one-side benefits in the short-term.

SCF programs, so, are not necessarily a quick win but they can strengthen global supply chains and also release working capital that has been historically tied up, and in today's world "cash is often king" (Hofmann & Belin, 2012). As a consequence, SCF solutions are focused at improving the financial measures of a firm, both directly, by lowering the cost of financing, and indirectly due to the improving of the processes described above.

Hoffmann and Belin (2012) identified general enhancement which SCF solutions embed and bring in the organization and which are the drivers for the benefits :

TRANSPARENCY, every party involved have visibility on the process, decreasing the need for trusted partner and consequently facilitating the procurement phase – no matter if my supplier is in China if I know exactly the status of order;

PREDICTABILITY, in a supplier/customer relationship, knowing in advance the behavior of your customer allows a significant reduction of the bullwhip effect, reducing the WC immobilized in the stock and improving the efficiency of the plant;

CONTROL over the process, thanks to real-time data and transparency, allow production manager to take timely decision, in some cases by switching from a reactive to a preventive logic;

Ultimately, it facilitates the process of COLLABORATION between parties, which involves the development of new product/service and the planning.

These performances may vary according to the specific solution adopted and the characteristics of the firms, the relation and the products involved, but all of them

strongly rely on the DEMATERIALIZATION and AUTOMATION of the process in order to get these benefits.

The kind of benefits, deployed on different function, reflect this last statement and a general distinction is often made between QUANTITATIVE and QUALITATIVE benefits (Hoffmann and Belin, 2012).

2.1.5.1 Quantitative Benefits

- WACC and MARGINAL COST OF DEBT (Hoffmann and Belin, 2012): decrease, direct and immediate benefits intrinsic of the innovative SCF solutions. Part of this reduction in the cost of capital is due to lower risk associated with each orders: being sure of the punctuality of their cash inflows suppliers can better arrange their production, avoiding the risk of bankrupt, in the worst cases, due to the lack of liquidity. On the other side customers have less uncertainty on the punctuality of their suppliers and can better plan their production, having at the same time lower pressure in reconciling their invoices due to higher day payable outstanding. Further benefits derived from the saved money, which can be reallocated in other strategic investment such as equipment and plant (Palliam 2005).

- RISK COST SAVINGS (Hoffmann and Belin, 2012): mainly derived from two factors.
  First, the digitalization of the process and the total visibility approach lead to an increase in transparency and collaboration, which bring major benefits as a drastic reduction in the non-compliance of the orders and a better risk evaluation of the investments. This bring a 'per se' reduction of the risk premium expected by investors.
  Secondly, from the moment most of the solution are used by a bland of big customer/ small suppliers, as in the case of Reverse Factoring, the risk of

insolvency is transferred on the customer, which typically is considered as an entity with higher financial stability.

- ADMINISTRATIVE COST SAVING (Hoffmann and Belin,2012): by using digitalization and automation silent information are shared in a cheap and fast way. Firms can thus improve the efficency of several process such as invoice reconciliation, billing and dynamic monitoring of credit limit of its buyers.

2.1.5.2 Qualitative Benefits

- REPORTING BENEFITS (Hoffmann and Belin, 2012): due to the transparency of the processes, which reduce the information asymmetries between the information system and the physical availability of products/materials and facilitate the interoperability and so the collaboration between parties;

- ENHANCED SUPPLY CHAIN RELATIONSHIPS (Hoffmann and Belin, 2012): accepting or actively encouraging the adoption of a SCF solution is a form of differentiation which bring to a real competitive advantage;

- ENHANCED COMPLIANCE WORTHINESS (Hoffmann and Belin, 2012): regulators are increasingly imposing a mapping of the flow from sales to cash. SCF incorporate the effort for mapping and analyzing in the solution itself.

2.1.6 Barriers of Supply Chain Finance adoption

SCF has become more and more popular in recent years thanks to the fact that the potential benefit of alternative financing programs has been investigated by several experts. But, over time, multiple impediments for a wider SCF adoption has emerged. (Lamoureux and Evans, 2011).

- *Global trade transformation*: in recent time, companies are decentralizing their businesses in order to pursue new favorable opportunities. Geographically dispersed supply chains are facing problems due to an increased level of complexity and risks and, additionally, the control over distributed business network lacks of visibility and well-established procedures. Furthermore, communication problems and lack of business information affect the financing process of multiple actors involved (More, 2013).

  The adjustment process due to such an innovative business configuration is slow and cumbersome but, SCF solutions can reshape the actual scheme and promote new benefits. Nevertheless, several SMEs still prefer traditional lines of credits and banking services.

  In order to answer such a problem, focal companies should highlight SCF benefits and encourage the adoption of innovative financing solutions among different actors. More practically the focal firm should promote SCF programs providing incentives. The program adoption should bring the supply chain on new performance-related levels.

  Supply Chain partners shall be responsible to establish long lasting relationship with their suppliers providing strategy programs to enhance cost reduction, coordination and speed. As a consequence, the bigger company should define a plan in order to deliver a flexible solution tailored on the need of supply chain participants (Van Woelderen and Witteveen 2008).

- SMEs credit gap: SMEs are experiencing restrictions to access the traditional form of financing for their operating activities, resulting in a poor set of alternatives at an high risk incentive. Issuing financial instruments towards SME has always be seen suspiciously by banks. The risk perceived is accentuated by the lack of automated and standardized processes, paper based transaction and lack of an adequate infrastructure, resulting in the impossibility to visualize data in real time and a general increasing of the transaction costs

within the SC. Moreover "low-quality credit information limits the risk assessment process, to their unproven managerial capabilities and business models that result in higher required collaterals" (Omran, 2017).

- *Focal Company oriented*: SCF programs are designed and issued for supply chain partners. In most of cases, big global players with well-established business position that are not looking for financial support, being able to focus their attention to enhance improvements and performances of their suppliers. In addiction, financial player are pushed to traget smaller companiess thanks to their credit ratings.

- *Lack of a standard technology*: Technology is reshaping every industry and financing activities are no exception. Recently, SCF programs started to get much closer to alternative financing solutions. For instance, multiole bank neutral platforms have been created to finance supply chain under the strict attention of banks. Thus, can be translated into an increasing number of "bank neutral" initiatives aimed to deliver alternative financing to SMEs. Unfortunately, these initiatives are not heading out as expected. At the date, these programs are not able to show scalability properties: the number of involved participants does not enable alternative financing solution to undermine the leading position of banks. As a conclusion, high investments are not worth the risk. (Fellenz et al. 2009, Hurtrez and Salvadori 2010, Dunn 2011, Lamoureux and Evans 2011, More and Basu 2013, Nienhuis et al. 2013, Camerinelli and Bryant 2014).

- *Accounting rules and tratments:* SMEs, for which supply chain finance solutions are designed for, are affected by a general lack of accounting rules and risk assessment procedures. Additionally, cash flow forecasting activites are poor, thus, SMEs, when looking for funds cannot show their real state-of-health but

are classified according to banks disadvantageous parametersOn the other side,, also banks lack of innovative regulations able to detect and deliver better financing alternatives. *Additionally, their* traditional KYC procedures are slow and cumbersome and in most cases is not automatized. As a result, financial providers are deterred to carry out time-wasting and costly activities, especially for SCF initiatives delivered on global scale.

In addiction, the Basel III Capital Reform, which is a international regulatory framework for banks, has influenced the diffusion of SCF programs. The figure below shows the capital requirements defined the agreement developed to avoid the repercussion of 2007-2009 financial crisis.

Figure 11- Description of the enhancement in regulation introduced by the Basel III Capital Reform (Global Business Intelligence 2016)

Basel III standards are requirements that have to applied to active banks. The regulatory has been designed in order to improve regulation, supervision and risk management. From a practical point of view, it sets as minimum requirements a set of indicators when banks are issuing loans and release financing.

By the way, the traditional configuration of SCF programs with a focal company

that lowers the interest rate would possibly be a starting point for banks to provide fundings to SMEs. (Fellenz et al. [2009], Hurtrez and Salvadori [2010], Hofmann and Belin [2011], Xu and Zhong [2011], More and Basu [2013], Camerinelli and Bryant [2014], Hofmann et al. [2017]).

- Lack of secondary markets: emerging financing options have been deeply investigated in the last decades and, the theoretical benefits have been highlighted and investigated by several experts. Although, SCF has not spread out as expected, due to the fact that financial institutions remain on their traditional day-to-day practices without exploring the potential market tied up in SCF initiatives, alternative solutions cannot show their potential.
More practically, secondary markets are not enough established to support these initiatives with other investors. The extremely high complexity about the implementation of SCF frameworks still frighten investors. (Siddall [2010], Camerinelli and Bryant [2014]).

2.2 BLOCKCHAIN TECHNOLOGY

2.2.1 The Origin of Blockchain Technology

In 2009 Satoshi Nakamoto, a programmer whose real identity is still unknown, publish the white paper "Bitcoin: A peer-to-peer electronic cash system" (Nakamoto, 2008) explaining its idea of peer to peer virtual currencies, able to operate worldwide without financial intermediaries: ' The Bitcoin protocol'.

In the head of Nakamoto, allowing people to use money in a decentralized way, without censorship to any institution, nor the need to get any permission, was a major statement of protest against the financial industry which lead the world to the biggest economic crisis till the great depression. 10 years later, its creature, Bitcoin, reach a capitalization of 830+ billions $ and together with hundreds of other cryptocurrencies seems to have lost that anti-conformist / antiestablishment spirit it was created for. Rather then, nowadays it is seen principally as a financial asset, an investment able to ensure fat returns in a small amount of time which made the fortune of many lucky early investors.

In a certain sense we could affirm that, for a multitude of reason, Bitcoin failed its primary objective to disrupt the financial industry.

Surprisingly, what generated more interest around Bitcoin is not the currencies itself, rather the underlying technology on which it works: the BLOCKCHAIN, described in the paper as 'The Blockchain protocol'.

That was the real disruption, able to "overcome the problem of "double spending on the internet" (Nakamoto, 2008), the very one thing with the potential to radically change the world in multiple aspects, with the same pervasiveness internet did in the last 2 decades. And as for the Internet in the '90s, in its infancy, the world at the date is not able yet to understand, manage and even imagine all the possible (and impossible) application of this extraordinary technology.

Therefore, the difference between Blockchain and Bitcoin is substantial, although the two term are often uncorrectly used as synonyms. From now on the dissertation will focus lonely on Blockchain and its benefits and Bitcoin, along with other cryptocurrencies will be used only as examples of BC practical applications.

The timeline below, shows the evolution that gave birth to the blockchain technology. The origin of the innovation, that can be considered as the starting point of the process, is the invention of Markle trees and cryptographic hashes. Further developments, led to Satoshi Nagamoto publication in 2008.

Figure 12- Blockchain Roadmap

Once the application spread out, the technology became an hot topic among experts. More and more researchers started to explore the possible application of such an innovation. The very first implication came out in 2016 when a critical finding has emerged. The blockchain technology was not strictly related with financial services but the technology could had been considered radical also in non-financial activities (Swan M. , 2015) The studies got more and more sophisticated and many possible applications had been identified. Belisle, has created a framework, that today is the most representative, that classifies the blockchain technology field of expertise under three dimensions (Belisle, 2018).

2.2.2 Blockchain Definition and The Internet of Value

The definition of blockchain has changed is perspective over the year, from just cryptocurrencies oriented, to a broader and complete definition. This fact is certainly due to the novelty of the theme and the discovery of multiple filed of application, which pushed scholars to rethink about its definition:

"A blockchain is a digitized, decentralized, public ledger of all cryptocurrencies transactions. Constantly growing as 'completed' blocks (the most recent transactions) are recorded and added to it in chronological order, it allows market participants to keep track of digital currency transactions without central recordkeeping. Each node (a computer connected to the network) gets a copy of the blockchain, which is downloaded automatically."

- Investopedia

"Blockchain is a transactional database, which is distributed among nodes linked in a peer-to-peer (P2P) communication network. The access to the network is based on a permission mechanism, which enables the nodes to perform transactions that hold validity based on a consensus mechanism."

- Glaser, 2017

The protocol described by Nakamoto enable the creation of a decentralized network which, relying on the computational capacity of the network participants, allow the exchange of asset between untrusted actors through online transaction, without a trusted intermediaries (Swan, 2015).

In truth, Blockchain is not a single technology developed by a single programmer (Nakamoto nrd.), but rather *"a solution which unifies decades of research and was built on four main pillars"* (Antonopoulos, 2014):

- PEER-TO-PEER NETWORK: The architecture provides the database structure for a public distributed ledger and each transaction occurs between nodes without recurring to a central nodes (Omran, Henke, Heines, & Hofmann, 2017). Each nodes store and forward information to all other nodes (Iansiti, 2017). Thus, it is not required the presence of a central node that operates at validator of all the activities and transactions done on the platform.

  The blockchain technology allows users to have rights to access to the database in real time. Furtherly, if permissioned, they can store a copy of the ledger. (Salviotti, De Rossi & Abbatemarco, 2018)

- TRANSACTION LOGIC: Cryptography and a digital signature is used to secure the transactions process between anonymous accounts (Omran et al., 2017).

- IMMUTABILITY OF DATA: "The ledger consists of consecutive data blocks individually secured and cryptographically sealed, interlinked to previous data within a chain" (Omran et al., 2017). Moreover, to ensure a unique version of the record in all the ledgers, the process uses a set of algorithms with the specific function of make each record permanent, chronologically ordered and available to all the users (Iansiti, 2017).

- CONSENSUS MECHANISM: Consensus mechanism can be considered as a set rules and protocols for governance that the execution of transactions, their validation and their record. (Kandaswamy, Furlonger & Stevens, 2018). More practically, it is an algorithm that enables a global election allowing users to agree about one true systemic-state of the network for synchronizing the shared ledger (Omran et al., 2017). In addiction, those algorithms allows distributed networks to take unanimous decisions if necessary (Sankar, Sindhu & Sethumadhavan, 2017).

Moreover, other two principles, shared in practice by all kind of existing BC, can be added to the previous:

- SAFETY: cryptography and digital firm ensure privacy on one hand and trust between party on the other.

- PROGRAMMABILITY: it is possible to write piece of software, known as smart contract, which allow a transaction only where all the condition specified in the contract are verified. This make the system is incorruptible, because it is not run by a human, but by an algorithm.

2.2.2.1 PEER TO PEERALUE EXCHANGE SYSTEM

"Unlike physical assets, digital cash or other digital assets are simply a computer fi le (sequence of bits), and just like any other digital file, they can be copied"

- Hofmann, Strewe, & Bosia, 2017

Till now all the exchanges on the web where in truth only fictitious: when a user sends a file to another user it does not transfer the real file, but a copy of it. This scheme works well with all kind multimedia file, but becomes unadapt if we talk about assets, which cannot be merely copied, but require the verification and the approval of a trusted intermediary, an institution, which physically transfer the asset. This is the so called DOUBLE SPENDING problem, traditionally avoided recurring to a central ledger (centralized network) used to verify each node/transaction (Cham, 1992).

The previously illustrated principles allow a radical shift from the past, it is finally possible to use the internet to exchange value between parties in a decentralized way, through "An authoritative record of all transactions of the digital asset" (Hofmann et al., 2017), this is the rise of the INTERNET OF VALUE.

Nakamoto proposed its own solution to this problem:

"We propose a solution to the double-spending problem using a peer-to-peer distributed timestamp server to generate computational proof of the chronological order of transactions"

The paragraph above is dedicated to the description of the architectures and the mechanisms proposed by programmers to solve this problem.

2.2.3 Technology Overview

The following section have the aim to provide a structured and in depth analysis of the Blockchain technology illustrating its mechanism, its key aspects and its main application starting from the identification of a structured framework. The paragraphs will follow the structure illustrated by Brening:

Figure 13- Blockchain Architectural Framework

- BLOCKCHAIN PLATFORM: defined as "decentralized consensus system" (Brenig, 2016). Nowadays it is possible to find different player on the market, such as Bitcoin and Ethereum, which provide the baseline infrastructure and compete to affirm their own standard on the market (Brenig, 2016).
- BLOCKCHAIN APPLICATION: functionality providers which rely on BC platform to run their services (Brenig, 2016).

- BLOCKCHAIN SERVICE: not linked to a platform, but to a specific application, aim to extend its functionalities and efficiencies (Brenig, 2016).

2.2.4 Blockchain Platform

First of all the world 'Platform' is largely used and discussed nowadays. For sure the most popular version refers to the 'multi-sided platform' as AirBnb, Netflix, Uber and so on, characterized, according with Hagiu and Wright, by two main features:

- *They enable direct interactions between two or more distinct sides"* (Hagiu, 2015)*;*
- *"Each side is affiliated with the platform"* (Hagiu, 2015);

Blockchain platform seems to fit into this definition, but in fact it can be noticed substantial differences in comparison with the examples mentioned above: all the traditional multi-sided platform still relies on an central intermediary, the owner and manager of the platform, which provide the platform as a service for a very specific function. Blockchain platforms instead *"are platforms or ecosystems on which other platforms work"* (Van Eijk, 2015) infrastructure which allow for the creation of platform and more important, a protocol not written for a specific purpose, but adaptable to every use.

The following part of this section is dedicated to the description of the building block which compose the BC infrastructure from a technological point of view, this blocks are in particular those which give BC the properties illustrated previously.

2.2.4.1 Network Architecture

A characteristic features of BC is the 'Distributed' nature which differentiate it from the 'Centralized' and 'Decentralized' network (Swan, 2015), allowing it for substantial benefits.

"A distributed system is one in which the failure of a computer you didn't even know existed can render your own computer unusable."

-Leslie Lamport

Beside this alternative definition, another one is proposed by Schollmeier, which reverse the perspective to give a positive, and usefull, connoteation to the term

"A network where the participants share a part of their own hardware resources, such as processing power or storage capacity. These shared resources are necessary to provide the service and content offered by the network (e.g. file sharing, storing or shared workspaces for collaboration), and they are directly accessible by other peers without passing by intermediary entities"

-Schollmeier (2002)

A distributed system consist in a network of

- MACHINE, running a specific program;
- CONNECTIONS for sending and receiving data;
- Machine and connection collectively offers a coherent interface to client computers;

(a) centralized   (b) de-centralized   (c) distributed

Figure 14 - differences between network, Morabito 2017

In BC data and transaction resides in the database of each node together with its metadata (chronological list of data). The block which compose the chain contains all the ordered transaction in the ledger, but only authorized user (those who have the signature) can read those information (Morabito, 2017).

The nodes represent a machine (both virtual or physical) and are identified by an IP address; machines exchange data via TCP/IP standard protocol (Glaser, 2017).

Moreover each nodes own a pairs of public/private key which allow, through the TCP/IP protocol, to make transaction with all the other nodes in a distribute way, without any intermediaries, just knowing the receivers public key (Glaser, 2017).

The authority is fictitiously represented by the 'Consensus mechanism' between users, with the beneficial effect to strengthen the security of the entire network (Xu, 2016): the lack of a central hub with relative central servers and database reduce drastically the traditional DOS (Denial of service) attack, aiming at bombing the central servers with a multitude of fake request with the aim of provoke a default in the system (Pearson, 2016).

Eric Brawer in its "Symposium on Principle of Distributed Cputing" brought evidences on how the distributed systems can imply alternatively three attractive properties:

-CONSISTENCY: every node receive the same response, avoiding the undesired effect of a different answer to the same question. A system can be considered consistent if all transactions starts in a consistent state and ends in a costintent state (Eric Brawer, 2000);

-AVAILABILITY: all clients get a response eventually (in a reasonable time period)(Eric Brawer, 2000);

-PARTITION TOLERANCE: the system tolerate partial losses of information without resulting in a failure of the entire system, allowing the system work even when part of the node are offline or the communication is slow (Eric Brawer, 2000);

In its studies Brawer formulate the CAP theory (Eric Brawer, 2000), illustrating the impossibility to built a system which embed the three properties at the same time. A more complete analysis on the space of this TRADE-OFF had been further carried out by Daniel J. Abadi in 2012 in its "Consistency tradeoffs in modern distributed database system design." (Abadi, 2012, Computer-IEEE Computer Magazine 45.2), with the formulation of the PACEL theorem.

Figure 15- CAP Theorem Trade Off

For the sake of the dissertation this chapter will not discuss in depth the formulation of these theorem. What evince an interest is to show the implications of them, which result in the differentiation of three different kind of distributed network:

- CONSISTENT and AIVALABLE systems;
- CONSISTENT and PARTITION TOLERANT systems
- AVAILABLE and PARTITION TOLERANT systems;

2.2.4.2 Ledger Architecture

"Blockchain ledger can be described as a string of blocks, which include a detailed list of transaction record similarly to a conventional public ledger" (Chuen, 2015). Every single block contains two part:

- BLOCK HEADER, containing the following components:

- TIMESTAMP: a 4-byte file, which is based on the number of seconds elapsed from 1 January1970, midnight UTC/GMT (Epoch Unit Timestamp) (Antonopoulos, 2014) which indicate the moment of creation of the block, it is used to verify the uniqueness of the block and the transaction contained in it and to order chronologically the transaction in the ledger (Deloitte, 2016), (Hofmann, 2017), (Nakamoto, 2008), (Nofer, 2017), (Pisa, 2017), (Subramanian, 2017)

- HASH VALUE: an alphanumeric string of arbitrary lengh obtained with an hash function, a non-injective function with the properties of being 1. a one-way function 2. Hash value $h(M) = h$, with $|h| = k$, is easy to compute with given M;

- HASH VALUE of the previous block;

- NONCE: an arbitrary number adopted for verifying the hash value through the consensus mechanism (Nakamoto, 2008).

- BLOCK BODY: the list of transaction stored in the block.

Figure 16 – BC Visualization, Zang., 2016

In the following section the role of each of this item will be gradually illustrated, along with the process in which they are used.

2.2.4.3 Security Objectives

The composition of each block have the aim to ensure the different security objectives which, together, ensure a save exchange of value using an unsafe network as it is

internet, in particular the cryptographic objectives, widely accepted by scholars are the following:

- Message CONFIDENTIALITY: only authorized party (the designed receiver) can access the content of the message (Pearson,2016);

- AUTENTICITY: the receiver have to determine if the senders really is who he pretend to be. Also in this objective can be achieved using the process of encryption in the proper way (Pearson,2016);

- Message INTEGRITY: the receiver have to recognize if an alteration in the content happen along the network (Pearson,2016);

- NON REPUDIATION: no message have to be denied (Pearson,2016).

Different tools and processes to ensure each of the objectives are listed and explained below, even though, when speaking of cybersecurity, it is important to underline the fact that no system can be 100% safe and in practices firms face a TRADE-OFF between the level of security desired and the cost involved in the solution.

Figure 17- Cryptografic properties, Boris Dudder

- ASYMMETRIC ENCRYPTION to ensure AUTHENTICATION and CONFIDENTIALITY: as already said each nodes owns a pair of asymmetric keys, a public one available in ad-hoc public database and private one which

have to be kept secret and changed periodically (Pearson,2016). Encrypting the massage with one key or the other, as shown in the figure below, can ensure a single objective. Bridging together the two processes guarantee the achievement of both the objectives (Pearson,2016).

Figure 18- Cryptografic Proess, Pearson, 2016

- DIGITAL SIGNATURE to ensure INTEGRITY: being able determine if the senders is authentic and the confidentiality of the message does not prevent also from the possibility that the message had been altered by a third party (Pearson, 2016). The DIGITAL SIGNATURE is a cryptographic process to prevent from this event:

- SIGNING PHASE: the hash function is applied on the message to be sent in order to get the DIGEST (a 'resume' of the text with a fixed length) and then encrypted with the sender's PRIVATE KEY to get the final DIGITAL SIGNATURE, finally the original message and the digital signature are encrypted together with the reciver's public key. The massage is finally safe to be exchanged.

Figure 19- Hash Process, Pearson 2016

- VERIFICATION PHASE: when the receiver gets the message can decrypt it with the receiver' s private key in order to disclose the original message and the digital signature. The original signature is then decrypted with the sender's public key to get the digest and the hash function is applied on the message received. Finally the two digest are compared, if they are equal, due to the properties of embedded in the hash function, the property of integrity, confidentiality and sender's authentications are guaranteed.

Figure 20- Digital Signature Process, Pearson 2016

The figure below shows a representative example for the blockchain, the use of the digital signature in a Bitcoin transaction. In this case the senders transfer the ownership of an asset directly by applying its digital signature on the hash value of the previous transaction and on receivers public key (Nakamoto, 2008).

Thus the digital signature, made with senders private key, represent the link between transactions and guarantee confidentiality, integrity and non-repudiation (Nakamoto, 2008) and owners private key stand for the its ownership right (Swan, 2015).

This transaction logic based on a pair of asymmetric key, common to many BC platform, guarantee also an high level of privacy without renouncing to transparency of the entire network (Tapscott, 2016), (Subramanian, 2017), (Underwood, 2016): every participants in the network are able to see the transfer of ownership of a certain asset,

from the owner of a public key A to the owner of a public key B. While the private key demonstrate the effective ownership over an asset, the public one is just the "reference address" of a node and till the identity behind the public key stay anonymous, the privacy of the node is guaranteed (Tapscott, 2016), (Subramanian, 2017), (Underwood, 2016).

Figure 21- Digital signature in Bitcoin, Nakamoto 2018

The use of Digital Signature in Blockchain in general can enable different function such as data governance and provenance, physically unique item identification in through a public-key infrastructure and right delegation (including delegation from human to robot).

2.2.4.4 Transaction Mechanism

Before proceeding with the explanation of the transaction mechanism, it is important to differentiate what till now has been generically called 'user' or 'node' in order to describe different role present in a BC network:

- USERS THAT READ DATA: they represent the majority of the users, they are node of the network and can access and view the transaction which happen in the network;
- USERS THAT WRITE DATA: a subset of the first, are all the users which are involved in a transaction, equally as senders or receivers;

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- USERS THAT VALIDATE DATA: are those node in charge of validate the transaction in order to create new block to add to the chain. In the literature is common to refer at them as 'miners', 'validators' or 'full nodes'.

As regard the working mechanism of the transaction process via Blockchain five main steps can be illustrated (Froystad, 2016):

- TRANSACTION DEFINITION: the sender specify the object and the value of the transaction (the message) and proceed with the creation of the digital signature and the encryption with the receiver's public key, coherently with the process showed in the previous paragraph (Morabito, 2017).

- TRANSACTION AUTHENTICATION: The encrypted message is received and decrypted, finally the two digest are obtained and compared. Its important to underline the fact that during this phase the transaction "is waiting in a pool of pending transactions until a block is created" (Froystad, 2016).

- BLOCK CREATION: A set of pending transactions are collected by a node of the network in order to create a block. Before the ledger is update with the transaction contained in the new block it have to be validated by the network. The number of a transaction contained in a block vary according to the platform used to form the chain (e.g Bitcoin, Ethereum).

- BLOCK VALIDATION: this process is in charge of the miners in the network, which uses a 'Consensus mechanism' to decide over the approval of discard of single transaction in a block. Different platform use different mechanism and a focus on this theme will be made in the following paragraph.

- BLOCK CHAINING: Once the block is validated it is timestamped and chained to the last block forming the chain trough the hash mechanism. Finally the updated version of the ledger is shared with all the network.

Figure 22- Ledger updating process

Figure 23 - Generalized overview of a blockchain transaction Frøystad & Holm, 2015

2.2.4.5 Consensus Mechanism

As already stated, BC distributed network substitutes the role of the central authority, necessary in transaction which involve two or more entities which do not trust each others, with a validation process of each transaction based on a Consensus mechanism, defined as follow by Buterin:

> *"to allow for the secure updating of a state according to some specific state transition rules, where the right to perform the state transitions is distributed among the economic set. The economic set can be users which are given the right to collectively perform transitions through an algorithm"*
>
> -Buterin, 2013,

Morabito illustrate three main characteristics which define a Consensus mechanism (Morabito, 2017):

- *"Common acceptance of laws, rules, transitions and states in the Blockchain";*
- *"Common acceptance of nodes infrastructure, methods and stakeholders that apply these laws";*
- *"Common perception of identity that all the nodes accept and comply to the same rules".*

Although multitude of mechanism have been defined over the years, for the sake and brevity of this paragraph the two most used will be described and analyzed, Proof Of Work and Proof of Stake:

- PROOF OF WORK: introduced by Dwork and Noar in 1993 and currently used as Consensus mechanism by both Ethereum and Bitcoin. "The consensus protocol is based on a problem that is difficult to solve but easy to verify, thus avoiding the possibility other nodes could redo the whole PoW in order to accept the transactions (Omran et al., 2017). The miners able to solve a cryptographic puzzle which involves the inputs (nonce, timestamp and hash of the last block in the chain) to extract the hash value lower than a target one

(which represent a proof of work) in the shortest time obtain the right to create and chain the block and update the ledger. (Crosby, 2016), (Nakamoto 2008), (Deloitte, 2016), (Nofer, 2017), (Severeijns, 2017), (Vranken, 2017). Being this process intensively resource consuming (Nakamoto, 2008), (Ferenzy, 2015), (Watanabe, 2015), the more the amount of computational power owned by the miners, the more are he chances of solving the problem and, consequently, the higher is its voting right. Miners are rewarded for their work, for example, to mine a Bitcoin transaction with a predefined amount of Bitcoin.

- PROOF OF STAKE: proposed by King and Nadal represent a valid alternative to the PoW due to its less resource intensive process. The scares resource representing the voting shares of the miners here is represented by the amount of asset owned (Hofmann, 2017), (Tapscott, 2016), (Xu, 2016). The algorithm does not rely on the nonce, rather, the timestamp changes every seconds. This limits the number of attempts a miner can do to one per second, reducing the computing power needed for the process (Christidis, 2016), (Vasin, 2014).

  Other benefits are related to an higher level of security of the process: to pilot the vote a miner should control the majority of the resources in the network and own the 50% +1 of the resources in the network cost more than own the 50%+1 of the computational power in the network (Tapscott, 2016), (Vasin, 2014), (Xu, 2016); as a direct consequence, larger network with a larger number of total resources are less controllable by one nodes (or a group of them) (Tapscott, 2016), (Vasin, 2014), (Xu, 2016).

This method, despite the mechanism used, allow to secure the network and guarantee the integrity property of the ledgers containing the transactions. It requires a minimum number of block tied to the chain to ensure this properties (Antonopoulos, 2014), in Bitcoin for example it correspond to 6 block, which requires a time period of approximately 1hour (Antonopoulos, 2014)

2.2.5 Access and Control

Nowadays, while the world is still struggling around in order to exploit blockchain technology to develop new business models and fix those problems that today put a limit the profitability, scholars started a phase of classification and analysis of the real use cases, with the objective of codify knowledges in a clear framework, facilitating the work of those interested in enter this field. Immediately after Nakamoto's publication, the blockchain technology benefits where considered mainly related to cash exchanges activities. But, over the years, people started to analyze and understand how the technology could be exploited on bigger scale, more precisely how the technology could be used by enterprises to imporove their businesses, by national and financial institutions to improve their security level and their performances. In 2015, Swanson said "I like blockchain but I don't' like Bicoin" reinforcing the idea that blockchain features constitute a crucial improvement in many different sectors.

As a result, a huge number of possible configurations has emerged, in order to translate the blockchain application advantages in enterprises ecosysytems. Nakatomo designed a blockchain based on a public paradigm but a private switch in the concept was required. So, totally private ecosystems have been created and rapidly, terms like "closed", "permissioned" ecosystems became more and more popular.

Here is one of the most largely accepted classification around the world, including Osservatori.NET which develop this slide:

Figure 24- Blockchain classification

This framework classify blockchain architectures according two dimension:

- PRIVATE vs PUBLIC: the difference among the twos reside in the accessibility of the network. In the public case everyone have the possibility to become a node of the network without the permission of any third party (a regulator) as in the case of Bitcoin. On the other side private networks are made only by authorized nodes, thus a limited and trusted number of actors can read the transaction which compose the chain. (Deloitte, 2016), (Hofmann, 2017), (Mattila, 2016).

- PERMISSIONED VS PERMISSIONLESS: this further distinction is made on the basis of the nodes which can write on the chains and validate the blocks. In permissionless BC every node have "equal right power" and full node compete to validate blocks in a permissioned BC the validators are decided a priori and typically there is no consensus mechanism (Deloitte, 2016), (Hofmann, 2017), (Mattila, 2016), (Pisa, 2017), (Vukolić, 2017).

From this bi-dimensional classification is it possible to originate four possible BC configuration, three of them with its characteristic and field of application, plus one, which is possible theoretically but with no utility in practice (until now):

Figure 25- Blockchain classification II

Let's consider, for brevity and clearness, only the PUBLIC/PERMISSIONLESS and the PRIVATE/PERMISSIONED -the two opposite cases-, to analyze the differences in performances and determine the suitability for firms need (in particular along the supply chain) referring to the paper "Rethinking permittioned Blockchain" by Vukolic, 2017:

	PUBLIC	PRIVATE
DISINTERMEDIATION	🟢🟢🟢	🔴
DECENTRALIZED	🟢🟢🟢	🔴
IMMUTABILITY	🟢🟢🟢	
TRANSPARENCY	🟢🟢🟢	🔴
VERIFICABILITY	🟡🟡	🟢🟢🟢
TRACEABILITY	🟢🟢🟢	🟢🟢🟢
PROGRAMMABILITY	🟡🟡	🟢🟢🟢
DIGITALIZABILITY	🟢🟢🟢	🟢🟢🟢
PRIVACY	🔴	🟢🟢🟢

Figure 26 - Public and Private Characteristics

PUBLIC/PERMISSIONLESS BC are network open to everybody, thus an important step is the anonymization of the data exchanged in the network, problem arise when is not possible to anonymize all of them, while the private configuration guarantee no diffusion of sensible data (Vasek, 2015), which typically firms need to exchange internally or within the supply chain, avoiding an external spillover. Beeing no trusted party, the validation process in the permissionless network has to be achieved on the base of consensus mechanism, which, at the date, is still inefficient in terms of speed and resource consumption.

In a network formed by trusted party (permissioned) it is possible to delegate this process to the regulator nodes, making the data sharing less immutable and censor-

resistent, but much more efficient (Greenspan, 2015). This allow private network to have the benefit to be more flexible and scalable, they are therefore

more adaptable to the transaction volumes of the mainstream economy and would be more favourable to regulators and legislators (IFF 2015).

The performances highlighted, with particular emphasis on the privacy, are the reason why the PRIVATE BC are more suitable for traditional company which are looking for applicaition oriented to Business. Examples are the Financial ecosystem created by R3 or the supply chain monitoring adopted by Wall-Mart

PUBLIC BC on the other hand have a focus on resilience, make them more suitable for application oriented to Customers. Here the most known examples are the cryptocurrencies, but also the research in the field of open notarization and traceability systems.

> *"Permissioned ledgers may well be more useful because you don't need to do proof of work so all of a sudden you can have a business model with much higher transaction throughput".*
>
> A. Batlin, Senior Innovation Manager at UBS, 2014

Given what stated above, it is worth to illustrate two characteristic configuration of Permissioned blockchain identified by Buterin in 2015:

- CONSORTIUM BC: *"are distributed ledger systems where the consensus process is controlled by a preselected set of nodes. For example, a consortium of 15 fi nancial institutions, each of which operates a node and of which 10 must sign every block in order for the block to be valid. The right to read the blockchain may be public or restricted to the participants"*.(Hofmann et al., 2017);

- FULLY PRIVATE BC: *"permissions remain centralised to one organization, and read permissions may be public or restricted to a closed number of participants.*

Likely applications include database management, auditing or other internal uses for a single company, so public readability may not be necessary in many cases at all" (Hofmann et al., 2017);

Addictionally, Wust & Gervais, developed a framework that was able to describe which configuration the blockchain should have according to the access requirements needed by participants and to the need of a trusted-third party or central authority.

"The framework is useful when multiple mutually mistrusting entities want to interact and change the state of a system, and are not willing to agree on an online trusted third party."

Wust & Gervais

Mistrust among different participants can be solved by blockchain technology, enabling transactions and exchanges in a completely decentralized way. The framework suggests as optimal configuration when the number of participant is not limited and the number of transaction is not limited a permissionless sysyem. On the other hand, permissioned ecosystems fit much better with a limited number of authorizable actors.

Do you need to store state? — yes → Are there multiple writers? — yes → Can you use an always online TTP? — no → Are all writers known? — no → Permissionless Blockchain

Do you need to store state? — no

Are there multiple writers? — no

Can you use an always online TTP? — yes

Are all writers known? — yes → Are all writers trusted? — no → Is public verifiability required? — yes → Public Permissioned Blockchain

Are all writers trusted? — yes

Is public verifiability required? — no → Private Permissioned Blockchain

Don't use Blockchain

Figure 27- Blockchain Usability Model, Wüst & Gervais 2017

More recently, Hofmann proposed this cross-case analysis highlighting how BC configurations vary along 6 explicative variables:

	Traditional centralised database	Fully private DLT	Permissioned consortium DLT	Permission-less public DLT
Network	Many private networks (intranet VPN), silo systems	Private (intranet)	Private validation/public ledger (intranet)	Public (Internet)
Protocol	EDI, HTTP	Any open source protocol, modified or own protocol	Any open source protocol, modified or own protocol	Open source protocols (e.g. Bitcoin, Ethereum)
Validation mechanism	Manual, singularly automated by internal protocols	Organised between participant nodes (e.g. Ripple's BPCA)	Organised between participant nodes. Low difficulty PoW or PoS for integrity	Through PoW, PoS
Scripting system	Turing-complete	Turing-complete or limited script	Turing-complete or limited script	Turing-complete (e.g. Ethereum) or limited script (e.g. Bitcoin)
Security	Central organised identity system and private and costly data storage	Decentral organised identity system (nodes are known and legally prosecutable)	Decentral organised identity system (nodes are known and legally prosecutable) or PoW, PoS	Through PoW or PoS difficulty and crypto-economic theory
Privacy	Confidentiality of centrally stored data	Organised between participant	Through cryptography	Through cryptography

Figure 28- BC type Characteristics, Zackmann 2017

2.2.6 Blockchain Applications

Szambo, among the firsts considering the idea of writing a software which imply contractual obligation, described a Smart Contract as:

> *"a computerized transaction protocol that executes the terms of a contract"*
>
> *Szabo,1994*

A definition which three years later completed by stating the efficiency in the execute this kind of contracts:

> *"contractual clauses […] embedded in the hardware and software we deal with, in such a way as to make breach of contract expensive […] for the breacher"*
>
> *Szabo, 1997*

Smart contracts are designed to state the agreement between parts (which includes payment terms, liens, confidentiality and enforcement (Hofmann et al., 2017) , decreasing the possibility for intentional breach and accidental violation, resulting in an independence from an third part for signing a contract.

Flood and Goodenough (2015) proved the feasibility in translating a legal entity like a contract into a code executed by a software. Throught the decomposition and explititation of the terms which

They demonstrate that contracts are state transition systems that encode explicittransition rules for shifting the relationship from one state to another.

Also Szabo suggested the characteristics which define a smart contract in the sense are meant now and really distinguish it from the Ricardian one:

- VISIBILITY (he call it observability): the parts engaged in the contract should be able to prove the fulfillment of their obligation and at the same time have a view on the fulfilment of the terms of the counterpart. In the definition is included also the visibility on the action which incur in the process of fulfilling those terms (Szabo, 1994);

- ONLINE ENFORCABILITY: "making certain that the terms of a contract are being fulfilled" (Szabo, 1994), with the possibility to adopt countermeasure to protect its own interest. In particular two main classes of countermeasure are possible, the proactive measures, which consist mostly in building technical barriers which prevent the drop out of the other part to its contractual terms, and the reactive measures, such as the possibility to recover asset when a contract breach occur or deterrent tied up to the reputation and image of the company (Szabo, 1994);

- VERIFIABILITY: a transaction have to be effectively verifiable by the parts of the agreement;

- PRIVACY: a smart contract have to remain as private as possible, all data and information involved during the period of validity of the contract have to be shared and visible to the other parts only when it is necessary (Szabo, 1994).

The aforementioned pillars are leading BCT to become one of the most investigated technological topic on a global scale. Below it can be seen a recap of the industries interested the most in blockchain technology applications.

2.2.6.1 Cryptocurrencies

The first application of blockchain and by far the most known around the world. Due to it popularity sometimes people confuse the Cryptocurrency application whit the underlined infrastructure and use the term Bitcoin as the Blockchain.

Anyway Bitcoin is only the first of series which today count more than two thousand cryptocurrencies around the world, including different peculiarity which solved in one way or another the inefficiencies embedded in the first Bitocoin version.

The characteristics of this item are in the cryptography and in the transferability, they can be exchanged around the world at no costs and nearly in real time. The transaction is completely trackable and can be even automatized thanks to the recourse to Smart Contracts.

The main pain points which obstacle the growth of this applications and the introduction of cryptocurrencies in the everyday life is their unstable value, against the stability generally guaranteed by FIAT Currencies. With this aim some of the latest Crypto maintain a fixed exchange rate with FIAT currencies, proposing themsef as disruptive application with the right characteristics to establish as principal form of money in used in the daily life.

(Salviotti, De Rossi & Abbatemarco, 2018), (Swan, 2015).

2.2.6.2 Digital Identity

On Blockchain every node have the possibility to be univocally associated to some credential which define the digital identity of the actor, allowing him to run transaction in the network, and at the same time protecting its identity and sensible data. A typical example are the digital wallet offered thought which it is possible to store, send and receive digital assets. The wallet is identified by an alphanumeric number and all the information are crypted, when a specific is requested to verify the credential of a wallet it becomes visible to the authorized actor.

The same logic may be applied to the Legal Identity of peoples. By digitalizing its own identity people can show to be the owner of a valid drive license, an hunting license, to be authorized to pass throught a reserved area, to have the age to by alcohol and so many other cases in the daily life, in the respects of the privacy of the individual.

(Pinto, Forbes 2018). PII (Personally Identifiable Information) (Daily Fintech, 2015). (Salviotti, De Rossi & Abbatemarco, 2018 Patel, IBM 2018)

2.2.6.3 Tracking

The fundamental characteristics of the Blockchain to guarantee visibility over the historical records involving a single asset allow to reduce information asymmetries over the Supply Chain. The enabling factor for this kind of applications is represented by the wide use of IoT systems along the path of the goods. The 'Proof of Location' is

an innovative trust mechanism which rely on the node in the network to triangulate the position of a good with maximum precision, speed and an higher level of safety in comparison with GPS systems.

(Salviotti, De Rossi & Abbatemarco, 2018), (DHL, 2018)

2.2.6.4 Financial Services

A wide market of applications and a multitude of providers are characterizing the market for Financial Services.

In the past years the services offered was affected by an high number of intermediaries which raise the costs and time to complete transactions. Introducing a distributed network in this market allow to cut intermediaries and make transaction instantaneous and automatized.

Services as Cross-Boarder Payments and Crowdfunding experienced major beneficial effects (Salviotti, De Rossi, Abbatemarco, 2018).

3.OBJECTIVES AND RESEARCH PROCESS

3.1 THE CONCEPT

As far as SCF solutions are concerned, theirs endeavours to improve financial performances through optimizing the working capital are well recognised. These solutions are being introduced more and more frequently and the possible advantages, captured in the literature review, have clear evidence within different business network configurations.

On the other hand, the scale and the rate of adoption of SCF solutions is heavily linked to a common urge of digitalization among companies, inherent to both internal and external processes. Nowadays, the flow of digital technologies is affecting every industry, restructuring well established processes and providing new opportunities to improve performances under many different point of views. Supply Chain is no longer an exception.

As a direct consequence of the literature, a wide range of inefficiency drivers have been identified, underlying that some further steps must be undertaken to boost the diffusion of SCF solutions and to boost their performances through large-scale IT systems.

The resulting scenario is leading to a debate about the most suitable digital technologies to be exploited in Supply Chain context. The focus of this observation is related to SCF solutions: physical, financial and information flows are the heart of the transformation and represent the activities that mostly require a general speed up of procedures.

The BCT, chosen for its disruptive properties, seems to be tailored on these common needs. Its pillars can provide substantial benefits if correctly applied to SCF solutions, nevertheless they require appropriate digital infrastructures to ensure efficiency, effectiveness and risk minimization.

At the date, theoretical studies highlighting benefits brought by BCT to specific SCF solutions, were published. In particular, Reverse Factoring (Omran et al., Hofmann 2017), Inventory Finance (Hofmann 2017) and Dynamic Discounting (Omran et al.) are the most analysed well-sampled solutions.

As a result of these studies, a list of benefits was drawn but giving evidence of general lack of empirical validation. More specifically, theoretical concerns about benefits of the introduction of bSCF were identified but still require to be crossed with specific emerging solutions available on the market. The fast pace of BCT and DTL innovation is giving birth to a significant number of companies that are trying to set up a concrete Business Model exploiting BCT on SCF solution. These providers represent the first examples of how to translate theory into practice.

The ultimate goals of our research are, firstly, to identify and map contextual requirements needed to apply the BCT to SCF solutions, as well as what are the BCT pillars that can be considered pain relievers when implementing SCF solutions. Secondly, to prove the consistency of these theoretical implications through use cases and applications for the researched SCF instruments. More specifically, a theoretical framework will be developed and discussed in order to validate possible approaches for the forms that bSCF will assume in the next future.

RQ1: The first research question is not emerging from a literature review gap, but rather deepens the focus of the present thesis. Indeed, it was necessary to investigate in detail the existing bSCF offer to enlarge the knowledge of the authors about the topic and formulate the next research question, to be answered with the final model.

"How can be described the state of art of Blockchain technology solutions applied to the Supply Chain finance industry?"

RQ2: Once identified a list of innovative providers of bSCF programs, the primary aim of this dissertation is to analytically verify the findings of the above mentioned studies. The output of this phase is the assessment of a BCT solution impact on different areas

of improvement. Once the market study proved theoretical findings, it is possible to focus on single inefficiencies at a time and try to assess the effects brought by the firms on the market. The purpose is the assessment, at a macro level, of the expected impact brought by the innovative solutions on each inefficiency, main drivers to this result and effective availability of the service in the market.

"How Blockchain Technology mitigates the inefficiencies characterising the Supply Chain Finance industry?"

3.2 RESEARCH PROCESS

In order to answer research questions in a punctual and scientific way, a structured research process was followed. All phases of the process are briefly illustrated in this chapter in order to give the reader a synthetic but clear view of the path followed developing this research. In the following sections each phase will be observed in detail including the logics, the metric, the data use and finally the delivered output. The process requires multiple data sources to perform the analysis, in particular:

- academic information, coming from the Literature review;
- available secondary data on the web;
- primary data directly collected from the source in order to feed a specific phase of the process.

Figure 29- Research Process

- GAP IDENTIFICATION: the process starts with a first and obligated phase, common to all the research processes of this kind, consisting in the identification of gaps in the literature. After a long and meticulous research and study of any kind of paper dedicated to the two main topics in scope - SCF and BCT- to acknowledge and understand the field of work, an empty space in the literature was identified and translated in two Research Questions, above mentioned and presented. From this point, the whole process design and development was tailored to find and provide proper answers, with due motivations, to the research questions.

- PRELIMINARY RESEARCH FRAMEWORK: it is the framework aiming to identify the correlation between SCF inefficiencies and BCT features. It has been drawn with a view to map how blockchain features are able to lower SCF barriers. The 2-dimension matrix is composed by SCF inefficiencies on the rows

and BCT features on the column. The, the SCF inefficiencies were reconducted to the appropriate driver, in order to decrease the complexity of the variables, decomposed into much simple problems.

Both the activities of filling the matrix and assigning drivers to inefficiencies were executed on informations coming from Literature and Secondary Data. Thus, the framework has theoretical nature, and its validity was certified by a panel of experts in the field of SCF industry.

- CASE STUDIES: In order to value all observations emerged theoretically, a set of use cases was identified and analyzed. The aim of this analysis is to verify and validate the findings that represent the pillars of the research framework throughout a comprehensive empirical research of all existing shades of bSCF already available on the market. As far as these topics are concerned, to a greater or lesser extent, both BCT and SCF are newcomers on the global market. As a consequence, the identification of practical examples strategically significant for the research required a meticulous online research.

- CASE STUDY GROUPING: after having sampled a sufficient number of case studies, a cross-case analysis was performed and through data visualization techniques the case studies were discriminated and clustered according to the inefficiencies on which their service focuses the most. Mapping clusters on the theoretical framework allowed to establish wherever the predictions of the scholars already registered a match on the market.

- IMPACT ASSESSMENT: once identified and described the Groups, it was possible analyse the impact they have on the inefficiency. Each nefficiency was analyzed at a Driver level and the innovative solution replied was reported highlighting the BCT key features to enable the benefits. Finally the impact was evaluated at an Inefficiency level, merging the impacts of the drivers composing it.

4. METHODOLOGY

4.1 LITERATURE REVIEW

This section of the research work, shows how both SCF and BCT literatures were investigated and analysed in order to obtain the foundations of the dissertation research framework.

Being the main goal of the research related to the possible adoption of Blockchain Technology solution for Supply Chain Finance programs, it was necessary to conduct a literature focused on both topics. Each one was singularly studied in order to better contextualize the boundaries of the research. Both topics were then reviewed trying to find out possible connections between them.

This phase of acknowledgment was the starting activity of the research process. Authors publications, were useful in multiple activities: firstly, to highlight the state-of-art of both BCT and SCF and, secondly, to find out existing gaps about the correlation between the two topics.

Going deeper in the literature review architecture, initially, a quick introduction about Supply Chain Management existing dynamics and configurations was carried out to better understand which are the general characteristics of the discipline that gave birth to SCF, one of the two main topics of the dissertation work.

Once boundaries of Supply Chain Management were identified, the attention shifted to existing SCF theoretical foundations. The analysis was carried out by examining different articles, working paper and books which concern the SCF area of expertise.

The research project was issued by Supply Chain Finance Observatory of Politecnico di Milano, having the possibility to access and study all available resources shared by the Italian leading technical university.

The SCF literature review main objective was to carry out a comprehensive and detailed overview about the topic, which could underline the state-of-art of the

discipline and bring up possible problems, inefficiencies and barriers that could be potentially mitigated by the adoption of emerging technologies.

For what concerns the state-of-art of SCF, a vast array of documents were combined and compared, in order to detect the theoretical pillars of the discipline.

Additionally, being different by the traditional SC domain, characterized by a waterfall sequence of Supplier – Customer relationship, the SCF environment includes the figure of intermediaries of different nature: financial, technological, operational. Thus, the relationship between actors involved was studied in order to properly identify their roles when working on a SCF program.

Once identified the theoretical pillars in the SCF dominium, different solutions were studied to get the proper understanding of those programs that could be built and delivered on a blockchain-based ecosystem.

Subsquently, benefits related to the adoption of SCF programs were identified, both from a qualitative and quantitative point of view.

Once SC and SCF analysis were concluded, the attention focus shifted to the Blockchain Technology.

Firstly, the evolution of the BCT was investigated starting from Satoshi Nakamoto's Bitcoin whitepaper (2009) to recent findings about how the adoption of blockchain could be exploited on many different business activities. Then, the technology was studied from an ontological point of view, to better identify key pillars, possible configurations and the unique advantages brought by the adoption of distributed databases. The blockchain technology literature review was characterized by a lack of academic papers and documents about how the technology improves performances in different areas of expertise. For what concerns the identified gaps, they are related to the adoption of bSCF programs and about how blockchain unique features could impact on SCM and SCF practices.

For what concerns the analysis of relevant publications, some papers were deemed off-topic and as too collateral for the research project. For instance, when dealing with the SCF literature review, some papers related to the impact of SCF programs in the

logistic business practices were discarded due to an extremely high focus on procurement activities.

Numerically speaking, 70 papers were studied in detail both considering BCT and SCF disciplines. The table below shows the distribution of papers according to their data of publication. The graph shows that, in recent years, both SCF and BCT are becoming more and more attractive topics.

Figure 30- Paper Classification

Furthermore, the following pie chart graph shows the different sources of the relevant publications. Academic journals, books, online journals and conference papers are the different sources highlighted in the literature review. The tale shows that more than 50% of papers have been published by academic journals but this data is mostly affected by SCF documentations, much more tailored for academic research activities.

Figure 31- Paper Classification II

4.2 CASE STUDY ANALYSIS

In order to value all observations gathered from the theoretical study, a set of use cases were identified and analyzed. The aim of this analysis was to verify and validate the findings that represent the pillars of the research framework throughout a comprehensive empirical research of all existing shades of bSCF already available on the market.

As far as these topics concerns, to a greater or lesser extent, both BCT and SCF are newcomers on the global market. As a consequence, the identification of practical significant examples for the research required a meticulous online research.

The degree of innovation of both topics does not allow to find categorizations about how supply chain finance inefficiencies and implementations barriers can be mitigated by BCT unique features. Due to the lack of existing studies, the only way to find useful information about the functional relationship between BCT and SCF, was to study in detail all bSCF initiatives available on the market, to understand the way in which they leverage on BCT to deliver trade finance activities and to elaborate the available data to find regular patterns and homogeneous groups.

4.2.1 Data Collection – Secondary Data

The data gathering phase started analysing available secondary sources that guarantee proven expertise and reliability about the day-to-day evolution of bSCF market. These sources showed the existence of bSCF solutions offered by both start-ups and incumbents. The very first research, looking for solutions available on the market, was carried out considering as key resources:

- Academic papers, studied in the literature review, referring to specific bSCF solution. Specific use-cases were used as practical evidence of theorical considerations, thus ensuring empirical validation.

- Whitepapers, documents presenting the vision for a technology or service and providing talks about it, can impact on their reference sectors once the technology will be launched.

- Notorious and influencing newswire and information source websites for the Fintech community (Finextra, Pymnts, Global Trade Review).

- Leading blockchain-based websites providing useful insights about uses of blockchain in trade finance and supply chain management market. (Blockchain4Innovation, Ledger Insight).

- The most relevant online start-up available databases. These websites allow detailed researches, enabling to filter Start-ups by searching the most identificative tags, such as: "supply chain management", "trade finance", "invoice financing", "invoice", "blockchain", "fintech". Crunchbase powered by TechCrunch, StartUpGenome, Angelist, ICObench and ICOholder are the most representatives of this website category.

- Coindesk, news website specialized in blockchain, bitcoin and other cryptocurrencies. By filtering research using tags ("blockchain", "blockchain + supply chain", "blockchain + trade finance", "fintech" solution providers are cited in different articles.

The detected applications were firstly categorized considering their blockchain related field of expertised: *data management, capital markets, advertising management, lending, payments, property registry, tracking & supply chain management, supply chain finance* as relevant topics for the objectives of the research. This first research led to the identification of 45 applications, both start-ups and incumbents, providing bSCF platforms.

4.2.2 Data Screening and Reduction

The initial database included both Start-ups and initiatives carried out by IT incumbents or consortia but, from a more detailed analysis of available sources of information, evidence was that Start-ups fit much better with these topics.

Start-ups, along their path of activation to the market, consider as crucial to show what are the theoretical basis of their offering and to highlight their key enabling improvements in the way they deliver their services. On the other side, incumbents tend to focus their effort on the technological side without providing much information about the acknowledgment steps that led to the launch of bSCF initiatives. Once most of the initiatives on the market were discarded from the database due to a general lack of information and details about projects and a set of 27 use cases was defined.

4.2.3 Data Collection – Primary Data

On one hand, secondary data enabled to categorize companies according to their value proposition, most relevant BCT characteristics and about the improvements brought to SCF dynamics. On the other hand, being data available online, they may be characterized by a general lack of accuracy and in some cases, critical features were not explained exhaustively.

Consequently, being the dissertation project a quanlitative work, the decision was to

obtain as much primary data as possible, in order to bring value to the emerged theorical findings. Using primary data means collecting them in first person: this is possible in different ways, for example by observing and taking organized notes, recording interviews or measuring activities and data, for example through a questionnaire. Informations that can be considered is endless, so the choice of the proper ones is very important. Referring to this research project, such an approach allows to gather irrefutable and influential informations about how companies integrate BCT unique advantages with SCF implementation barriers. Additionally, data reached by first hand bring additional practical findings able to validate the previously identified preliminary research framework.

In order to collect primary data, the decision was to carry out as many interviews as possible. Thus, an interview prototype was created (see APPENDIX A-B). The interview aimed to gather following data: general informations about the company, about the bSCF solution charateristics and about the BCT architecture.

- *General information about the company.*

  This section has been created to better contextualize the initiative. The reasons that led to the creation of the initiative, the stage of maturity in their way to become active on the market and, last but not least about the nature of the ecosystem. The nature of the ecosystem constitutes a vital information to understand the very first reason that gave birth to the platform.

- *The bSCF solution offered.*

  This section investigates the unique features of the offering. At first, information about the service and target customers aims to obtain a bigger picture of how the company operates. Secondly, in this phase, data about the way in which the BCT mitigates SCF inefficiencies are investigated.

- *Blockchain platform characteristics.*

  This section is the one in which data about the usage of BCT features are gathered. Not only from a structural point of view, but also in terms of how

each feature works and improves performances in trade finance activities.

Once the interview master-scheme has been developed, the interview has been attached to an engagement e-mail (see Appendix A). The role of the engagement email is to set a direct connection with companies. More practically, a brief explanation about the research project and about the investigated topics has been written. Then, the e-mail has been sent to all the bSCF initiatives considered relevant after the review of secondary data availble.

5. PRELIMINARY RESEARCH FRAMEWORK

The first step of the analysis consists in the creation of a framework of theoretical nature in which present the variables and their inter-correlation. In particular the variables constituting the framework are distinguished in three different types -a categorization which will be maintained in the whole research process- called the SCF inefficiencies, the Drivers of the inefficiencies and the BCT features. The first two groups present a particular 'Parent-Son' relation, more specifically the SCF inefficiencies can be decomposed in a particular subset of Drivers. This relation allows to decompose a complex and broad problem as a SCF inefficiency is, in more simple and direct problem, enabling higher levels of detailing and completeness in the analysis of the first. Later in this section the variables are presented and explained one by one.

This phase is needed to resume and visualize the actual state of art of the literature into a univocal frame, which will be used both to start the market research and to evaluate it.

In fact, all the punctual variables searched in the case studies, useful to perform a valuable analysis, are extracted at this stage. The same answer to the RQ1 will be reached by comparing this theoretical and preliminary framework with the one built on empirical evidence of the market.

Recalling the famous statistical concept of 'Garbage-in-garbage-out' the goodness of the framework in terms of the variables composing it together with their inter-correlation is of fundamental importance for the whole process, input data of poor literature basis would directly and indirectly affect the answers to the RQs invalidating the results of the research. For this reason, the set of variables presented in the models is not broad and general, but includes only the most 'Popular' and recognized attributes according to a triple perspective, academic paper, white paper and the direct opinion of an expert in the field.

5.1 VARIABLES IDENTIFICATION

Once identified and analyzed the inefficiencies of the SCF programs, in order to better understand the causes of these inefficiencies and identify possible strategy to solve it at a macro-level, it is valuable to understand the drivers which lead to scares performance.

Therefore, after having identified drivers, a de-structuring phase had followed, in which each macro-level inefficiency had been reconducted and explained through those drivers.

From the literature had been extracted seven drivers, representing specific and very basic problems.

Their nature makes them applicable to multiple industries and processes and so the same driver may assume slightly different connotation according to the inefficiency it stands for.

Being able to solve these problems would bring a little advantage per-se, independently from the industry and the process. However, the aim of this research does not focus on solving singles drivers; rather on identifying Business Models able to solve a whole inefficiency, by eliminating, one by one, the specific subset of drivers forming that inefficiency and thus, bringing major value adding to their customers.

In particular drivers have two different, the entry barriers and the performance destroyer. The firsts are those drivers normally met before the implementation phase, which disincentivize the adoption of a SCF program. The lasts instead are problems tied up to the execution of a SCF solution, that will recur during the whole lifecycle of the program and negatively impacts on the performances on a regular base.

5.1.1 SCF Drivers of the Inefficiencies:

- LACK OF STANDARD and TRUSTED INFRASTRUCTURE: pursuing standardization across a SC means improving various aspects and rising the

efficiency of internal and external process. "Administration, verification, approval, transaction and settlement" (Omran, 2017) are all example of process which can benefit from the recurs to standardization, in terms of "time, errors, costs, waste and resource allocation and friction" (Omran, 2017).

Beside this, adopting an infrastructure easly compatible with the suppliers/buyers systems has also a strategic reasons, which facilitate the firm in establishing strong and transparent collaboration with partners.

Standardization can be achieved in different form, in terms of technology used, reporting metrics, systems and architecture configurations. There is not a prior aspect with an higher priority a priori, every industry supply chain has its peculiarity, but in general terms every good relation is based on easiness of data sharing and process integration. Despite this today the majority of companies rely on siloed and centralized data, and a lack of focus on data cleaning and validation create a barrier the fully usage of owned data.

Looking specifically in the SCF market, a proliferation of infrastructure provider can be notices, depside this the market is still fragmented and disomogeneous, no big player have conquered high market shares and a standard architecture have not emerged yet.

The affirmation on the market of standard architecture, and related processes proposed by this players, would enhance the collaboration between extraneous firms and facilitate the onboarding process of participants to a SCF programs for investors. (Camerinelli E. &., 2014), (More, 2013), (Omran, 2017)

- CREDIT ASSESMENT: the credit rating is an index of the creditworthiness of a firm, in other words, its capacity to meet financial duty toward the investors. There is not a univocal formula, even thought traditional methods of credit rating assessment involve the payment history, the debt issued, the length and type of credit used (FICO, 2018)

As visible, it includes items of financial nature of the, completely denying the operartive results of a company. As a result, the most penalized firms by this approach are the SMEs, generally characterized by worst financial performance and in some cases a lack of reporting data.

Therefore, the credit rating tend to be higher, which means lower cost of financing, for the large corporation, in this paper identified with the role of buyers, and lower for the SMEs which supply the large corporation.

Buyer-led solutions as Reverse Factoring are a widely used techniques to improve the financial conditions of the suppliers, which relying on the credit rating of teir Buyer can decrease their cost of capital. Anyway this solution is a pain relief only for the direct supplier, while, if considering a long Supply Chain with n-levels of suppliers, shows an important lack of holistic perspective, a serious lack given the SCF objective.

- LACK OF A SECONDARY MARKET: while the demand for SCF is continuously growing especially in the emerging market, the unserved market rate still does not decrease. Banks tend to avoid unserved market, due to a lack of trust in the SMEs, and internal policies which tend to privilege few higher-returns/ low-profitability investments rather than a vastity profitable investments generating a modest surplus.

  The space for a secondary market is huge and seems to be attractive for other formal investors and informal investors. Start-ups around the word have already developed business models aiming to create such a market, offering different service under the common form of a marketplace.

  In truth while the buyer and supplier side is often crowded by firms willing get financed their invoices or whatever other asset, these businesses still struggle to find investors willing to provide capitals. The investments in SCF still remain largely unknown or considered too complex and investors tend to put their funds in most popular industries. (Camerinelli E. &., 2014), (Siddall, 2010)

- LACK OF TRANSPARENCY: all SCF programs have as the primary aim of fostering the transparency across the SC. In fact, transparency is recognized as a true source of value and one of the main drivers to strengthen the relationships along the supply chain. This reason clarifies the presence of reporting platforms, used by the actor involved in a SCF program, to share data and information, decrease the information asymmetries and possibly reduce risks related to the behavior of other participants.

  By the way the modality in use nowadays to bring transparency to the SC seems not appropriate to satisfy the level of performance desired, putting a brake to the potential benefits spillover of the SCF initiatives. "Deficient information, rules, collaboration, governance and distrust of authorities (..), invisibility of errors, misappropriation, and misdirection" (Omran, 2017) still affect the information systems of many business creating situation of opacity.

  The effort sustained since today brought to a situation better resumed under the term visibility than real transparency, which is not enough to enable unconditioned trust and superior level of collaboration.

  Process such as "trace and control the key product information and documentation of each item (e.g. foods, metals, jewels, raw materials) throughout its lifecycle, the manufacturing, the maintenance, the compliance to regulations and the recyclability of resources, a real-time verified certification of authenticity, quantity, quality and ownership of each physical resource that is moving along the SC" (Gelsomino, 2016) require a drastic improvement in transparency. With the actual technological resources firms are forced to increase investment with modest delta on the time and effectiveness brought by new solutions.

  (Gelsomino, 2016), (Omran, 2017), (Protopappa-Sieke, 2017)

- PAYMENT PROBLEMS: in B2B the form of payment is more complex than in B2C. The amount of liquidity to be exchanged is huge and in some cases has to be transferred in a deposit at a large distance. Moreover, some trades can involve

firms using different currencies and multi-banks. To manage this complexity firms and financial institution deployed a real process which, in the case of a generic transaction, start after the invoice approval by the buyer and finish when the Bank of the supplier receive the money and confirm the good outcome of the process.

Due to the multitude of intermediaries which appear in this process – up to three banks, the Supplier's, the Buyer's and a Correspondant Bank and up to two local clearing networks- the costs are sensible, and the process is far from be efficient in terms of time.

For funders instead providing early payments means exposing at risk financial capitals with very low insurance measure in case of fraudulent behavior from the recievers

Forms of Digitalization of payment have emerged and refined in the last years, they guarantee higher traceability over the financial flows but they are still maintain a centralized architecture and it is in doubt the effective security and reliability of the process.

(Accenture, 2015), (Hofmann E. S., 2017), (Swan M. , 2015)

- PAPER BASED DOCUMENTS AND TRANSACTION PROCESSES: in popular SCF solutions such as Letter of Credit, Factoring and Reverse Factoring, paper based documents still exists and are processed manually to verify their compliance. The process is particularly time consuming and it is subject to accidental faults and intentional manumission.

  Being able to eliminate this old-fashioned process means boost the exchange of information and the financial flow in the SC, rising the efficiency -in terms of accurate data- and thus incentivizing a collaboration.

  It is actually possible for a firm to recur to forms of dematerialization and automation, such as "e-invoicing, which replaces the paper-based distribution and provides faster receipt of the document by the buyer" and "the self-billing procurement model, which can be deployed in the large ERP systems and

simplifies the approval of payments due to electronic three-way matching."
(Hofmann E. S., 2017). This digitalization process should be comprehensive and extended also to the back- end system in order to switch digital the totality of the delivery documents, in order to trigger faster invoices with major benefits.

Moreover, recurring to digitalization and automation require for sure an initial cost, but when intensively used within -and out- of the organization achieve economies of scales which lead to a saving cost per se, in comparison with the cost of the provision, logistics and maintaining deriving from paper-based transactions and processes.

(Gomm, 2010), (Hofmann E. &., 2010), (Hofmann E. &., 2011), (Hurtrez, 2010)

5.1.3 SCF Inefficiencies

From the literature had been derived six major inefficiencies which affect generic SCF initiatives, covering the whole lifecycle of a SCF program, from the adoption to the management. Of course, each of the single SCF solution illustrated in chapter 1 respond differently, some inefficiencies may be a particularly relevant pain point of a certain solution and a low-impact barrier to other and vice-versa. At the same way, also the actors affected by the inefficiencies are different and get different impact. The role of this section is to analyze and report the macro-problem specific of the SCF programs, pointing out the zone of impact and the gap to be filled, together with actual most innovative solution in use to face those problems.

Below the inefficiency are explained in detail, including the drivers composing it and the actor suffering the negative spillover :

- FINANCING OPTIONS FOR A LIMITED NUMBER OF SMES: SMEs worldwide experience the same restrictions to access the traditional form of financing their operating activities, resulting in a poor set of alternatives at an high risk incentive.

Issuing financial instruments towards SME has always be seen suspiciously by banks, The risk perceived is accentuated by the lack of automated and standardized processes, paper based transaction and lack of an adequate infrastructure, resulting in the impossibility to visualize data in real time and a general increasing of the transaction costs within the SC. Moreover "low-quality credit information limits the risk assessment process, to their unproven managerial capabilities and business models that result in higher required collaterals" (Omran, 2017).

These barriers prevent the full adoption of SCF program in the SC; in this circumstance of scarce participation, the spillover of benefits for the entire SC is strongly affected by the lack of collaboration. More general effects are tied to the role played by SME in many industries, in many case their expertise are key to the focal firm, and a lack of financial resource of the small suppliers would have significant effect downstream the SC. A major solution adopted to solve in part this problem, consist in an onboarding action of the focal firm which allow the small suppliers to obtain financing at the more convenient risk price of their customer. (Camerinelli E. &., 2014; Camerinelli E. &., 2014), (Gelsomino, 2016), (Hofmann E. S., 2017), (Hua, 2013), (Jensen, 2017) (Lamoureux, 2011), (Milne, 2009), (Nienhuis, 2013), (Omran, 2017), (Saleem, 2017), (Wuttke, 2016), (Zhang, 2009)

Figure 32- Financing Options For A Limited Number Of Smes

- SUPPLIER ON BOARDING PROBLEMS: the traditional market for SCF see the major role of the bank as funders and financial intermediaries, making them central actor in the success of a financial instrument. Both protecting their interests and the interests of the all stakeholders of a program, against criminal behavior and money laundering attempts, banks operate a careful know-your-customer activity every time it is required to onboard a new supplier in the programs. Analyzing those kinds of process several inefficiencies can be reported, lack of automation and standardization lead to inaccurate data, typo and missing files. Moreover, being the task and the actors involved in this process multiple and interconnected the flow of data exchanged is intricated and require long amount of time.

  At the date, with the traditional methods. Banks have to perform this process singularly and internally, with no exchange of information with other institute nor access to past process performed by other banks.

  Particularly suffering of these problems are those supply chain with a central megafirms and an ecosystem of supplier of small and medium size. Onboarding customer activities costs up than 2 000 € per firm, represent an important source of inefficiency if considering solutions involving 100 – 150 suppliers, often located in different part of the world, as in the industry of automotive, aviation and shipbuilding.

  Removing those inefficiencies means higher margin for financial institutions, increasing the attractivity of the SCF market and thus fostering the competition between banks. This may turns into a better service delivering in general and may represent an enabling factors for a multitude of SME, due to better financial condition offered in the programs.

  (Deloitte, 2016), (Goldman Sachs, 2016), (Hofmann E. S., 2017) , (Mainelli M, 2016), (Nassr I, 2015) (Omran, 2017), (Wuttke, 2016)

	Drivers						Actor Involved		
	Entry Barriers			Performance destroyer					
	Lack of Standard Infrastructure	Lack of Trusted Infrastructure	Credit rating Assesment	Lack of a Secondary Market	Lack of Transparency	Payment problems	Paper Based Documents and Transaction Processes	Suppliers	Buyers	Investors
Supplier On Boarding Problems	1	1	1		1	1	1	1		1

Figure 33- Supplier On Boarding Problems

- DOUBLE FINANCING: the definition of digital asset involves a wide range of asset, which vary from digital currencies to software, data, music, digital properties all affected by the same problem, known as Double Spending problem. All digital asset in fact, despite what they represent, can be reduced to a string of bits and when users exchange assets they simply send each other a copy of the original file. In some cases, exchange a copy, rather than the original file is not a huge problem, it is normal for everyone to exchange text and multimedia files via internet, being barely aware of what we are sanding.

  For B2B companies, and in all those cases a user needs to exchange value via internet, the Double Spending problem becomes relevant, given the impossibility to copy a digital currency or an ownership certificate from a wallet and transfer it to another one.

  The same problem is faced by the investors in a SCF program. They need to be sure the Invoice they are going to financing is the 'original copy', not financed yet in a different bank or marketplace. In fact, companies with malicious intention can rise double, triple or quadruple liquidity from a single invoice by financing it many times from different intermediaries, and the same tactic can be applied not only to invoices -the most typical case- but on any kind of collateral.

Eliminate the Double Spending problems and provide proofs on quality and quantity of the goods contained in an invoice means reducing the risk for an investor, making the market more attractive and in general rise the offers for funding.

Nowadays, to tackle this problems, financial investors rely on an intermediary which, relying on its database, have the role of validate single invoices in a transaction to make it safer. Of course, this third party require time and rise the amount of transaction cost, impacting on the efficiency and profitability of the investment.

(Cham, 1992), (Catalini, 2017), (Deloitte, 2016), (Harris, 2016) (Hofmann E. S., 2017), (Oliver Wyman, Euroclear, 2016), (Nakamoto, 2008), (Pisa, 2017), (Subramanian, 2017), (Swan M. , 2015)

Figure 34- Double Financing

- LACK OF ACCOUNTING RULES AND TREATMENTS: besides all the benefits described above, a contingent effect of the SCF programs often contributes to rise the attractiveness of the discipline for the different actors, in particular:

- SUPLLIERS: SMEs multitude, representing the supplier of a focal firm in a SC, have as prime financial objective to free up liquidity. Liquidity in fact, "is one of the key financial ratios for measuring the riskiness of SMEs – i.e. the probability of default-" (Altman E, 2007).

  For those company is possible to get financial capitals at a lower cost, relying on the better credit rating of their large customers;

  (Altman E, 2007), (Hofmann E. S., 2017), (Lussi, 2009)

- BUYERS: accounting regulation usually do not consider trade payables as a debt in the balance sheet, in this way all the issued financial asset doesn't affect the debt ratio, bringing better credit rating over time. Due to certain accounting treatments, buyers can face the risk of 'Reclassification' of their trade payables in financial payables, nullifying the positive effects on the debt ratio. The intent of this reclassification process is to avoid collusive behaviors between Buyer and Bank with the scope of appropriate and share all the savings coming from a cost reduction in the SC, given by a SCF program.

  The reconciliation involves an auditing process particularly consuming in terms of time and costs, mainly due to a siloed nature of the data -which imply also a lack of standardization- required to perform it and it is even more complex when the collaboration between parties lack of transparency and efficiency.

  (Aite Group, 2018), (Gustin, 2014), (Hofmann E. S., 2017)

- FINANCIAL INSTITUTIONS: after the word financial crisis in 2008, the Third Basel Accord, signed by Basel Committee on Banking Supervision in 2011, provide a regulatory framework for banks capital requirements by "by increasing bank liquidity and decreasing bank leverage" (Wikipedia, 2018). SCF investments, characterized by low insolvency levels and freed-up

liquidity from trade credits, turned out as a convenient set of financial instruments to deal with this framework. Programs initiated by buyers in particular shown the most potentiality, due to lower risks level and a profitability enhanced by the capital requirements, by far less demanding in comparison with other financial services.

(Aite Group, 2018), (Altman E, 2007), (APEC(Asia-Pacific EconomicCooperation), 2018), (Cham D. , 1992), (Camerinelli E. &., 2014), (Deloitte, 2016), (Gustin, 2014), (Hofmann E. S., 2017), (Lazanis, 2015), (Leventi-Perez, 2018), (Loom, 2018), (Muldoon, 2018), (PWC, 2014)

Figure 35- Lack Of Accounting Rules And Treatments

- LACK OF EFFICIENT COLLABORATION: "According to its potentials, we define supply chain collaboration as a business process where supply chain partner work together to execute supply chain operations" (Mentzer, 2001). SCF discipline first objective is to foster this coordination, with the ultimate goal to establish "win-win relationships" (Fellenz, 2009) among partners.

The effort to turn the SC into a digital infrastructure aims, entirely or in part, to fulfill this collaboration objective, bringing actors in a new, integrated ecosystem. In particular the automatization of process and transaction bring synchronization of the three SC flows, material, information, financial.

The Buyer- Supplier relation can be seen from the Principal- Agent theory point of view. Information asymmetries and different incentives in reaching a goal creates major problems.

The best real time infrastructure to exchange data between partner is useless if not continuously updated and/or checked on a real time base.

Thus, technology alone is not able to close the gap to reach full efficiency in a relationship, being necessary a cultural and mindset alignment with this objective within the whole organization.

Technology and culture have to proceed together; the infrastructure needs to prove its benefits, be reliable and user-friendly. The culture has to be transmitted to the employee with a managerial effort, interiorized and, most important, have to be introduced in the daily process of the firm.

Process as information sharing, goal alignment, joint decision-making and benefits sharing are drivers of an advanced level of collaboration in which also the perspective of a small supplier is taken in consideration, an optimal case to minimize the Principal-Agent divergence.

Adapting to this considerations, innovative SCF instruments progressively rely on data exchange and integrated business to optimize the amount of working capital in a SC; despite the attention dedicated on the theme, a general lack of holistic view of the SC still lack in the firms.

(Camerinelli E. &., 2014), (Fellenz, 2009), (Gelsomino, 2016), (Hofmann E. &., 2011), (Jolyon, 2015), (Mentzer, 2001), (Randall, 2009), (Steeman, 2014)

	Drivers		Actor Involved		
	Entry Barriers	Performance destroyer			
	Lack of Standard Infrastructure	Lack of Trusted Infrastructure	Credit rating Assesment	Lack of a Secondary Market	Lack of Transparency	Paper Based Documents and Transaction Processes	Payment problems	Suppliers	Buyers	Investors
Lack of Efficent Collaboration	1	1			1	1	1	1	1	

Figure 36- Lack Of Efficient Collaboration

- HIGH TRANSACTION COSTS: high transaction costs coming from different process sensibly affect the overall costs of implementing and maintaining a SCF program, with the results of reducing the benefits and the profitability of all the initiative for multiple actors. In most cases are the SMEs the players affected the most by transaction costs, which even make a SCF program unsustainable and leading those companies out of the market.

In general transaction costs arise due to the presence of intermediaries which pretend a fee to the service provided, the more are the intermediaries stuck in a process, the highest the transaction costs, with peaks in certain process, such as bond issuing, reaching 10% of the overall value of the bond.

Two major sources of transaction costs are the security settlement in a securitization process and the international payment to suppliers.

In the first cases the process starts after the trade, when the funders get confirmed its financial operation. Three intermediaries appear in the process:

- o a Custodian Bank, "that holds customers' securities for safekeeping so as to minimize the risk of their theft or loss." (Investopedia, 2018) ;

- o a CDS (clearinghouse) "responsible for settling trading accounts, <u>clearing</u> trades, collecting and maintaining <u>margin</u> monies, regulating delivery of the bought/sold instrument, and reporting trading data" (Investopedia, 2018);

- o An information service provider with technical expertise to provide and run the infrastructure;

Similar processes are executed also in post-shipments SCF initiatives involving the trade of invoices, but the inefficiencies are particularly relevant when the asset trade is physical -the securities- and require on-field inspections. A particularly critical case is the one of Reverse Securitization, characterized by "fixed income securities and short maturities" (Hofmann E. S., 2017) and a high ratio $\frac{cost}{investor's income}$. An effective securities settlement in terms of time and costs would mean sustainable financing costs for small suppliers, lower costs for investors and benefits on the WC which interest also the core firm.

The second case is more general and affect all those firm working with international suppliers.

Multi-currency transactions are, indistinctly by the SCF programs chosen, a major source of costs and require time to be performed, due to the presence of multiple banks needed to perform such a process in a centralized way.

(Accenture, 2015), (Abeyratne, 2016), (Delmolino, 2016), (EBA (European Banking Authority), 2015), (Hofmann E. S., 2017), (Mattila, 2016), (Severeijns, 2017), (Tapscott, 2016), (WEF (World Economic Forum), 2016), (Wright, 2015)

	Drivers				Actor Involved				
	Entry Barriers			Performance destroyer						
	Lack of Standard Infrastructure	Lack of Trusted Infrastructure	Credit rating Assesment	Lack of a Secondary Market	Lack of Transparency	Paper Based Documents and Transaction Processes	Payment problems	Suppliers	Buyers	Investors
Transaction costs	1	1	1			1		1	1	1

Figure 37- High Transaction Costs

5.2 BLOCKCHAIN FEATURES IDENTIFICATION

This section introduces a list of characteristics, addressed in this paper as "Blockchain Technology (BCT) features" which distinguish this specific technology from the others. The features are presented in general terms, not concerning the type of SCF used -es. Public or Private-. Anyway the forms of BCT used by the firms composing the case studies are various and present substantial difference, which, are specifically reported and defined in each of the case study.

▪ DISTRIBUTED TRUST MECHANISM

The distributed consensus mechanism is one of the selected unique attributes of BCT that can be considered an enabler for SCF solutions. A centralized approach does not fit with real world requirements.

Try to imagine a focal company trying to integrate its system with all its suppliers and retailers. Data would be centralized in their database without much difficulty. On the other hand, all of a sudden, in their turn, every supplier will have to

integrate with its own suppliers and retailers. All this, from a theoretical point of view, sound workable but not feasible.

As a consequence, the distributed ledger technology and the distributed trust mechanism gives the possibility to create a permissioned and distributed network of peers able to share data in a secure, transparent and standardized way.

BCT has reshaped the mechanism of consensus: from a a central authority, in other words a trusted third party, has the medium to reach approved consensus to a new model with no middleman. The Blockchain algorithm provides consensus without the need of central and allows to transfer digital assets, through private – public keys, and enables efficient transactions and settlements through the use of distributed ledger.

This would remove the need for post-trade affirmation or confirmation and central clearing during the settlement cycle, and it reduces the scope for data errors, disputes and reconciliation lags, which speeds up the end-to-end process (Oliver Wyman and Euroclear, 2016).

The time-stamped hash-based algorithm that underpins the DLT automatically authenticate and time-stamp all information registered in it without the need for an intermediary. Interested parties can be sure that given information existed at a particular date and time. The possibility of hashing documents in a blockchain guarantees authenticity and prevents tampering. (Hofmann, 2017)

- SMART CONTRACTS

    As emerged in the literature review, a smart contract is a set of logic rules in the form of a coded script which can be embedded into the blockchain to govern a transaction. It is is a computerized transaction protocol that executes the terms of a contract. The general objectives are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimize exceptions both malicious and accidental, and minimize the need for trusted intermediaries. Related economic goals include

lowering fraud loss, arbitrations and enforcement costs, and other transaction costs.

The contract is executed autonomously and is used to govern the transaction (Buterin, 2016). In this way, contracts act as smart software agents (Stark, 2016). Once a smart contract is embedded in the Blockchain, it becomes an autonomous agent that is tamperproof.

The nature of a smart contract is not just the application specific code; it can also be used codify the terms and condition of an agreement into the transaction workflow (Karim Sultan, Umar Ruhi, Rubina Lakhani, 2018).

The Blockchain Technology have allowed the running of small programmes, which potentially enable trusted automation of contractual relations between trading parties. If the Internet permitted the exchange of information between peers, BCT has made it possible to exchange value. The consequences of this technical revolution are difficult to foresee and will probably generate great opportunities for all industries and human activities. (Hofmann, Bosia, Strewe, 2017).

As a consequence, to bring practical evidence to earlier statements, all the largest financial services firms, for example, are planning to use BCT as a record of ownership and transaction in order to avoid the time-consuming reconciliation of each internal ledger in order to create a faster and safer system. Analysis suggests that this new technology could reduce banks' infrastructure costs attributable to cross-border payments, securities trading and regulatory compliance by $15–20 billion per annum by 2022 (Santander InnoVenture, 2015).

Smart contracts are one of the features chosen as enabler for bSCF for several reasons. A Smart contract makes transactions traceable, transparent, and irreversible, the tenets of a sustainable supply chain. This solution would be best applied when multiple actors in a vertical supply chain want to create sustainable change.

TRADITIONAL CONTRACTS	SMART CONTRACTS
1-3 days	Minutes
Manual remittance	Automatic Remittance
Escrow necessary	Escrow may not be necessary
Expensive	Fraction of the cost
Physical presence (wet signature)	Virtual presence (digital signature)

EFFICIENCY

- FULLY P2P:

  BCT networks can record and score transactions. These transactions take place between differents actors, which act as nodes. Nodes process, receive and transmit the information in the peer-to-peer network configuration. Additionally, every node of the blockchain stores all the records.

  The revolutionary side of this configuration is related to the absence of a central node that acts as trusted third-party. No central nodes that act as regulator, that stores, process, validates and verifying transactions. This is allowed by the fact that participants a linked together in a blockchain-based marketplace where transparency is fully assured. The blockchain enables real-time access and visibility over the contents stored in the distributed database.

  Addictionally, the is no central server. It means that the likelihood on central failure is almost canceled and that the network is more reliable both in terms of security and availability. (Omran, Henke, Heines, & Hofmann, 2017).

  From a practical point of view a peer offers a portion of computing resources such as processing power, network availability to other participants without no need of centralized servers. New systems of communication could be established by exploiting the P2P network nature of blockchain technology.

(Salviotti, De Rossi & Abbatemarco, 2018).

What this means is that the transactions recorded on a blockchain cannot be deleted or attacked. Doing it would mean destroying all the nodes of the network. Therefore, as long as a single node with a copy of a blockchain exists, all the records will remain intact, providing the possibility to rebuild that network.

The P2P configuration has a great potential, it allows to cut inefficiencies. The auditing process can be automatically ensured by fully transparent and incorruptible data without the requirement of an authorized central institution that proves the authenticity. As result, the barriers are removed by deleting the middle-man in the back office activities. Furthermore, this would be translated into less settlement costs and less costs to verificate data.

- SMART ASSET MANAGEMENT:

  In recent times, a new term started to become more and more popular in the world of blockchain and, it was related to the security management system. The so called tokens, is an item, digital items that can be transmitted in an easy and secure way.

The process that allows to convert a stored asset into its corresponding digital equivalent. Using smart assets means offering autonomy, anonymity and lower transactions costs when compared to the existing real world.

More practically, smart assets are unique digital currency tokens that are the virtual representation of a real tangible asset or certificate of ownership that can be sold, exchanged or bought according to the rules on which smart contracts are executed. The most powerful innovation leaded by smart asset management processes are related to several different activities such as: on-boarding, document management, trade execution and settlement, data ownership. Thus, is possible through the

explotation of the new logical and automated scheme of smart contracts. They are able to automate and digitalize the business process.

As a result, smart assets, jointly with smart contracts could be the medium through which revolutionise asset lifecycle management.

As mentioned before, tokenization is the replacement process of sensitive data with unique digital identifiers called tokens. This transformations is a key feature to enhance security in blockchain networks. Tokenizing data means minimizing the amouth of data that have to be managed off blockchain: it has become more and more frequent for SMEs, to convert their assets into their digital counterpart using tokens.

- DATA IMMUTABILITY:

  Blockchains are designed to be immutable.

  Nowadays, immutability is one of the most representative issues at the heart of the blockchain. Blockchain-based platforms allow only to add data and not to modify or take it away. That why, blockchain networks are denominated append-only system, which means you can only add data to it, you cannot take it away. That means that all the information on a blockchain is essentially permanent and immutable.

  Immutability is the feature at the heart of the trusted nature of blockchain. Data on the blockchain is legitimate and validated by the other participants joining the network. Data are stored at each node that could not remove anything and each node cannot process them according to its specific needs.

  An immutable transactions history could also provide a chain of possession in supply chains, providing a clear indication of provenance and allowing tracking of the traded products (i.e. chain of possession).

  According to a recent working paper by Oliver Wyman and Euroclear (2016), the major benefits of this technology in the financial space are derived from the ability of this technology to provide transparent real-time data. This peculiarity of the

blockchain could eliminate the need for data enrichment (such as aligning trade data with settlement data), reconciliations and disputes amongst counterparties Participants could selectively reveal trusted data to another counterparty ahead of trading time to provide greater certainty of their own worthiness and thereby reduce risk and/or credit exposures.

- SECURITY:

As reminded by its name, blockchain technology is composed by different virtual blocks, each of them owns the records of transactions. Blocks are all connected each other. Therefore, it is complicated to tamper a block since the attacker would have to modify all the blocks to elude detection. This is not the unique feature that enhances security but, is a really important enabler to improve the overall security of the network.

The second technique that improves the level of security is cryptography. Participants are in possession of their private keys, assigned to the transactions they execute. Therefore, private keys behave as identifier or digital signature: if a record is corrupted, the signature will be invalidated and the network will detect that something happened. (Salviotti, De Rossi & Abbatemarco, 2018)

In this day and age, hackers are becoming more and more sophisticated but, blockchains still represent real-time p2p networks, with the lower default likelihood. The absence of a centralised server source allows to split the decentralized the failure on multiple blocks that cannot be attacked contemporary That is th reason why, blockchain is portrayed as an extremely secure solution in many industries, from trade finance, to marketing automation.

Additionally, blockchain technology offers great opportunities for both enterprises and financial institutions in terms of control, speed and reliability of their supply chain. Furthermore, these improvements are backed-up by a significant reduction of infrastructure costs. Exchanges can be monitored on real-time and through

digital systems by both the actors involved: it means suppliers are no longer subject to unfavourable position in the buying process.

- FAULT TOLERANCE:

A Blockchain is an intrinsically decentralised system which is made of different actors who behave according to the incentives they have and to the information they can access.

On the platform, when a new transaction is transmitted to the network, nodes can include that transaction to their stored copy or ignore it. Then, once the majority of participants validate the data, consensus is achieved.

Related to the aforementioned characteristic, a problem about distributed networks and multiple participants platforms has emerged: the overall network has to be reliable in other to avoid default. In order to do this, the consensus protocol has to be fault tolerant.

By definition, blockchain are not controlled by central entity. Every node has equivalement power in the network and could have great advantages by causing faults in the network. That is why blockchain has to ensure Byzantine Fault Tolerance, the solution of the Byzantine Generals' Problem.

Without a BFT system, a peer might act fraudently, sending false transactions and data compromising the system reliability. And potentially, there is no central node able to tackle the attack.

Two methods have been developed in order to combat the BFT. The first one the typical consensus algorithm that regulates Bitcoin's network and other crypto networks. This configuration is the "proof of work" algotirhm. From practical point of view, different actors computing power is used to solve a puzzle that represents the new block. The puzzle is used to avoid attacks and make the verification process more transparent due to the fact that validation is conducted by honest members. Those members are rewarded for verification when the network can certify the new block before its creation.

Alternatively, "proof of stake", which does not create the new block starting from the validation made by all the computer on the network. When a system is regulated by "proof of stake" consensus algorithm, the creator of the new block is chosen in a deterministic way according to its wealth, also known as stake. The actors that owns the biggest percentage of total coin supplied is the behave as the creator of the new block. This, due to the exclusion of thousands of computers from this process allows to reduce energy consumpio and, as a consequence costs: only few computers are involved in the verification in each block.

Nowadays, although "Proof of stake" is more efficient, is does not allow to reach the same degree of attention and legacy timespan compared to "Proof of work". In an easier way it can be defined and less secure and reliable. (Frøystad & Holm, 2015).

5.3 THE FRAMEWORK

5.3.1 Matrix Presentation

Going more specifically in the description of the framework, it is composed by a first 2-dimentional matrix, matching the variables defined as Supply Chain Inefficiencies on the raws and the Blockchain Technology features on the columns. This Framework will then be used to run the Cross-Case Analysis and to visualize and evaluate the results. Than the level of details can be increased by visualizing the SCF inefficiencies as the set of drivers composing it and the Actors affected by that problem.

The last two column of the tables are dedicated to the Group selected to explain each specific Driver and the most representative Group impacting the Inefficiency as a whole.

actors involved	SCF inefficency	inefficiency Driver	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)	Driver/Groups
Suppliers, Buyers	Financing Options for a Limited Number of	Lack of Standard and Trusted Infrastructu								
		Credit Assesment								
		Lack of a Secondary Market								
		ased Documents and Transaction Proc								
Suppliers, Buyers, Financial Investors	High transaction costs	Lack of a Secondary Market								
		Lack of Standard and Trusted Infrastructu								
		Payment problems								
		Credit Assesment								
Suppliers, Financial Investors	Supplier On Boarding Problems	Lack of Standard and Trusted Infrastructu								
		ased Documents and Transaction Proc								
		Lack of Transparency								
		Credit Assesment								
		ased Documents and Transaction Proc								
		Payment problems								
Suppliers, Buyers, Financial Investors	Lack of Accounting Rules and Treatment	Lack of Standard and Trusted Infrastructu								
		Lack of Transparency								
Suppliers, Buyers	Lack of Efficient Collaboration	Lack of Standard and Trusted Infrastructu								
		Lack of Transparency								
		Payment problems								
		ased Documents and Transaction Proc								
Investors	Double financing	Lack of Standard and Trusted Infrastructu								
		ased Documents and Transaction Proc								
		Lack of Transparency								

Figure 38- Preliminary Research Framework Matrix

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5.3.2 Research Framework Validation

The output of the theoretical framework has been built on the state of art on the two pillars involved in the dissertation, Blockchain Technology and Distributed Ledger Technology.

Given the scarce litterature, in partcular about SCF inefficencies, the authors founded out a lack of standardization and codification of knowledges in the scenario of reference. The direct consequence is the impossibility to refers to a single paper in order to identify and explain all the variales reported in the framework. The analysis had been carried out from an heterogeneous spectrum of sources, each of them focused on specific aspects rather than on the whole indutry, sometimes also in contraddiction. The need for veridicity brought the authors to overtake a panel consensum approach, interviewing expert in the field to obtain validation over the variables composing the framework. All the efforts in this sense are meant to rise the confidence in the Framework, fundamental for the achievement of unbiased results.

In the identification of SCF variables the objective was to identify macro-inefficencies affecting the industry, including the wider number of sulutions in the analysis. The interviwed expert is Enrico Camerinelli, contacted for the first time in October 2018, and met in the same month in Monza. Mr Camerinelli is a world-famous author on Suply Chain Management and his research appear multiple time in the litterature of this dissertation. The interview was both based on a semi-structured interview track (see APPENDIX C) and based on the its own considerations about the preliminary research framework developed by the authors of this thesis.

What emarged from this panel was a general satisfaction of Mr. Camerinelli with the variables proposed, suggesting to identify drivers to describe the primary inefficencies and to discriminate them between ante-solution, reported in green in the framework, and pot-solution, reported in yellow.

As regard the BCT features, the analysis was easier to carry out, in fact despide the scarcity of the litterature on application services, the papers related to the technological

description of the BCT and its deriving characteristics shows and higher level of standardization in comparision with SCF inefficencies. The variables proposed along this dimention were directly retrived from the CBS – Copenaghen Blockchain Summer School – attended in August 2018 at Copenaghen Business School. In particular the framwork was proposed to prof. Roman Back, prof. Boris Düdder and prof. Omry Ross, promoters and responsables of the summer school and its final hackaton. The variables were unanimely accepted and the whole BCT dimention was considered complete and accurated.

6. USE CASES ANALYSIS

6.1 DATA GATHERING

The initial database included both Start-ups and initiatives carried out by IT inc umbents or consortia but, a more detailed analysis of the available sources of information, has shown that Start-ups fit much better with those topics.

Start-ups, during their way to become active on the market, consider as crucial to show what are the theoretical basis of their offering and to highlight which are the key features enabling improvements in the way they deliver their services. On the other side, incumbents tend to focus their effort on the technological side without providing much information about the acknowledgment steps that led to the launch of bSCF initiatives.

Once most of the initiatives on the market have been discarded by the database due to a general lack of information and details about projects, a set of approximately 27 start-ups has been identified.

During the use-case analysis bSCF solutions providers have been classified according to 14 different variables in order to simplify and clarify the categorization of each Start-Up.

The obtained categorization is shown in the table below. It represents the final start-ups dataset and highlights general features that lead us to consider them a critical for the validation of the research framework.

Figure 39- Database attributes

The "Company/Commisioner" and "Application" attributes represents the ID of each specific initiative and shows that SCF applications might be offered by start-ups, by a consortia consisting of different companies or by incumbents looking for emerging opportunities.

The "Date of the project", "Phase", "Market" and "Industry" attributes allows to obtain a bigger picture of the general features of the application: they provide information and details about the maturity, the market and industry of reference of the application.

In particular, the attribute "Phase" allows to understand at which stage of the development phase is the application:

- Proof of Concept, also known as "POC" is a description of an application prototype created for business processes. It is the first step in the implementation process, and highlights business needs and expected configuration of the application. It enables understanding about the concept providing a sketch of a certain project or method, with the aim of demonstrating the feasibility and the merits of constituent principles of the application. For what concerns bSCF applications, the proof of concept illustrates that a how specific BCT platforms might have potentially a positive impact on SCF. Occasionally, POCs are accompanied by the MVP of the application. The Minimum viable product, which could be translated "working prototype" represents a middle ground between the idea written on a sheet of paper and the finished product to be presented to the market. It is a concrete draft of your product, something that should convince the investor to believe in the project.

- Seed, is a phase in which it is not possible to demonstrate the adequacy of the business idea and fundings are required to demonstrate the technical validity of the innovation that is to be proposed to the market. In other words, it is the period of time necessary for the technical-qualitative development of the project. In most of Blockchain-based projects, this stage lead to a release of a

preview application, known Beta release, of a more exhaustive and articulated application that will be delivered in the next future. These Beta releases demonstrate that the platform is potentially ready to be exploded into a product ready to enter the market. The key to convert prototypes into a valuable business are fundings; it can be translated in a request for the Initial Coin Offering.

- Active: the application is available on the market. The companies identified by the tag "active" have already reached the market and are turn cash flows into profits and to enlarge their business boundaries.

The "Blockchain Type" and "Blockchain Platform Provider" attributes refers to the general features of the blockchain platform. More practically, they aim to explain the platform structural configuration focusing on the provider and on the nature of the chosen blockchain type. The objective of the following classification is to identify differences not only at a high level but also at the application level. The technical considerations related to specific blockchain structures are related to the network dimensions and the relative presence of rights to enter the platform it. From a practical point of you, the main differences between Blockchain, are detectable analysing the number of the participants.

The research focuses the attention on the degree of distribution of the platform, who are the actors enabled to join the platform distinguishing two distinctive typologies.

- Permissionless Blockchain, are defined as platforms that require no authorization to access the network, perform transactions or participate in the verification and creation of a new block. The most notorious providers of permissionless platforms are Bitcoin and Ethereum: they have no restrictions or specific access conditions. This configuration allows to join a completely decentralized structure, without requiring any kind of central authority which authorizes the network access. No network user has privileges on the others, noone could control the information that is stored on it, modify or delete it, and

nobody can modify uploaded data.

- Permissioned Blockchain are application that enables interactions and accesses under surveillance of a central authority. This entity determines who have rights to join the ecosystem and which are the authorized interactions among different nodes. Basically, it defines who is authorized to be part of the network and the roles that a user can cover within the systems. Permissioned Blockchain, led to the introduction the concept of governance and in the network, originally born as fully decentralized and distributed.

The attribute *"Blockchain Platform Provider"* refers the underlying structure behind blockchain, and how vendors are currently utilizing it. The most famous BCT providers are well established. They were born as platforms enabling trade of crypt-currencies with a permissionless configuration, but, over time, the advantages provided by BCT enabled improvement and a diversified approach to many different industries. Thus, leading companies offering BCT platform for crypto currencies have been able to enlarge their out market boundaries: a focus on the technical advantages provided by BCT allowed to diversify the compatibility of the platform with many different fields of applications. SCF is no exception.

The most diffused and adopted providers of BCT paradigms have been able to identify new opportunities in both supply chain management and trade finance market.

Furthermore, another relevant parameter is the type of relationship between the platform and financial institution. Every ecosystem has its own regulations, banks might be involved or not according to the preferences of the platform provider. Three possible configurations, characterized by extremely different orientations, have been identified.

- "Bank neutral" SCF platform: the ecosystem is regulated by an "open" paradigm. The platform does not restrict the presence of financial institutions. Bank neutral marketplaces are platforms designed to match the needs of buyers

and seller with the requirements of investors, and being banks organizations able to provide credit and liquidity are welcomed in the ecosystem. A 'bank neutral' orientation does not deny banks to access the platform and to establish a direct relationship with potential clients. Banks, with their well-established back-end financing activities are able to bring consistency to the group of liquidity providers involved in the platform.

On the other side, solution providers that, in first place, aim to streamline all the collaborative activities on a supply chain scale can be considered 'bank neutral' if they enable banks to access their distributed database to improve the financing performances both in terms of costs and time. A Real-time database would allow banks to access faster and secure information about the SMEs. This practices are more related to the way in which banks classify firms rather then to issue loans; the ultimate goal is to modify banks back-end cumbersome procedures. This architype enables participants to achieve funding sources, to lower the dependence on banks and potentially to syndicate with financing entities. The credit risk data collected on the platform would enable banks to adopt SCF programmes. Traditional documentary finance is becoming obsolete. The benefits brought by a distributed blockchain-based database are related to a global standardization in risk assessment procedures and settlement infractructure that allows the diffusion of SCF practices.

Financial institutions data handling and data protection issues, as well as revenue sharing agreements, and risk assessment processcan be seen a "SaaS" solution, with specific features tailored on their specific needs. (Dunn [2011], Nienhuis et al. [2013], Camerinelli and Bryant [2014], Hofmann et al. [2017], Saleem et al. [2017]).

- "Bank free" ecosystem, banks are considered the most critical barrier when SMEs are looking for financing options, therefore banks are not welcomed in

the ecosystem. The financial investors available on the platform are not banks but different approved public funding entities.

Off the blockchain, banks still remain the most common supplier of SMEs finance, even though, banks risk aversion represents a critical barrier. The initiatives identified by the tag "bank free" think that banks pay more attention to the personal data of buyers: start-up do not have registries of transactions, collaterals and positive cash flows. Therefore, an attempt to streamline banks procedures might be translated into a very difficult practice with lower attractiveness for the SMEs seeking for financing options in which financial institutions are not involved.

- Bank-owned platform: banks are tasting the opportunities brought by BCT technology. More precisely, financial insitutions has realized that, through the BCT, they can innovate their the back-end activities and deliver new SCF inspired financing option for SMEs. As mentioned several time, globally, the credit gap generated by SMEs financing options, has a potential value of approximately 3 trillions dollars. Thus, banks are slyly working to create alternative ecosystems designed ad-hoc for SMEs.

As a consequence, some of the studied initiatives are carried out by banks, both singularly and in form of consortia. Hence, bSCF solution owned by the traditional financial institution, are created in order to manage ensure different financing options for SMEs. In particular, they are trying to develop tailored applications that would enable the adoption of specific SCF solution for groups of companies. Moreover, banks would be able to built trust and long-term relationships with new potential clients (SMEs) . (Van Woelderen and Witteveen [2008], Hurtrez and Salvadori [2010], Siddall [2010], Albrektsson [2011], Camerinelli and Bryant [2014], Saleem et al. [2017]).

	WEBSITE & FEATURED ARTICLES (Secondary Data)	WHITEPAPER (Secondary Data)	INTERVIEW (Primary Data)
Lendflo	✓		✓
TradeFin	✓	✓	
EXIMCHAIN	✓	✓	
primechain	✓	✓	
INVIOU	✓		
ANTA VIRA	✓		
PayPie	✓	✓	
POPULOUS	✓	✓	
DEBITUM NETWORK	✓	✓	
we.trade	✓		✓
skuchain	✓		
SOFOCLE TECHNOLOGIES	✓		
TRADE FINANCE MARKET	✓		✓
XinFin	✓	✓	
CHAINED FINANCE	✓		
edgeverve	✓	✓	
AXenS	✓		
Equipment Connect	✓		
Jed	✓	✓	
symbiont	✓		
inventoryclub	✓	✓	
TRADESHIFT	✓		
invox FINANCE	✓	✓	
33.CN	✓	✓	✓
hive	✓		
ACUDEEN	✓	✓	
bubi.cn	✓	✓	

Figure 40- Use Cases data source

6.2 CASE STUDY MAPPING

This analysis has been carried out exploiting multiple inputs: the findings highlighted by the theoretical research framework, the interviews made with the start-ups that have decided to play an active role in the research project once received the authors engagement e-mail and exploiting all the available online secondary sources (websites, press, blog, whitepapers).

This section of the research works aims to classify the existing bSCF solutions trying to identify possible regular patterns. Each use-case have been studied in detail (see APPENDIX C) and have been compared with the other 26 use-cases in order to identify different approaches to the disciplines, different key pillars and core features of the bSCF platform.

Every group has been described accordingly with the preliminary research framework in order to detect their own distinctive elements. The results of such analysis are described by figures 43, 47 and 51.

From a practical point of view, initiatives have been grouped according to their orientation towards SCF. All of them are providing an alternative financing option for SMEs but they differ in their approach and orientation towards the SCM as a whole.

Figure 41 - Use Cases Grouping Framework

Furthermore, this section has been crucial to address the first research question of the project and to gain all the elements to carry out a detailed analysis of how each BCT features might answer specific SCF inefficiencies (RQ2).

6.2.1 Liquidity Oriented Group

Figure 42- G1 composition

The second group identified is characterized by a unique focus on solutions created for companies looking for faster and efficient dynamics in trade finance activities. The group, named Liquidity-Oriented group, counts 12 firms that, inspired by malfunctions in the financing activities for SMEs, want to create a blockhain-based ecosystem to unlock a market that approximately counts 19 trillion dollars of business potential. As a consequence, several of entrepreneurs decided to exploit the practical advantages brought by BCT in order to developed a platform which aims to streamline all those slow and costly processes, in the day-to-day financing activities. More practically, those companies have created a platform that matches the needs of SMEs with the requirements of financial investors, overcoming the most critical barriers of financial institution denying the credit for regulatory reasons.

In most of cases, the initiatives are platforms customized with specific tolls and functions that regulate a marketplace in which both buyers and sellers can automatize their trade finance activities on a global scale, with lower interests' rates and better conditions. On the other side, investors can access new incorruptible distributed databases that show the state of SMEs in real-time. Usually, the most typical and

critical barrier for small and medium enterprises are bank's assessment procedures. Those procedures are extremely influenced by cash flow performances, which is a pai resulting more and more often in denied funding.

Additionally, the initiatives that are part of this group, are characterized by the fact that potentially they can enlarge their services improving not only the financial performances of single companies but to create ad-hoc consortia in which, on a supply chain scale, buyers and suppliers can act simultaneously and jointly in order to improve both supply chain visibility and collaboration.

From a geographical point of view, the group is made of 11 companies well distributed all over the world. China, Singapore and Israel, counts for 5/11 of the group, and are the representative countries of Asia. All of those companies are focusing their efforts to contribute positively to decrease the credit gap for SME's in south east of Asia. Australia is represented by Invox Finance and, Europe by four start-ups, two of them are UK-based, one from Slovenja and one Lithuania.

All of the aforementioned initiatives are characterized by their way to exploit smart contract. Smart Contracts have been used in order to automate SMEs financing processes and, in some cases, to help banks in modifying their credit releasing activities.

The data referring to specific transactions data are exploited to process, with a "waterfall structure", different financing options according to predefined contract terms.

The graph below shows the initiatives' stage of maturity. It can be seen an almost equitable scheme: 4 companies have delivered their value proposition from a theorical perspective (POC phase), 3 companies are experiencing the 'seed phase' and 4 companies have already reached the definitive platform and are now struggling to make profits and to increase their market opportunities.

Figure 43- G1 maturity stage

Going deeper in the value proposition of the different use cases, it can seen a common aspect. In first place, platforms have been designed to make transactions, to allow the transfer of money between different parties, and to exploit the BCT features to have full visibility and immutability on the data generated and processed. As a result, all the use cases analyzed have shown the presence of 9 marketplaces focused on invoice financing activities. Invoice financing solutions is considered are most powerful remedy in order to create short-time liquidity for SMEs. Furthermore, the two remaining use cases, have shown the presence of ad-hoc ecosystems tailored to specific financing need of groups of companies, the whole business network can be financed from the focal company. And this is on a blockchain-based network. Both use cases have created tolls in order to execute respectively dynamic discounting and inventory financing, and equipment financing.

As far as blockchain characteristics concerns, 8 out of 11 have shown the presence of permissioned ecosystems, 2 public ecosystems and 1 hybrid ecosystem. The hybrid (Hyperledger Fabric and Stellar) ecosystem (TradeFin) derives by the adoption of some pillars of the blockchain public orientation in order to ensure immutability, trust and integration with external institutions that might be interested in the data stored.

Addictionally, 7 out 11 are built on Ethereum, one by the permissioned ecosystem of Hyperledger Fabric, one POC has not yet adopted protocol while AXenS is the only proprietary.

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Figure 44- G1 Blockchain Platform and Nature of the providers

Last but not least, the role of financial institution represents a critical point for companies belonging to this group. Potentially, banks can be considered investors in all the platforms offering a marketplace. Such inclusion is in the hand of the platform provider. 5 (all marketplace applications) out of the 11 use cases have shown a clear orientation: banks and their cumbersome procedures are not welcomed since, on a regular base, they represent a big problem for SMEs looking for credit which is mostly denied.

On the other hand, the remaining 6 companies, have decided to potentially include banks. BCT is seen as an opportunity both for SMEs and banks, SMEs can get advantages from the efficiency brought and banks by accessing to revolutionary real-time databases.

Addictionally, the fact that 1 of the use cases (ChainedFinance) is constituted by 2 emerging Chinese start-ups and Bank of China adds further value to the aformentioned consideration. Banks are perceiving the value of blockchain and this has been confirmed by ChainedFinance once again.

Figure 45- - G1 area of impacts

6.2.2 Collaboration and Liquidity Oriented

Figure 46- G2 composition

The second Cluster is the subset formed at the intersection between the Information Flow and the Financial Flow. It is defined as the groups of those firms oriented not olny to an efficient liquidity provition, but also to a series of related services aiming to facilitate the financing program on its lifecycle in order to decrease the time and cost needed, and augmenting the attractivity of the program.

For this reason the group had been labeled 'Collaboration and Liquidity Oriented', formed by nine firms located in a dispersed geographical context: the headquarters are based in Canada, USA, Singapore, Philippine, Russia, two in UK and two in India.

The average foundation year of the firms suggest the novelty of the theme, the oldest of was founded in 2013, but the modal year of foundation is the 2017. The data than, further remarks the novelty of this kind of Business Models, as a matter of fact the number of Active firms is only two. Anyway it can be noticed a quick and dynamic growth, with 6 firms having already reached the phase of Seed, while just one steady at the Proof of Concept stage.

Figure 47- G2 maturity stage

The groups is represented mostly by innovative start-ups, while the bank industry seems still uninterested in offering this kind of solutions, given the single firm founded by a bank consortium. To conclude one firm is a subsidiary of a large industrial corporation. Just three are the business models involving a Marketplace, a sensibly lower tendency in comparison with Group 1. The firms in general seems to prefer to adopt a bank neutral approach with 5 firms looking forward toward bank industry, rather than a single bank agnostic solution.

Figure 48- G2 Blockchain Platform and Nature of the providers

An element further characterizing the business model of this Group is the additional services provided, more oriented to the information sharing coherently with the group definition. Fine firms offer credit rating assessment and management services, and five take care of the smart asset management including the tokenization process including

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all the activity to securely own, fraction and transfer the token. Two firms also take cares of the KYC procedures and 2 focuses also on the bond issuing.

As regards the BC type the most popular form is permissioned chosen by 7 firms, while just 2 rely on a permisstionless infrastructure. 3 firms use the open source BC provided by Ethereum, and 4 outsource it from Hyperledger which confirms to be the most popular platform. One firm developed its proprietary BC while on the remaining one firm data are not available yet about the kind of BC used.

To conclude all the 9 firms provide Smart Contract Management, which seems to be a fundamental feature of BC and wide utilized for a large number of practical application.

Figure: G2 area of impacts — matrix of blockchain platforms vs. problem areas.

G2	Financing options for SMEs				High Transaction Costs				Double Financing			Lack of accounting rules		Supplier onboarding problems						Lack of Efficient Collaboration			
	Lack of standard and trusted infrastructure	Lack of credit rating procedures	Lack of secondary market	Paper-based documents and transactions process	Lack of secondary market	Payment Problems	Lack of standard infrastructure	Lack of credit rating procedures	Lack of Standard and Trusted infrastructure	Paper-based documents and transactions process	Lack of transaparency	Lack of Standard and Trusted infrastructure	Lack of transaparency	Lack of standard and trusted infrastructure	Paper-based documents and transactions process	Lack of transaparency	Lack of credit rating procedures	Lack of secondary market	Payment Problems	Lack of standard and trusted infrastructure	Paper-based documents and transactions process	Lack of transaparency	Payment Problems
Lendflo	■	■	■	■			■	■	■	■	■	■		■	■	■	■	■		■			
ANTAVIRA	■						■	■	■	■		■	■	■	■					■			
EXIMCHAIN								■	■	■		■	■	■	■					■			
PayPie	■			■		■	■		■	■		■		■	■	■				■	■		■
we.trade	■	■		■			■	■	■		■	■	■	■	■	■				■			
ACUDEEN	■					■		■	■	■	■	■	■	■			■			■			
symbiont	■						■	■	■	■	■	■	■	■						■			
edgeverve		■				■		■	■		■	■		■						■	■		
primechain	■	■						■	■		■		■	■						■			
TOTAL G2	■	■							■	■	■	■	■	■	■					■	■		

Figure 49- - G2 area of impacts

6.3.3 Supply Chain Oriented Group

Figure 50- G3 composition

The third Cluster is at the intersection between all the three flows and it is the only group analyzed in this study including the material flow. The firms contained have the objective to provide holistic SCF solutions, involving a large set of additional service both from the Information and Material Flows, with the aim to facilitate the execution and the accessibility of the SCF programs. Their Business Models are the most innovative and advance and, depside the absence of a specific market niece, the trend seems to confirm a continuous growth of this kind on providers.

In fact, the Group is composed by 7 firms, the first born in 2009 -but implementing a BC based solution only in the latest years –, then can be observed one foundation per year from 2013 to 2017, with 2018 representing the most populated year with 2 firms born.

From the location analysis a geographical pattern can be denied, in fact the headquarters are in UK, Singapore, USA, Panama, India and 2 in China. As for the other groups the location of the firms seems casual, with no specific area of concentration for specific solutions, anyway, it is evident how certain countries such

as the area of Far-East together with USA and UK are the most alert and mature in the field, having located at least on Headquarter per Group.

The stage of maturity of the groups reflect the date of foundations, with 3 firms already at an Active Stage, one in a seed stage and other 3 in at a POC stage. It can be considered a regular path of developing, without a rapid growth nor a stagnation to the first stages of development, among the two POC in fact can be found the 2 firms born in 2018 and the one born in 2017.

Figure 51- G3 maturity stage

The entire sample is represented by Fintech Start-up born from scratch, no bank consortium have been found active on the theme as a provider. Anyway the presence of financial institution as actors involved in the programs is not denied, having 5 bank neutral business model against just 2 bank agnostic, with three firms also offering a Marketplace.

Figure 52- G3 Blockchain Platform and Nature of the providers

The tendency of the other groups to be more inclined to offer Invoice Factoring solution is lost here, with just 3 firms offering it and a more heterogeneous offer including Dynamic Discounting, Inventory Financing, Equipment Financing and Landing, each appearing in 2 cases. The results of this analysis seem to confirm the nature of the groups, less oriented to pure liquidity provision. The Invoice Factoring Solutions in fact are the simplest form among the SCF programs, requiring a focus only on the costs and time of the financing, while the other solution, more complex, require a broader innovation space to be executed efficiently.

This aspect is reflected also in the Additional Service offered, where the kind of service are distributed and there is no one voice outstanding the others in terms of presence, as in the case of Credit Rating and Digital Certification for Group 1 or Credit Rating and Smart Asset Management in Group 2. In particular the Tracking service appear 3 times, Credit Rating and Smart Asset Management 2 times and KYC procedures and Cross-Border payments 1 each.

As regard the Blockchain layer, also in this case the Permissioned type is the preferred with 6 firm adopting it, against one firm using an Hybrid BC (Permissioned + Permissionless) and none adopting a Permissionless infrastructure.

Another peculiarity of this Group is in the platform used: Hyperledger Fabric confirms its high penetration with 3 firms, just 1 rely also on Ethereum, while 3 are the Propietary platform, a significantly different context from the other groups.

To conclude all the 7 firms provide Smart Contract Management, which seems to be a fundamental feature of BC and wide utilized for a large number of practical application.

Figure table — G3 area of impacts

G3	Financing options for SMEs				High Transaction Costs				Double Financing			Lack of accounting rules		Supplier onboarding problems						Lack of Efficient Collaboration			
	Lack of standard and trusted infrastructure	Lack of credit rating procedures	Lack of secondary market	Paper-based documents and transactions process	Lack of secondary market	Payment Problems	Lack of standard infrastructure	Lack of credit rating procedures	Lack of Standard and Trusted infrastructure	Paper-based documents and transactions process	Lack of transaparency	Lack of Standard and Trusted infrastructure	Lack of transaparency	Lack of standard and trusted infrastructure	Paper-based documents and transactions process	Lack of transaparency	Lack of credit rating procedures	Lack of secondary market	Payment Problems	Lack of standard and trusted infrastructure	Paper-based documents and transactions process	Lack of transaparency	Payment Problems
skuchain	■		■	■	■		■							■						■			
XinFin	■		■	■	■	■	■		■					■	■					■	■		■
inventoryclub			■	■	■				■	■													
AXenS			■	■	■		■		■	■					■						■		
SOFOCLE	■		■	■	■									■	■					■			
bubi.cn			■	■	■		■			■													
TOTAL G3	▦		▦	▦	▦		▦			▦					▦	▦							

Figure 53- G3 area of impacts

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7. IMPACT ASSESSMENT

After the Groups identification and description, having pointed out their focus and their differences, it is possible to assess the beneficial effects each Group brings to the inefficiency. In particular, the assessment of the impact is performed in the following way for each inefficiency: the Drivers identified in the Preliminary Framework had been matched with one or more Groups addressing the problems; where a significant beneficial effects had been found, the solution had been reported and explained highlighting the BCT features fundamental for improving the as is situation and the SC actors interested. Finally an assessment of the overall inefficiency is given and, after having analyzed all the inefficiency, a summary framework.

7.1 Financing Options For Smes

actors involved	SCF inefficency	inefficency Driver	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag.)	Driver/Groups	Inefficency/Group
Suppliers, Buyers	Financing Options for a Limited Number of SMEs	Lack of Std and Trusted Infrastructur			x	x	x	x	x	Group 1,2	Group 1,2,3
		Credit Assesment			x			x	x	Group 1,2	
		Lack of a Secondary Market		x	x			x	x	Group 1, 3	
		Paper Based Documents									

Figure 54- FINANCING OPTIONS FOR SMES analisis matrix

CREDIT ASSESMENT:

Once the credit assessment is done, it is signed with the crypto-firm and recorded on the DLT of the network. From that moment the rating can been automatically updated in real time with new data and visible to the party interested and authorized with minimum effort.

More than this, innovative business models fo Group1 and Group 2 are oriented toward an enlargement of the credit rating assessment including operative data, transactions and payments; keeping an historical track of all of this record with a high level of trust allow to get a holistic and historical view of the performance and behavior of a firm in order to establish the level of risk in repay its debt.

Using this approach, the rating can also be dynamically adjusted, if delays in the payments or in the delivery happens. It is a strong incentive for SMEs in being reliable and punctual; rising this performance on a steady peace, as a matter of fact, decrease their cost of capital over time.

LACK OF STANDARD AND TRUSTED INFRASTRUCTURE:

Evidence shows how relying on a Blockchain as the infrastructure connecting the SC every actor will be in direct contact each other in remote. The fault tolerance guarantees the availability of the infrastructure and no transaction is lost in the network, thus the flows can be exchanged in a safe and supervised way with lower control on invoice status or suppliers onboarding process. Group 1, Group 2 and Group 3 promise a reduction of the information Asymmetries and thus the risks, incentivising financial institutions to enlarge their offer to smaller entities and with new services, targeting even dynamic transactions with higher-pace and lower returns.

Also the actors of the SC have benefits, having the possibility to enlarge their Portfolio of Supplier/Buyer by targeting and send Offers -Suppliers- or Request of Offer -Buyers - to every nodes in the network, being able to assess the status and the performance of the counter part by checking the DLT.

LACK OF SECONDARY MARKET:

Two-side platforms are a popular business model toward start-ups in the field of SCF, even though not everyone necessary implement a BCT based infrastructure. All the groups contributes to this cause, but in this sense the most appropriate and focused Group is the number 1. Marketplaces dedicated to alternative financing, aiming to increase the appetite of the investors by decreasing risks and rising profitability of investment is an optimal solution enlarge the pool of Small Suppliers with operative financing access. In a while, if the Business Models of the Start-ups of Group 1 will establish on the market with important market shares, they will be able to rise the

competition toward traditional funding methods, bettering off the commercial offers of the formal investors also toward SMEs.

Moreover, the latest fractionable token offered by Group 2 and Group 3 thought their Smart Asset Management Service, allow for the presence of a multiple-investors involved in the funding of a single token; or even the creation of bundled financial products, containing shares of different tokens to differentiate the risks and attract investors.

IMPACT ON THE INEFFICENCY:

Being a broad problem at the base of the SCF, it appears natural it is addressed by all the 3 Groups, even if with differences. The coverage on the Driver is large, only the *'Paper Based Documents and Transaction Processes'* is left out, while the concrete possibility to create a Secondary Market running on a safe and trusted infrastructure, matched to an innovative credit rating assessment will bring major impacts on the SMEs company opening new and convenient access to financing. The most recurring and important BCT features are *'Data Immutability'*, *'Smart Contract'* and *'Tokenization'*.

7.2 Supplier Onboarding Problems

actors involved	SCF inefficency	inefficency Driver	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)	Driver/Groups	Inefficency/ Group
Suppliers, Financial Investors	Supplier On Boarding Problems	Lack of Std and Trusted Infrastructure			x	x	x	x	x	Group 2	Group 2
		Paper Based Documents			x			x	x	Group 2	
		Lack of Transparency	x		x		x	x	x	Group 2	
		Credit Assesment									
		Lack of a Secondary Market									
		Payment problems									

Figure 55- Supplier On Boarding Problems analisis matrix

LACK OF STANDARD AND TRUSTED INFRASTRUCTURE:

From the observation of Group 2, using BCT, Banks has the opportunity to reduce the efforts in KYC activities, just relying on the information held by competitors. Relying on a distributed database, shared with other banks in the network, there is no more need to perform onboarding activities for every single customer, but instead, check if

an instance had been already registered in the records, allowing to insert the customer in the customer portfolio without further due diligence. Two possible implementation way had been identified, a more conservative scenario, less efficient, but more feasible in the short term and a more innovative one. In the first case there is no consolidation of the customer registry at a network level, rather, each customer, after been successfully processed in an onboarding activity receive a cryptographic identity reusable in case of need by other banks. The second case requires full sharing of registry, on which banks upload the digital identity of the processed customers, giving full access to the other banks to access the integral version of the documentation attached to the customer.

LACK OF TRANSPARENCY:

As observed for the Group 2, throught Digital Certification BCT offer also the possibility to update the current records with new details, activities and any kind of transaction in general in a real-time and encrypted way. Thus, it is possible to create a complete historical and immutable registry, accessible and modifiable only by authorized entity.

PAPER BASED DOCUMENTS AND TRANSACTION PROCESSES:

The information collection process executed and shared by banks, with the consequent creation of a trusted, immutable ledger increase the opportunities and the incentives for banks. Acting as validators, the banks has the concrete chance to be the owner of a trusted database about customers, useful for the ordinary KYC internal activities, but definitely attractive for any clients willing to obtain that information.

IMPACT ON THE INEFFICENCY:

The inefficiency had been analyzed taking in consideration only the G2. It is in fact the only Group in which specifically targeted services, as KYC procedures, are present. Doubts remain in the quantification of the benefits, especially in the early stage of

development of this innovative paradigm. Banks in fact will really benefits the use of a shared registry only when it will reach a huge number of records increasing the probability to find the new-customer; in the meantime, the majority of KYC activities will still require a due diligence. It is still necessary even in those cases a digital identity of the customer with the attached documentation is recorded on the ledger but validated by one single banks – or few banks- being impropriate considering a single record as an unquestionable truth. The process executed by a bank in fact still face the risk to be incorrect due to casual or intentional errors in the due diligence process.

The effectiveness of the BCT in this case will be enough, and the savings sensible, only when the critical mass of nodes participating the network is reached.

In general term the most impacting BCT features are the Data Immutability and Tokenization. Moreover, the sharing of sensible data in different geographical context may face limitation due to different legal scheme applied in each jurisdiction.

7.3 Double Financing

actors involved	SCF infficency	inefficency Driver	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)	Driver/Groups	Inefficency/ Group
Investors	Double financing	ack of Std and Trusted Infrastructur			x				x	Group 1, 2	Group 1, 2, 2
		Paper Based Documents			x			x	x	Group 2, 3	
		Lack of Transparency	x		x	x		x	x	Group 1,2, 3	

Figure 56- Double Financing analisis matrix

LACK OF A STANDARD AND TRUSTED INFRASTRUCTURE:

Blockchain platforms guarantee participants of the network to trade in a direct and trusted way, any kind of asset with all the other nodes.

The asset management carried out by both G2 and Group3, has in the enabling element the tokens and the programmability of the transaction, through the use of Smart Contracts, allow to define 'a priori' the SLA and also define the penalties in case of breach of the contract. Even the financial flows can be integrated in the Smart Contracts, which can automatically trigger the payments at the meeting of predefined events coded in the contract.

The marketplaces of the Groups born around this paradigm are extremely transparent and secure, the fault-tolerance avoid any kind of fraud or lost transaction, making this platform a suitable place for investors.

PAPER BASED DOCUMENTS AND TRANSACTION PROCESSES:

All the risks brought by paper-based documentation can drastically be solved by the services of Smart Asset management and Digital Certification carried out by Group 2 and Group 3.

Relying on the Tokenization process, widely recognized as one of the strongest features for its wide range of application, perfectly fits the needs of the investors: qualitative and quantitative proofs about the financial asset to be funded. The Cryptographic process illustrated in the literature ensure at the same time confidentiality over the owner identity and certainties about the validity of its ownership. Moreover, the latest fractionable token, allow the presence of a multiple-investors involved in the funding of a single token; or even the creation of bundled financial products, containing shares of different tokens to differentiate the risks and attract investors.

LACK OF TRANSPARENCY:

Besides few, the firms of G1 and G2 offering a Permissionless and Hybrid Blockchain offer a great example. Implementing the innovative, computational inexpansive trust mechanisms, each transaction signed and encrypted by both the party involved is validated by the network, before being registered on the records, in an instant and efficent way. The resulting ledger of transaction, given its properties, represent a single source of truth visible and verifiable by auditors and inspectors over the financial flows without involving any intermediary.

The KYC activities carried out by G2 and the Track&Tracking services of the G3 rise the level of transparency over the information flows and also material flows, giving

visibility to the ownership and the effective location of the assets in a trusted environment

IMPACT ON THE INEFFICENCY:

The inefficiency is addressed by all the three Groups. It is a heavy problem affecting the SCF and the trade finance in general, but, as proved by the complete covering of drivers composing the inefficiency by the Groups, BCT is Break-through innovation in this field. Immutable Registry and Tokenized assets running on a safe Infrastructure leave no space for fraud, at least within the network boundaries. Therefore '*Data immutability*' and '*Tokenization*' are the fundamental BCT features impacting the '*Double Spending*' inefficiency.

7.4 Lack of Accounting Rules and Treatments

actors involved	SCF inefficency	inefficency Driver	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)	Driver/Groups	Inefficency/ Group
Suppliers, Buyers, Financial	Lack of Accounting Rules and Treatments	lack of Std and Trusted Infrastructur			x	x	x	x	x	Group 2	Group 2
		Lack of Transparency	x		x		x	x		Group 2	

Figure 57- Lack Of Accounting Rules And Treatments analisis matrix

LACK OF STANDARD AND TRUSTED INFRASTRUCTURE:

The first and most immediate use of BC, to solve the pain caused by this inefficiency, is in the corporate accounting. DLTs were firstly thought to be used in a network as distributed accounting architecture to records digital wallets and transactions occurring between nodes.

The same characteristic of immutability and the tendency to deny siloed data storage, make DLTs suitable architecture also in the field of corporate accounting. G2 in particular shows the main advantages in the auditing process.

Of course, BCT cannot change the way the regulatory frame of the accounting process, anyway relying on a corporate accounting run on BC it is possible to experience strong

benefits to the way the audition processes are performed. Auditors are empowered to verify, in a short period time, a large amount of financial data needed for the auditing process from their office, reducing the effort for this activity and keeping the same -or even higher- quality of the output.

Making this critical, but not-value adding activity, more efficient free-up time of the auditors which can focus on more value-adding activities.

LACK OF TRANSPARENCY:

Extending the previous concept in the medium period, hypnotizing a more mature environment toward Blockchain Technology in general, it is possible to think at a disrupting scenario.

If considering for instance a network in which all the transaction is recorded on a DLT, in addition to the use of the already explained recourse to BC in the corporate accounting, it will be possible to automatize the entire auditing process, eliminating the relative costs.

IMPACT ON THE INEFFICENCY:

The problem is targeted by both the Group 2. The overall evaluation may appear incouraging, KYC activities are proving its beneficial effects in bringing transparency and efficiency in the auction process. Anyway, the main concern of the buyers and investors is to avoid the reclassification of their payables into financial debt. This risk is not lowered by the recourse to the BC, rather, the dilemma is if the freed-up time of the auditors may increase the attention dedicated to the reclassification theme.

In this case BC can become a threat more than an opportunity. Fundamental BCT features in the auditing process are the *'Data Immutability'* and *'Security'*.

7.5 Lack Of Efficient Collaboration

Figure 58- Lack Of Efficient Collaboration analisis matrix

LACK OF STANDARD AND TRUSTED INFRASTRUCTURE and LACK OF TRANSPARENCY:

BCT is an intended instrument to allow parties which do not trust each other to make transaction in a distributed way, without intermediaries. Therefore, it is clear the focus on collaboration, and logical the takeover of this concept to be adapted into the SC relationships.

In this case is not possible to discriminate between the drivers "Lack of Transparency" and "Lack of trusted infrastructure" because collaboration is jointly affected by the level of confidence a party has in both the infrastructure and its partners; as stated in the explanation of the inefficiency collaboration is mostly a matter of culture and willingness, factor which can be rised only by reducing info Asymmetries.

In this case the most relevant Group to evaluate is the Group 3 with their holistic services:

the immutability characteristic of the BC guarantees full traceability, allowing the creation of an environment in which it is possible solutions such as the Proof-of-Location based Tracking, to have confirmation, in real-time, about the provenience, ownership and impacts of all the single items composing the flows across the Supply Chain.

In the resulting scenario, the information asymmetry between parties are strongly tackled, the risks of a firm in dealing with any other node of the network are extremely reduced and consequently the collaboration in the SC becomes the most efficient choice.

PAPER BASED DOCUMENTS AND TRANSACTION PROCESSES:

Digitalization is one of the most significative intra-industry trend of the last years and it is a phenomena independent from Blockchain. At the date large corporation already rely on e-invoices and self-billing allowing to guarantee e triple confirmation on the payments.

As shown by Group 2, moving these processes and documents on the BC is it possible to gain in quality of the information: possible risk as typo, non-standard format, manual manipulation, non-compliant information, document losses or destruction can be avoided and replaced by automatic and fault-tolerant system for moving information. Another sensible advantage of BC, when speaking of invoices, is the time reduction in the financing due to a straight-through process: having the full documentation, approved and signed, on the BC allow the invoice approval to be almost immediate, which for firms means earlier availability of liquidity and higher days to return the financed capital. Finally, those processes performed manually as Auditing – already mentioned-, Reconciliation and Monitoring above all, increase in the efficiency decreasing the information asymmetries in the SC.

IMPACT ON THE INEFFICENCY:

The Group focused and used to evaluate the impacts on the Inefficiency is the Group 2 due to empirical evidence in the results, even if it is correct to mention also the Group 3, for its nature and objective. Even though no proof was found in this field about the '*Payment Problems'* driver, the digitalization and Tokenization of the documentation - and relatives processes- intra Suply Chain and the creation of a Shared Immutable Record of Transaction seems the most appealing solution in terms of Effectiveness and and Efficiency of the Solution, even though adopting this approach rely on the joint decision and effort at least of the whole SC. From this point of view the role of the Buyer may be critical in the adoption or not of a BCT solution oriented on the medium period. Foundamental BCT characteristics are '*Data Immutability', 'Security', 'Smart Contract'* and *'Tokenization'*.

7.6 HIGH TRANSACTION COSTS

actors involved	SCF inefficency	inefficency Driver	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)	Driver/Groups	Inefficency/ Group
Suppliers, Buyers, Financial Investors	High transaction costs	Lack of a Secondary Market		x	x			x	x	Group 1,3	Group 1
		ack of Std and Trusted Infrastructur		x	x	x	x	x	x	Group 1,2	
		Payment problems	x	x				x	x	Group 1	
		Credit Assesment									

Figure 59- High Transaction Costs analisis matrix

LACK OF A SECONDARY MARKET:

Given the existence of an important portion of unserved firms on the market, it is logical to find a great number of bSCF providers, addressing their innovative business model to this ecosystem of excluded firms. The peer-to-peer logic brought BCT broke the Pareto laws, enabling sustainable strategies in targeting the Long Tail with particular emphasis on the Emerging Market.

Those Business Models, well represented by the lite and flexible two-side Platforms of Group 1 dedicated to alternative financing, and in part by the Marketplaces of Group 2 and Group 3 dedicated also to financial institution, are all characterized by high levels of automation due to the use of Smart Contracts. This guarantee fast securities settlements -in some cases in few minutes, 1 working day to receive the funds- and in practice, an extended period to repay the capitals for the firms. A reduction in the insolvency rate can be noted, which turns into a reduction of risk, and thus over time of the cost of capital for virtuous firms who proved to systematically repay its financers.

PAYMENT PROBLEMS:

BCT has already proven to have a significant impact on the payment process. This field particularly extoll the BCT characteristics, not by chances the first applications focused on it. It is reasonable to expect the most mature solutions bringing major contributes on the transaction costs reduction.

Both the bank industry and peer-to-peers networks improve their performances when dealing with Blockchain infrastructure.

Cross- Borders / Multi-Currency payments are mentioned at first place as improved areas, well covered by the Group 1 and, more marginal, on Group 2. The elimination of any intermediary including Custodians and Correspondent Banks demolish the transaction costs, as well as the role of the bank in providing this services.

In addiction the possibility to use a Smart Contract to run a transaction allow automatize the recurrent transaction, autonomously moving financial flows when triggering events are recorded on the DLT.

IMPACT ON THE INEFFICENCY:

Group 1 is mostly used to analyze this inefficiency, due to its focus on the financial provision. Few evidences had been found on the topic, even if theoretically BCT are suitable to remove the intermediaries and the related Transaction Costs. The most promising field seems to be the Cross-Border transactions, affected by major costs due to the presence of multiple intermediaries, well solved by the peer-to-peer logic offered by Providers of Group 3. The presence of a Secondary Market may improve the coemption and more important, the demand for SCF solution forcing traditional providers to cut the costs related to the service provision, anyway the affirmation of this market have to be proved yet. Most promising features are *'Peer-to-Peer Logic'* and *'Smart Contract'*.

7.7 RESULTS SUMMARY

The table below (figures 60) shows the final output of the analysis in a summary Framework.

At this point it is valuable to make considerations at a comprehensive level, taking in account the whole set of Inefficiencies. All of them are reached by the Case Studies, even though there are differences in the observed Impacts, while on the BCT features application a clearer trend can be noticed.

As regard the Inefficiencies, the Market seems readier to tackle pure financial ineficencies as "*Double-Financing problems*"and *"High Transaction Costs"*. In both of these cases the improvements brought by BCT alone are critical, in the sense no other technological improvement is able to guarantee the same performances and trigger comparable reaction in the Supply Chain. Moreover in both the cases BCT represents stand alone solutions, which do not require additional efforts to spillover tangible benefits.

These problems are effectively tackled at a pure infrastructural level, especially by G1 and in part by G2, being able to provide a trusted infrastructure and a real, functional disintermediation which demolish costs.

 "*Accounting Rules and treatments*" and "*Supplier Onboarding Problems*" less incenrated on the financial flows and more on the other two flows are directly and actively targeted by the Case Studies, especially from G2 and G3. The potentiality to efficiently and effectively rise the level of trust, collaboration and visibility are high, despite this, the proposed application suffers from structural problems which require further effort to be solved, turning the service appealing on the market. As mentioned in *'Accounting Rules and treatments'* and *'Supplier Onboarding Problems'* the benefits brought are tangible, but doubts remain in the execution of the processes; in particular while the immutability and trust are guaranteed inside the Distributed Ledger, they still lack of sufficient certainties to guarantee the trust on the data input. Whiteout a proper Governance, Digitalization and Connectivity the services offered will not totally

eliminate risks, making the authors think the full deployment of these Business Models will be achieved in a Medium Term, if the current problem will be fixed.

Finally, *'Financing Option for a Limited Number of SMEs'* and *'Lack of Efficient Collaboration'*, very high level inefficiencies, including many drivers and affected even by other inefficiencies, are partially solved, but results can already be observed. As a matter of fact a multitude of SMEs are eligible to join SCF solutions, thanks to innovative and inclusive Business Model adopted by firms from all the Groups. The collaboration is effectively raised by connecting distant Buyers and Suppliers, enabling new partnership between players which do not trust each others. Although more efforts will be required to bring dramatic changes in the environment. In particular those two would particularly benefits from the growth of the entire BCT segment and the wide utilization in the Supply-Chain. The critical mass can be hypnotized as the target rate of adoption, being present in the Blockchain Services all the characteristics of a two-side platform. In this sense the growth and the adoption in the market of both key drivers as a crowded "*Secondary Market*", and other inefficiencies as the reduction of "*Transaction Costs*", would contributes and influence the benefits spillover of the BCT toward those inefficiencies. A real and Disruptive impact is so attended over the Long Period. All the results are summed-up in Figures 61.

Focusing on key BCT features, a clearer picture can be taken. It is visible from the Table how mainly 3 features are widely used across the Framework: *'Data Immutability'*, *'Smart Contract'* and *'Tokenization'* are the most used and valuable at the moment, given the solution offered by the firms.

actors involved	SCF inefficency	inefficency Driver	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag.)	Driver/Groups	Inefficency/Group
Suppliers, Buyers	Financing Options for a Limited Number of SMEs	Lack of Std and Trusted Infrastructur			x	x	x	x	x	Group 1,2	Group 1,2,3
		Credit Assesment			x			x	x	Group 1,2	
		Lack of a Secondary Market		x	x			x	x	Group 1, 3	
		Paper Based Documents									
Suppliers, Buyers, Financial Investors	High transaction costs	Lack of a Secondary Market		x	x			x	x	Group 1,3	Group 1
		Lack of Std and Trusted Infrastructur		x	x	x	x	x	x	Group 1,2	
		Payment problems	x	x				x	x	Group 1	
		Credit Assesment									
Suppliers, Financial Investors	Supplier On Boarding Problems	Lack of Std and Trusted Infrastructur			x	x	x	x	x	Group 2	Group 2
		Paper Based Documents			x			x	x	Group 2	
		Lack of Transparency	x		x		x	x	x	Group 2	
		Credit Assesment									
		Lack of a Secondary Market									
		Payment problems									
Suppliers, Buyers, Financial	Lack of Accounting Rules and Treatments	Lack of Std and Trusted Infrastructur			x	x	x	x	x	Group 2	Group 2
		Lack of Transparency	x		x		x	x		Group 2	
Suppliers, Buyers	Lack of Efficient Collaboration	Lack of Std and Trusted Infrastructur	x		x	x	x	x	x	Group 2	Group 2, 3
		Lack of Transparency			x		x	x	x	Group 2	
		Payment problems									
		Paper Based Documents			x			x	x	Group 2	
Investors	Double financing	Lack of Std and Trusted Infrastructur			x				x	Group 1, 2	Group 1, 2, 2
		Paper Based Documents			x			x	x	Group 2, 3	
		Lack of Transparency	x		x	x		x	x	Group 1,2, 3	

Figure 60- Inefficiencies analisis matrix

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SCF Inefficency	BCT Impact	Additional Effort Required	Full Application
High transaction costs	🟢 🟢 🟢	-Pure BCT solutions	Short-Term
Double Financing & Fraud Detection	🟢 🟢 🟢	-Pure BCT solutions	Short-Term
Supplier On Boarding Problems	🔴	-Governance -Digitalization -Connectivity	Medium-Term
Lack of Accounting Rules and Treatment	🔴	-Governance -Digitalization -Connectivity	Medium-Term
Financing Options for a Limited Number of SMEs	🟡 🟡	-Critical Mass -Reduction of the other inefficencies	Long-Term
Lack of Efficient Collaboration	🟡 🟡	-Critical Mass -Reduction of the other inefficencies	Long-Term

Figure 61 - Table of the Results

8. FINDINGS AND FUTURE DEVELOPMENTS

The entire research work focuses on the intersection between SCF and Blockchain technology. In detail, it investigates how the Blockchain technology, used as the carrier architecture of supply chain finance programs, can lower entry barriers for these kind of alternative financing initiatives.

This dissertation was written with the purpose to investigate the innovations brought by BlockChain Technologies in the discipline of SupplyChain Finance. The focus was on identifying and analyzing inefficiencies affecting the industry at a macro level, and studying how innovative business models promise to overcome them. On this base, the literature review covered the state-of-art of the two disciplines, Supply Chain Finance and Blockcain Technology.

We started exploring both SCF and BCT , reading and analysing in detail the literature review to identify existing gaps and draft the research questions.

According to the the very recent nature of both topics, the exploration of existing bSCF solutions helped us to reach multiple objectives: firstly, to get the broader picture about who is using to deliver SCF initiatives and, secondly, thanks to analysis of each single player, to understand from a structural point of view, how each BCT feature shall act when exploited on SCF programs.

As a consequence, once spotted existing gaps in the literature, the first research question wasdefined:

1. "How can be described the state of the art of BCT solutions applied to the Supply Chain finance industry?"

Answering this research question allowed to enrich the degree of understanding of a recently new market. SCF and, mostly, BCT have not yet been explored, thus the "as-is" analysis of available solutions offered the possibility to verify how theoretical considerations can be translated in practical applications. Furthermore, the exploration of the existing bSCF ecosystem provided significant insights about

problems that are holding the innovation outlining some suggestions for future developments.

Once identified a list of innovative providers of bSCF programs, one of the main purposesof this dissertation was to analytically verify the findings of before mentioned studies. The output of this phase was the assessment, at a macro level, of the expected impact brought by the innovative solutions on each inefficiency, the main drivers to this result and the effective availability of the service in the market.

In order to provide a wider picture of the actual bSCF players, case studies were used for the analysis. They were founded among a datasets including the best ranked blockchain based firms on reference websites such as ICOBench, CrunchBase, Finextra and Start-Up Genome, for a total of more than a hundred firms. The dataset than was reduced based on the services provided by the firms, targeting innovative offers about the management of the Financial and Information flows within Supply Chains, coherently with the directions of the dissertation, leaving aside the Material Flow. The resulting sample was composed of around 40 firms. They were singularly analysed and contacted, then, when possible, the firms were interviewed following a semi-structured track to further deepen the analysis on the service offered and the objectives pursued. In some cases not enough informations were collected in order to carry out a valuable analysis and the number of use cases decreased to 27.

In order to clarify the analysis and to achieve stronger results the case studies were grouped and classified according to most recurrent patterns on the common features. As a consequence, they played an important role to better refine the second research question.

2. How Blockchain Technology mitigates the inefficiencies characterising the Supply Chain Finance industry?

This research question represents the added value of this thesis. The missing link between the two topics is related to the definition of an innovative business strategy

to exploit BCT in SCF area of expertise. Answering this research question, a set of guidelines that show how BCT impact on SCF inefficiencies were highlighted. BCT features, outlined and studied in the literature review, were classified according to their role when offering SCF solutions. Furthermore, the impact assessment phase explained in deeper detail how the theoretical research framework was finalized throughout the use-cases analysis and how each single feature can be exploited to overcome certain SCF barriers.

In order to associate specific blockchain features to different SCF inefficiencies, the preliminary research question was filled with theoretical findings and data gathered studying the use cases.

As a results 3 Groups were identified from the total 27 firms, while 3 firms were left out from the analysis, being addressable to none of the selected Groups. Named *'G1'*, *'G2'* and '*G3'* the groups were discriminated on the base of the Flow they impact on. In particular G1 is oriented to pure financial providers, and the services offered aim to facilitate liquidity exchange. G2 enlarges its scope also to the optimization of Information Flows and the service related aim to reduce the information asymmetries. Finally, G3 focuses on all the three flows, offering holistic solution oriented to the entire SC.

Once populated and described the groups, the area of impacts was identified and finally the inefficiency was studied at a driver level. Through a cross-case analysis the impacts of the most proper bSCF solutions was assessed together with the most important BCT features impacting on them.

8.1 Findings

At this point it is valuable to make considerations at a comprehensive level, taking in account the whole set of inefficiencies. All of them are reached by the Case Studies, even though there are differences in the observed impacts, while on the BCT features application a clearer trend can be noticed.

As a starting point, smart contracts are the most disruptive feature when dealing with bSCF programs. They are the power of the network: their self-executing trait allows to automate procedures that, nowadays are cumbersome and costly. More in detail, they are the medium throughout blockchain executes exchnages, validates certificates and authorizes transactions. Additionally, their level of automation enables to bring down transaction and operating costs.

Smart contracts revolutionary scheme plays a crucial role in this research. They perfectly match with all the SCF inefficiencies previously identified.

Secondly, BCT smart asset management, using tokens as digital counterparty of an existing asset, allows to provide a uncorruptable ecosystem able to answer multiple inefficiencies related to SCF programs: the double spending / double financing phenomena, the lack of efficient collaboration, the lack of a standard and trusted infrastructure and the lack of accounting rules and treatments. Moreover, considering the problem Double Financing and the High Transaction Costs, the BCT represents stand alone solutions, which do not require additional efforts to spillover tangible benefits.

Last but not least, the immutable nature of all the data stored and recorded by BCT is a critical feature to answer the painful lack of accounting rules and treatments. Being immutable, information can be exploited both to reshape KYC procedures and auditing processes and to enanche collaboration and trust in business networks.

The BCT potential to efficiently and effectively rise the level of trust, collaboration and visibility have been further testified by the emerged findings. But, on the other hand, distributed ledgers are still affected by a lack of enough certainties to guarantee the trust on the data input. Without a well-established and authorized international regulations, blockchain based-services offered cannot be completely exploited.

Shifting the perspective to the remaining SCF inefficiencies, it can be seen that the vast majority of bSCF are born in reaction to a general lack of financing options for SMEs. The peer-to-peer nature of blockchain, that allows to match investors and sellers with no time and location constraints, together with the revolutionary smart-contracts

based marketplaces are the features exploited the most to answer the aforementioned ineffieciency. In this cases tokens, as digital currencies are crypto used in transactions. To conclude improvements brought by BCT are critical, it means no other technology is able to guarantee the same performances and trigger comparable reaction in the Supply Chain Finance programs. All the SCF inefficiencies have shown high potential benefits when adopting BCT, but, as highlighted in figure 61, some of them still require additional efforts to be effectively reduced. The introduction of an international Regulatory Framework, the achievement of a critical mass of networks partecipants and the increase in the degree of Digitalization and Connettivity in the business processes are structural limits to be solved in the next future in order to release the full potential of BCT in SCF.

8.2 Limitations and Future Directions

Given the innovative nature of the topic, there is a broad empty space of action around it. Although this thesis aims to cover a large portion of this area with a general and wide Framework, limitations are still remarkable.

A first limitation, which comes up to mind from the reading of this paper,is the specific focus on the Financial Flow, with a partial inclusion of the Information and Material Flow. This was a clear choice of the authors, driven by notions acquired on the state-of-art, interest in the topic and nature of selected case studies, that evoked a sense of 'Urgency' toward Financial Flows.

There are no doubts on the need to enlarge the investigation in this direction, being the SCF a holistic discipline oriented in equal measure toward the optimization of all the exchanges appearing in a Supply Chain. Carrying out a cross-cases analysis based on Information and Material flows oriented firms and relative Inefficiencies would mean significantly wideningthe thesis perimeter, resulting in a complete coverage of the topic by the literature.

A second limitation affecting the research is the lack of a quantitative models able to statistically prove the validity and strength of the results. The adoption of a qualitative model was an obliged choice, given the statistically irrelevant dataset composed by the case studies. The hope is that in the next years market will move forward, resulting in theentrance of a higher number of new players, making the industry large enough to be statistically relevant. When this condition will be met, a punctual analysis to verify the assertion proposed in this dissertation will be possible.

A time slack will also be necessary to retrieve both quantifiable and not quantifiable results of the of the bSCF programs. At that point, it will be valuable to interview users of this programs -Buyer and Suppliers in the SC- to obtain primary and detailed data from another perspective, to support deeper and more specific Research Questions.

Another point authors decided to exclude from the analysis, for the brave and sake of the dissertation, is the correlation between inefficiencies. In particular 'Financing Option for SMEs' appears as the highest level inefficiency, affected both by drivers and other inefficiencies. It can be forecasted also an inter-correlation between inefficiencies and Drivers, such as *'High Transaction Costs'* and *'Lack of Secondary Market'*. Including this aspect in a quantitative and in a qualitative analysis would give punctual results both on single inefficiency voices and at a framework level.

Finally, it would look interesting to run lower level analysis discriminating the results according to single SCF solutions, or groups of solutions -Buyer-led vs Supplier-Led, Pre-Shipment vs Post-Shipment- in order to highlight different needs and approaches required by different solutions.

APPENDIX A - ENGAGEMENT MAIL

Dear Ms/Mr xxxx ,

We ask your attention for only few minutes.

We are Andrea and Fabio, students at Master of Science in Management Engineering at Politecnico di Milano (Leading Engineering University in Italy).

We are working on our final research project, supervised by Antonella Moretto, Research Director of the Supply Chain Finance "Osservatorio" at Politecnico di Milano.

The overall goal of our research is to understand and identify drawbacks in the implementation of Supply Chain Finance solutions and, consequently, to identify Blockchain technology disruptive features for faster and more effective diffusion of SCF practices.

As result of our wide market research, we identified your Company as one of the most appealing offers available on the market.

We would therefore kindly ask your availability for a call, in order to discuss the solution provided by your Company.

In particular ____ .

Here below you can find the interview configuration scheme.

We look forward to your kind reply, and please, do not hesitate to contact us for any further information you may need.

Thank you in advance for the attention,
Best regards,

Andrea Di Nisio, Fabio Congiu

APPENDIX B - USE CASE INTERVIEW TRACK

A) General Information about your Company

- How was your company born? Where did your idea come from?

- Considering that both Blockchain Technology and Supply Chain Finance are breaking in the market in the last years: at what stage of development are you?

- Are you still struggling with the biggest challenges of product development or have you already reached the market?

- Do you consider your company as a provider of pure SCF solutions or do you consider your services as means to enable and improve specific performances along Supply Chains?

B) Your Blockchain Supply Chain Finance (bSCF) Solutions

Offer:

- What services do you offer?

- Do you provide any bSCF program?

- Could you give us a short description of how this will work?

- What is your competitive advantage ("unfair advantage")?

- What are the key features of your offer that ensure this "unfair advantage"?

Targets:

- What is your customer target?

- What are this target customer characteristics?

- What industries are you targeting? Why?

- What is the average size of your client companies?

- What customers' needs your solution answers to?

- Who are the actors involved? What is their role? How do you deal with certified financial institutions?

Considerations:

- What are the SCF solutions drawbacks affecting the market adoption?

- How do you think the Blockchain Technology can solve these inefficiencies?

- What are the biggest challenges you faced while implementing your services?

- Do you think there are some other issues affecting a wide adoption of bSCF solutions? For example, which risks for your potential clients may incur joining your platform? How they can be solved?

C) Your Blockchain characteristics

- Can you tell us why you use blockchain technology instead of some other distributeddatabase technology?

- What are the features that lead to consider blockchain technology more suitable and more reliable?

- Is this a permissioned or permissionless system? Why?

- Is your permissioned system based on a private DLT validation process or on a consortium DLT validation process?

- What blockchain technology do you use (e.g. Ethereum, Hyperledger)?

- Can you explain why you chose this technology?

APPENDIX C – Prof. Camerinelli Interview Track

A) The Supply Chain Inefficiencies

Considering that both Blockchain Technology and Supply Chain Finance are breaking in the market in the last years:

- At what stage of development is the market of SCF and bSCF solutions?

B) Blockchain characteristics

- How important is blockchain set to be for businesses?

- How can blockchain improve supply chains?

- What are the advantages for businesses and consumers to join a BCT business ecosystem?

- Can you tell why the blockchain technology instead of some other distributed database technology?

- What are the features that lead to consider blockchain technology more suitable and more reliable?

C) Blockchain Supply Chain Finance (bSCF) Solutions

- What are the SCF solutions drawbacks affecting the market adoption?

- How do you think the Blockchain Technology can solve these inefficiencies?

- What are the biggest challenges faced while implementing bSCf solutions?

- Do you think there are some other issues affecting a wide adoption of bSCF solutions? For example, which risks for potential clients may incur joining your platform? How they can be solved?

- Who are the actors involved? What is their role? How to deal with certified financial institutions?

APPENDIX D – Use Cases

1) LENDFLO

Lendflo is London-based start-up founded in 2017. Their offer is a P2P invoice financing marketplace built on blockchain technology. Their goal is to help SMEs to unlock their business potential, trapped between purchase order and payment of goods, by providing access to cheaper and faster finance. The red thread running through is a common necessity of a more effective and efficient use of working capital tied up in Supply Chains.

The adoption of blockchain technology, hand in hand with the introduction of PSD2 (Payment Service Directive 2), enables Lendflo to lower Supply Chain Finance barriers, and foster business network collaboration.

For what consider the offering, invoice financing, is a form of collateralised loan and is delivered to specific customers. On the other hand, the possibility to issue bonds, constituted by invoices, allows financing on a bigger scale, providing money to the whole supply chain.

Lendflo onboarding process for new customers takes place in 5 steps, all of the are automatized: company information confirmation, accounting phase, PSD2 accounting, KYC practices on the user and KYC practices on the document. The credit rating activities are not on blockchain. Lendflo is proprietary of a machine learning credit scoring algorithm that accurately prices the business invoice.

Lendflo competitive advantage is the possibility lower cost on both sides of the platflorm. Everything from the decision process to the availability of funds in less than a minute rather then much longer and less flexible procedures when looking for banks invoice financing solutions. Additionally, banks do ratings considering the company as a whole, they look at the financial situation of the clients and at the market of reference of each specific potential customer. Lendflo wants to focus the attention of each specific invoice enabling cost reduction.

From the investors point of view, they deposit money and the sell the money and, as a token, kind of auditing processes in a much faster and cheaper way. All of that is allowed by automation, and automation is directly linked with the use of Blockchain Technology.

The mismatch with banks procedures might suggest that Lendflo is a platform for non-bank investors, but, it is not. Their smarter and faster risk assessment procedure, as well as the platform controlled automatically through smart contract and programmable tokenized securities, trading and back-end process make the business attractive for banks looking for easier and faster investing solution. DeutschBank, as a partner, has sensed the opportunity of a much more efficient way of financing SMEs.

Lendflo	Application: Lendflo	Foundation: 2017	Phase: Seed
https://lendflo.com/	Head office: London, UK	Market launch: Expected Early '19	Pure SCF solutions: Invoice Financing
Nature of SCF platform: Outsourced	Nature of provider: Marketplace, Bank Neutral, Fintech Start Up	Blockchain Type: Public Blockchain	
Additional Services: 1) Machine Learning Algorithm for Credit Rating (Off Blockchain) Based on: transactional data, financial health, social media, network effect		Blockchain Protocol: Ethereum	
Additional Services: 2) Bond Issuance (further development)		Smart contract management: YES	
Interviewed			

Appendix 1 - Landflow Identikit

SCF inefficency \ BCT Features	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
Supplier On Boarding Problems	■	■	■				
Lack of Efficent Collaboration	■	■	■			■	■
High Transaction Costs	■	■	■			■	
Double- Financing	■		■				
Lack of Accounting Rules and Treatments	■	■	■	■	■		

Appendix 2 - Landflow Areas of Impacts

2) EXIMCHAIN

Eximchain is a Singaporean start-up founded in 2015. Their aim is to offer a blockchain-based platform to enable a better connection among business networks and share documents in a more secure and efficient way. Eximchain wants to provide a tool, built on blockchain technology able to solve all the main inefficiencies related to supply chain and supply chain collaboration dynamics. Eximchain empowers companies to overcame traditional barriers: credit and suppliers rating, supply chain visibility and data sharing will be no longer perceived as pains along business networks, indeed, it will help in increasing coordination and installing trust in cross-border transactions.

Their vision is to provide a new platform which could be exploited on global scale. The scalability of the platform is a crucial driver to show if Eximchain is working in the right direction. Their goal is to become the medium to bring the supply chain of the future on global scale. The breaking down barriers and the integration of involved actors are the keys to bring transparency, inclusivity and security on global networks. They are focusing mostly on inventory management, sourcing practices (record of historical data and transactions in order to allow suppliers to prove their state-of-health to buyers and financial institutions) and SCF solutions.

The platform enables to unlock the potential revenues linked to a general lack of optimized performances in supply chains.

From a practical point of view, Eximchain offers a main service based on blockchain technology.

Eximchain SDK is a platform based on smart contracts that allows companies to build from sketch personalized and P2P supply chain applications. With SDK smart contracts developers are able to create applications from basic components, speeding up the set up of future SCF solutions.

During the last two years, Eximchain has been working to enrich its value proposition with the most innovative added services that can be build on blockchain. They recently

announced the use of Zero-Knowledge Security Proof that can generate proof and validation of any transaction by the network without showing the most critical information. Thus, allows the possible creation of a new public-blockchain ecosystem for financial products without the need of an authorized and central third parties.

On the platform, the EXC Token are used in order to pay fees, validate transactions and execute governance practices. Additionally, the EXC token, a native token, allows to access the application on the network and ensures Proof of Quality for all transactions available on the platform combining privacy, accessibility and security to set up a unique enterprise application.

EXIMCHAIN	Application: Eximchain	Foundation: 2015	Phase: Active
https://www.eximchain.com/	Head office: Singapore	Market launch: 2018	Inventory Management + Platform extensible for other SCF solutions
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Supply Chain Application	Blockchain Type: Public Blockchain	
Additional Services: 1) Automatize smart asset management system to prove certificates (based on EXC Token)		Blockchain Protocol: Ethereum	
Additional Services: 2) Inventory Management through smart contracts to enance SC collaboration		Smart contract management: YES	
Secondary Data Analysis			

Appendix 3- EximChain Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	🟩	🟩	🟩		🟩	🟩	🟩
Lack of Accounting Rules and Treatments	🟩	🟩	🟩	🟩	🟩		
Lack of Efficent Collaboration	🟩	🟩	🟩		🟩	🟩	
Supplier On Boarding Problems	🟩	🟩	🟩				

Appendix 4 - EximChain Areas of Impact

3) TRADEFIN

TradeFin is a fintech start-up founded in 2015, whose headquarted is set in New York. They offer a supply chain finance marketplace and e-invoicing platform. The company focus is clear and evident: financing options for SMEs making credit more obtainable and affordable for suppliers in order to unlock their business potential. Tradefin Network offers a decentralized blockchain based platform to foster and faster business payments and financial supply chain management.

The B2B market performances are affected by several barriers related to payments, credit securitization and transactional inefficiencies. TradeFin Network aims to connect actors and enable multiple financing.

TradeFin Network is built on a hybrid blockchain that enables participants to protect their sensitive data and, contemporarily exploit public blockchain characteristics to create trust, immutability and integration. By focusing on the financing dynamics on the whole supply chain, Tradefin prevents frauds and double spending that are both big problems when dealing with multiple financing options.

TradeFin identified a set of inefficiencies that represent the starting point for their project.

Firstly, the role of banks and intermediaries is leading to extremely high transaction costs due to a general lack of settlement procedures, as well as, slow and manual processes to onboard new companies in the financing solution.

Secondly, a lack of a standardized infrastructure that ensures immutability, validation and record of transactions and documents that would allow companies to work and interact in a completely trusted ecosystem.

Tradefin blockchain provides notable improvement considering those pain points for companies working in business networks. The hybrid blockchain, that combines the public Stellar protocol and the permissioned Hyperledger enable, allows company to solve different problems. The public nature of the blockchain favours instant payment settlement and financing options while the private nature of platforms guarantees

secure and immutable transactions, payments and receivables and financing risk profiles along the business network.

In addiction, Tradefin smart contracts makes possible to build specific SCF solutions for participants. Multiple automatized contracts enable users to build their own personalized financing option: invoice factoring, dynamic discounting and receivable financing are well-supported by TradeFin Network.

The start-up utilises the TPT Token (TradeFin Payment Token) pegged as a stable coin. This allows businesses to make and receive payments directly from the platform, dramatically reducing transaction fees. Apparently, this would avoid banks to be part of the ecosystem but, TradeFin wants banks to behave as anchors: potentially banks can adapt their own assessment procedure to the platform becoming potential investors within the platform.

TradeFin	Application: TradeFin Network	Foundation: 2017	Phase: Active
https://www.tradefin.com/	Head office: New York, US	Market launch: 2018	Pure SCF solutions: invoice factoring, dynamic discounting and receivable financing
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Marketplace, Bank Neutral	Blockchain Type: Hybrid Blockchain (Stellar + Hyperledger)	
Additional Services: 1) Automatize smart asset management system to prove certificates (based on TPT Token)		Blockchain Protocol: Stellar and Hyperledger	
Additional Services: 2) Marketplace for financing option considering banks as potential investors		Smart contract management: YES	
Secondary Data Analysis			

Appendix 5- TradFin Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs		■	■		■	■	■
High Transaction Costs	■	■	■	■		■	
Double- Financing	■		■	■			
Lack of Efficent Collaboration	■	■	■			■	■

Appendix 6 - TradFin Areas of Impact

4) PRIMECHAINTECH

Primechain is an Indian start-up which consideres blockchain as a medium to built a better future for businesses. Primechain, whose headquarter is set in Pune, strongly believe that blockchain and its disruptive features will be able to modify and improve business performances by increasing efficiency, security and transparency within business networks, as well as, decreasing and minimizing frauds.

Nowadays, financial markets performances are affected by several pain points: high settlement costs and high transactions costs, outdated procedures to carry out vendor on-boarding that in most of case are still manual and hostage to both intentional and unintentional human errors, and a general lack of integration between different companies IT systems (systems do not talk to each other).

Primechain offers a set of blockchain based services to improve performances in supply chain both for financial institution and businesses.

Their permissioned blockchain platform, powered by Hyperledger Sawtooth, aims at converting all those drawbacks into business opportunities. The platform includes KYC procedures, documentary credits, actors verification, document authentication and vendor on-boarding processes as the key to speed up all the activities related to the finance market.

Those services at the moment represents the core of PrimeChain business but, exploring new business opportunities they created a second ecosystem specifically tailored on bank needs, called BankChain.

BankChain is an ecosystem, it has 37 members and 9 live projects and is working in the optimization of those procedures negatively affecting the SMEs financing panorama. Bankchain goal is to create a single source of truth for transactions enabling real time monitoring of all the actors involed in the financing solution. The aim of such a project is to minimize the risk of fraud, to speed up the financing processes for SMEs and to provide a new winning experiences for banks.

Primechain offers a service called Primechain-Invoice, a permissioned ecosystems for suppliers that wants to provide easier funds selling invoices to specific investors. The

optimization of Working capital is a key pillar of the initiatives. The start-up believes that, mostly in emerging countries, blockchain based financing options are one of the greatest market opportunity, both for the issuer of the platform and for the actors involved.

Last but not least, PrimeChain offers a service for Non-Performing-Assets, called "stressed assets", that have become a trillion dollars challenge worldwide, it is a marketplace for reconstructured loans and assets under reconstruction.

The PrimeChain offer is one of the most articulated available on the market. They consider the blockchain technology as the key to unlock the capital locked-in business networks and the key to relieve the pain points of the financing dynamics between banks and users.

primechain	Application: PrimeChain	Foundation: 2017	Phase: Seed
http://www.primechaintech.com	Head office: Pune, India	Market launch: 2019	Pure SCF solutions: invoice factoring
Nature of SCF platform: Outsourced	Nature of provider: Bank Neutral, 37 banks involved	Blockchain Type: Permissioned Blockcahin	
Additional Services: 1) Primechain-Invoice: marketplace for easier funds selling invoices to specific investors		Blockchain Protocol: Hyperledger Sawtooth	
Additional Services: 2) KYC procedures, documentary credits, actors verification, document authentication and vendor on-boarding		Smart contract management: YES	
Secondary Data Analysis			

Appendix 7- Primechain Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Supplier On Boarding Problems	green	green	green				
Lack of Accounting Rules and Treatments	green	green	green	green	green		
Financing Options for a Limited Number of SMEs	green	green	green		green	green	green
Double Financing & Fraud Detection	green		green	green	green	green	green

Appendix 8 - Primechain Areas of Impact

5) INVIOU

Inviou is an Israeli start-up, founded in 2018, that is working to develop a new credit finance platform, specifically for invoice financing, leveraging on the key advantages and features of blockchain technology.

The value proposition is based on an underlying idea that: firstly, SMEs difficulties in reaching out funding, potentially represent and underground economy of trillions dollars; secondly, SMEs are required to pay extremely high fees when looking for funding, especially SCF solutions through traditional financial institutions and finally, invoice factoring adoption, which is the solution provided by inviou, is increasingly becoming popular when looking for immediate liquidity for companies.

Inviou offers a blockchain based platform that wants to modify the way in which SMEs access to findings eliminating slow, highly expensive and risky procedures that are affecting the industry. Inviou is a permissioned blockchain platforms that authorize actors involve to interact on a distributed ledger. On the platform invoice sellers are able to interact and sell their asset to buyers and investors exploiting the smart contract scheme that helps in automatizing the whole process.

The platform ensure Smart Ownership of assets and ensures full visibility on the risk, on the financial parameters and guarantees an immutable, durable and extremely secure financial registry. As a result, an immutable financial registry provides an anti fraud and risk elimination mechanism: no sensitive data can be detected, but all the data affecting the relationship among business partners are categorized on the platform showing the state-of-health of sellers in real time.

More practically, Inviou distributed database can be seen as a fully transparent registry of records, provided with permission to lenders for credit check procedures, that can be verified and audited when selling invoices to factors.

As an open-platform where is possible to buy and sell invoices, Inviou is a marketplace. It not all about providing digital validation and authentication but enabling the exchange of assets on the infrastructure.

As a POC, there is no practical evidence of the effectiveness of such a service, but potentially this business is an opportunity to improve working capital optimization and to ensure better cash flow conditions at sustainable cost.

Nowadays, Inviou is struggling to have its platform live at the beginning of 2019 and is working to furtherly expand its business community. This analysis has highlighted a very important specificity about the platform: banks are welcomed in the platform and represent a win-win opportunity for both sellers and investor. Banks will be able to streamline their financial solutions procedures thanks to the distributed database and SMEs will be able to prove easily their financial health.

INVIOU it's on record	Application: Inviou	Foundation: 2018	Phase: POC
https://inviou.com	Head office: Isreael	Market launch: 2019-2020	Pure SCF solutions: invoice financing
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Marketplace, Bank Neutral	Blockchain Type: Permissioned Blockchain	
Additional Services: 1) Marketplace for financing option considering banks as potential investors		Blockchain Protocol: Not defined yet - MVP: Ethereum	
		Smart contract management: YES	
Secondary Data Analysis			

Appendix 9 - Iviou Identikit

BCT Features ╲ SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
Double Financing & Fraud Detection	■		■	■			
High Transaction Costs	■	■	■	■		■	

Appendix 10 - Iviou Areas of Impact

6) ANTAVIRA

Antavira is a Russian start-up founded in 2016. It offers a blockchain-based credit risk management platform that aims to change the lending industry.

The stones of Antavira are transparent ecosystem and automated quality control but, most important, is the world first platform that will make loss underrating for lenders come true.

Lenders, risk managers, credit analyst, data providers and investors will be working contemporarily on the same distributed platform in order to foster efficiency and effectiveness when dealing with a loan issuance for SMEs.

Antavira considers its smart contracts as the medium to revolutionize the lending industry.

The advantages Antavira is leveraging on, are concering about the elimination of risks in credit business and to improve the service quality ensuring correct and congruent rules for all the actors involved.

In order to survive in a highly competitive credit market, lenders must constantly improve the quality of credit risk management, so they spend more and more money on it. Nowadays lenders are depending on risk managers, but risk managers absorb most of the profit. With Antavira, market players from around the world will be able to work with each other, earn more and spend less.

Antavira platform safeguards lenders on loan default using the extraordinary power of blockchain smart contracts. By verifying a set of key performance indicators, that must be simultaneously positively approved, allows an automated quality control process that undermines the loan settlement conditions.

The smart contract is encharged to find the client that answers specific lenders requirements granting participants to have incentives when reaching out the agreement.

Being designed "to become an undoubtable necessity", Antavira has as key objective the creation of a global ecosystem marked by trust. Trust itself, is consider as an immediate outcome of a fully transparent and automated blockchain platform.

But widely proclaimed good intentions still need to be translated into concrete execution. Antavira shows well-developed Proof of Concept but is still struggling to define the technological specifics of its platform. There are no available information about the nature and the provider of the platform, as well as the blockchain protocol of reference and the nature of transactions within the platform.

As newcomers on the market, they are studying and working in order to obtain a platform that could be translated into scheme of reference for the global lending market in few years.

Considering their partnership network the start-ups seems to be extremely appreciated by notorious actors involves in the fintech market such as Scorista, Microsoft Azure.

[ANTA VIRA]	Application: Antavira	Foundation: 2017	Phase: POC
https://www.tradefin.com/	Head office: Russia	Market launch: 2016	Lending
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up by Scorista, Bank Neutral	Blockchain Type: Permissioned Blockcahin	
Additional Services: 1) Automatize smart asset management system to prove certificates (based on ARMT Token)		Blockchain Protocol: Not defined yet -	
Additional Services: 2) Lending plaftorm + Blockchain Credit Risk Management platform		Smart contract management: YES	
Secondary Data Analysis			

Appendix 11 - Antavira Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Lack of Accounting Rules and Treatments	✓	✓	✓	✓	✓		
Financing Options for a Limited Number of SMEs	✓	✓	✓		✓	✓	✓
Supplier On Boarding Problems	✓	✓	✓				
Double Financing & Fraud Detection	✓		✓	✓	✓	✓	✓

Appendix 12 - Antavira Areas of Imact

7) **PAYPIE**

PayPie is a Canadian start-up founded in 2017 that is working to release a blockchain-based platform at the beginning of 2019. They provide a set of innovative tools able to help firms in achieving better financial results. Platform is designed to reshape the the financial performances of companies focusing on three main activities: cash flow forecasting, risk scoring assessment and business financing.

In order to ensure these improvements, the three activities are complementary: each of them can be considered singularly but, all together they aim at providing the best financial coverage for companies looking for solutions that could improve financial results as a whole.

The first service, cash flow forecasting, is determinant to reduce the percentage of denied financing requests as a result of cash flow troubles. PayPie cash flow analysis wants to show how and when the cash is moving from and to the the business. The platform itself, allows to cross-compare monthly results and to optimize the impact of account payables and receivables on the company liquidity.

The second service is a tool that should help SMEs, usually characterized by a general lack of automatized practices, to create their own business credit report. The report consists of a set of real time data that show the state-of-health of companies. Data are immutably stored and hashed on the blockchain platform in order to guarantee trust and security about seller credential. Thus, investors are aware of how borrowers are financially behaving.

The third service they provide is a direct consequence of the two mentioned above. PayPie offers a marketplace that matches SMEs needs for funding with investors looking for transparent and secure information about their possible business partners. Companies can apply on the platform for specific funding. Once the risk assessment procedure is concluded is hased and verified, then the application is released on the platform where smart contracts act to find the most suitable solution for each applier.

More specifically, they offer a supply chain finance solution: invoice factoring, considered as the most favourable practice through which borrowers can convert their countless invoices into liquidity.

From a technological point of view, PayPie has identified Etheruem as Blockchain technology provider and is working to release its platform on the market in the very next future. As proof of concept they are working to firsly test their services on a beta-release in order to ensure a well-oiled credit platform once the platform is ready to join the market. Additionally, they are striving to enlarge the business community: the greater the number of participant the faster is the way to become a standard on the market.

There are no considerations about the blockchain type but according to the types of services provided will be probabily characterized by a permissioned access.

PayPie	Application: PayPie	Foundation: 2017	Phase: Seed
https://www.paypie.com	Head office: Canada	Market launch: 2019	Pure SCF solutions: invoice factoring, dynamic discounting and receivable financing
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Marketplace, Bank Neutral	Blockchain Type: Permissioned Blockchain	
Additional Services: 1) Cash Flow Forecasting: determinant to reduce the percentage of denied requests as a result of cash flow troubles		Blockchain Protocol: Ethereum	
Additional Services: 2) Marketplace: matching SMEs needs for funding with investors		Smart contract management: YES	
Secondary Data Analysis			

Appendix 13 - Paypie Identikit

SCF inefficency \ BCT Features	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Lack of Accounting Rules and Treatments	✓	✓	✓	✓	✓		
Financing Options for a Limited Number of SMEs	✓	✓	✓		✓	✓	✓
Supplier On Boarding Problems	✓	✓	✓			✓	✓
Lack of Efficent Collaboration	✓	✓	✓		✓	✓	✓
Double Financing & Fraud Detection	✓		✓	✓	✓	✓	✓

Appendix 14 - Paypie Areas of Imact

8) POPOLOUS

Popolous is a European-based start-up founded in UK, in 2015. They represents one of the very first companies able to reach the market of bSCF solutions. With their outstandings results in 2016 and 2017 they turned out to be one of the most appealing offering on the market considering invoice financing market on a global scale.

It is a common issue the businesses lack of cash needed in order to pay off day-to-day needs such as buying stocks and paying wages. In Popolous invoice discounting platform, firms can unlock the cash needed as fast as never before.

Popolous.World is an invoice discounting marketplace built on Ethereum blockchain that provides speed and cost reduction thanks to the role of smart contracts that automatically, match seller and buyer, and release payments. Another representative stone of Popolous is related to the fact that the platform and its distributed globally, that allows transactions and interactions without constraints of time or location. In addiction, every transaction can take place with no approval of certified central authority streamlining and innovating all the funding-related activities.

Ethereum Blockchain public nature allows full visibility and traceability of transactions, thus ensures, unprecedented safety and transparency, fraud minimization and unappropriated use of data.

The product is mostly focused on SMEs needs, but the nature of the platform could allow big players to enter the ecosystem with their own set of suppliers in order to automate trade finance processes and consequently improve efficiency, accuracy and performances. On the other hand, SMEs get a double benefit: they are able to get funding faster and at lower interest rates, and to obtain auditable trial of their own transaction in a completely errorless way.

The platform is characterized by the presence of two different tokens with extremely different purposes. PPT token, issued as pre-ICO to raise funds, allows to enter the platform and to purchase Pokens, the fiat-pegged cryptocurrency (1:1 GDB), enabling transactions on the platform between actors involved.

Popolous is investing to enlarge its partnership network, they recently announced a collaboration with TradeSpace, an Indian invoice broker company to show that that business is tailored to help and improve performances also in emerging markets. The advantages brought by such a bSCF are perceived as the answer for those market where the access to funding is negatively affected by low coordination between supply chains and financial institutions, delays, frauds and untrusted atmosphere.

iPOPULOUS	Application: Popolous.World	Foundation: 2015	Phase: Active
https://populous.world	Head office: London, UK	Market launch: 2016	Pure SCF solutions: invoice discounting, dynamic discounting
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Marketplace, Bank Neutral	Blockchain Type: Public Blockchain	
Additional Services: 1) Automatize smart asset management system to prove certificates (based on Pokens Token) + PPT, ERC20 Ethereum Token)		Blockchain Protocol: Ethereum	
Additional Services: 2) Marketplace for invoices		Smart contract management: YES	
Secondary Data Analysis			

Appendix 15 -Populous Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
High Transaction Costs	■	■	■	■		■	
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■

Appendix 16- Populous Areas of Impact

9) DEBITUM NETWORK

Debitum Network is a Lithuanian start-up founded in 2015. The company mission is to create an ecosystem in which investors, sellers and buyers can interact and exchange value, issue loans and obtain added auditing services. Debitum has recently released its platform ABRA 1.0.

ABRA allows users to enter the platform, then they can invest, deposit or withdrawn both in cyprtocurrencies and fiat-pegged (EU 1:1). This is not the only token available on ABRA; DEB tokens are the one involved in value exchange (payments on the network) and used as a toll that can be locked as a collateral to guarantee the execution of the transaction. This is the reason why Debitum considers the blockchain technology as the most powerful option to ensure a trustworthy ecostystem.

As a lending platform, Debitum matches SME needs with financial providers or investors requirements. This takes place on a distributed database when everything is controlled and moved by smart contracts. Thus, no third-parties approval is requested. On the platform several services are provided: factoring, business loans, property registry, stocks are the possible assets available in the offer.

ABRA has been design with the underlying idea that once the network will be well-established and the number of active participants will be significant a risk assessment procedure will be built on the previous transactions made on the platform. That would allow to interpret the real state-of-health of actors involved and to provide specific and optimized solution tailored on borrowers needs.

Debitum Network has its root in the SMEs critical conditions when looking for funds: mostly denied due to a general lack of standards when dealing with companies that completely depends on their account payables and receivables. Thus, results in a 3 trillon credit gap on a global scale. The Lithuanian company has delivered a decentralized global financing solution. The network is trust based, every transaction is built on trust arbitrage smart contracts that would updata real time rating of each counterparty.

Debitum is hosted by Ethereum blockchain and still utilises its consensus mechanism to deal with fault tolerance and data securitization.

The start-up is currently focusing its efforts to expand its market in emerging countries where SMEs represents the driving force of the national economy. In 2019 the main target is Asia, more precisely India. It is well-known that this markets have a potentially extraordinary impact on the trade finance market. Apparently, emerging countries general need to digitalize their industry, could be translated into practice thanks to introduction of bSCF that will helps to unlock an incredibly valuable credit gap.

DEBITUM NETWORK	Application: Abra1.0	Foundation: 2015	Phase: Seed
https://debitum.network	Head office: Lithuania	Market launch: 2018	Lending
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Bank Agnostic	Blockchain Type: Permissioned Blockcahin	
Additional Services: 1) ABRA allows users to enter the platform, then they can invest, deposit or withdrawn both in cyprtocurrencies and fiat-pegged		Blockchain Protocol: Ethereum	
Additional Services: 2) Possibility for sellers to join invoice financing on the platform certificates (based on DEB Token)		Smart contract management: YES	
Secondary Data Analysis			

Appendix 17 - Debitum Network Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	██	██	██		██	██	██
Double Financing & Fraud Detection	██		██	██			
High Transaction Costs	██	██	██	██		██	

Appendix 18- Debitum Network Areas of Impact

10) WE.TRADE

We.Trade is a joint-venture is a company owned by a consortia of 9 European banks that are developing and licensing the first blockchain-based trade platform for clients and their bank on the market. Banks are aware that blockchain is influencing and affecting many industries: trade finance is no exception, they have perceived that the blockchain is about to reshape the boundaries of commercial business.

The 9 banks involved in the initiatives can rely on the most notorious banks of the old continent such as: Santander, Unicredit, Societé General, HSBC, Rabobank and UBS all of them national leaders in the banking industry.

On the platform several services are offered to clients. In the registration phase KYC procedures are carried out to identify and categorized the counterparts. Once the profile is created it is possible to access other service: it is possible both to buy and sell goods. When you are buying goods all the process allows to reduce risks and barriers enabling real time exchanges between multiple parties. Events take place in an automatic way thanks to smart contracts. Being a potentially scalable ecosystem it will be able to track and record all the transactions to proof the state of health of the actors involved. All the documents about transaction will be available to the various parties involved in the commercial process, subject to prior authorization.

The platform is hosted by Hyperledger Fabric powered by IBM, that is one of the most common permissioned ecosystem where approved participants can take part to the network. The private nature of the network assures secure and immutable exchanges and transactions, payments and investments profiling and auditing financial assets in real time. In addiction, the peculiarity of the project is the possibility of creating "channels", not visible to everyone, within a single blockchain.

Business and financial instituitions are seeking more efficient and cost efficient solutions to improve trade finance performances on a global scale.

Trust arbitrage smart contracts are the core competitive advantage provide a fast and fully automated order-fulfilment-payment process once all the contractual obligations are verified.

we.trade	Application: We.Trade	Foundation: 2017	Phase: Seed
https://we-trade.com	Head office: Europe	Market launch: 2018	Pure SCF solution: invoice financing but not as main service
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up by Bank Consartia (9 European Banks)	Blockchain Type: Permissioned Blockcahin	
Additional Services: 1) KYC procedures and credit risk procedures		Blockchain Protocol: Hyperledger Fabric	
Additional Services: 2) Lending plaftorm + Blockchain Credit Risk Management platform		Smart contract management: YES	
Secondary Data Analysis			

Appendix 19 - WeTrade Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
Lack of Accounting Rules and Treatments	■	■	■	■	■		
Lack of Efficent Collaboration	■	■	■		■	■	■
Supplier On Boarding Problems	■	■	■				
Double- Financing	■		■	■			

Appendix 20 - WeTrade Areas of Impact

11) SKUCHAIN

Skuchain is a US-based start-up born in 2014. It is one of the most advanced start-up dealing with blockchain with practical implementation in the supply chain field of expertise.

It empowers companies, and groups of companies constituting a supply chain, to optimized their value stacked in the business network (approximately 15 trillion dollars on a global scale).

According to Skuchain, the blockchain represents the new frontier of supply chain collaboration, enabling enterprises to work together reaching out important advantages in terms of revenues and control of their own network. Skuchain has developed a set of blockchain-based tools in order to do help enterprises to accomplish their goals.

The platform does consider both buyers and suppliers needs and provides an automated control process to all the activities that take place in the distributed ecosystem.

Skuchain offers 5 different products, all of them aim to act on supply chain performance in order to improve the quality of information and financial flows as well as visibility and traceability of goods when moving to different actors.

Popcodes (Proof of Provenance codes) are cryptoassets that characterize a specific flow of goods. The tokenized asset on the blockchain ensures full visibility and control over the physical value of goods. Popcodes, is a just-in-time inspired solution, that can revutionalize the SC ecosystem allowing maximized agility, planning and coordination. The tokenization of goods empowers companies to be much more engaged in the improvements: a token-based feedback loop underlines an innovative concept of one-2-one trade marketing.

On the platform, Brackets are crypto smart contracts that automatize the whole supply chain process. Brackets enables to tokenize and digitalize assets: invoices, letter of credit, PO's and bill of credit can be considered as smart assets on the platform. Triggering on smart contracts, Skuchain a set of pre-determined contractual

agreements and workflow operations are turned into completely autonomous processes. As a consequence, smart contracts enhance liquidity of collateralized assets within the SC by providing new innovative supply chain finance solutions aiming at optimizing the impact of account payables and receivables on the working capital.

Due to the presence of financing activities on the platform, a set of risk and credit assessment tools have been developed. They ensures to de-risk transactions, providing a real time measure about cash flows conditions highlighting if predetermined conditions are verified.

On the platform, Skuchain enables complete transparency. Companies are able to act together in order to achieve better performances but, thanks to the Zero Knowledge Collaboration technology they are controlling the access to specific sensitive information. Thus, is enabled by the chosen protocol: Hyperledger Fabric is the most representative type of permissioned BCT.

skuchain	Application: Skuchain	Foundation: 2014	Phase: Active
http://www.skuchain.com	Head office: USA	Market launch: 2018	Pure SCF solution: invoice financing as complementary services
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up by Scorista, Bank Neutral	Blockchain Type: Permissioned Blockcahin	
Additional Services: 1) Popcodes (Proof of Provenance codes) are cryptoassets that characterize a specific flow of goods. The blockchain ensures visibility and control over the physical value of goods.		Blockchain Protocol: Hyperledger Fabric	
Additional Services: 2) Brackets: crypto smart contracts that automatize the whole supply chain process.		Smart contract management: YES	
Secondary Data Analysis			

Appendix 21- SkuChain Identikit

SCF inefficency \ BCT Features	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset management)
Financing Options for a Limited Number of SMEs	✓	✓	✓		✓	✓	✓
Supplier On Boarding Problems	✓	✓	✓				
High Transaction Costs	✓	✓	✓	✓		✓	
Lack of Efficent Collaboration	✓	✓	✓			✓	✓
Double Financing & Fraud Detection	✓		✓	✓	✓	✓	✓

Appendix 22 - SkuChain Areas of Impact

12) EQUIPMENT CONNECT

Equipment connect is a UK-based start-up born in 2016, whose headquarter is set in London. Their digital asset trading platform has been release to he market in autumn 2018 led to consider them as one of the very first start-up using equiments as digital assets. This practices represent a specific SCF solution: equipment financing.

In order to compete in a competitive marketplace, companies demand best equipment and machineries. That is the reason why Equipment Connect belives that asset finance should be fast, affordable and easy.

The reason why, Equipment Connect decided to enter the business is that, SMEs industry has its roots in trillions dollars of equipment, so it is crucial to streamline the way in which enterprises purchase their assets.

Equipment connect is a new online platform focused on several sectors, including recycling, construction, printing and manufacturing. This alternative blockchain-based source of financing is flexible and reliable in which the platform works in tandem with equipment suppliers capturing all the important information. As a result, an online service which is completely stress-free.

As a fintech platform, the British start-up leverages on blockchain technology to deliver unprecedented efficiency. There are no paper forms, and thank to the cloud nature of the platform they can connect multiple APIs, with no paper form, focusing mostly on what really matters when taking about assets financing.

The telematic system developed on the blockchain increases robustness in the financing process.

The distributed ledger technology that underpins Equipment Connect, ensures fully visibility and traceability on transactions, data ownership during the all all the financing process.

Different counterparties, that usually act separately can finally reduce costs a dependency issues. Thus is due to the the hosting Blockchain platform, which is Ethereum. It ensures privacy, variable permissioning of participants and a completely trustworthy consensus mechanism.

They consider the technology as a disruption in the asset financing industry. The benefits brought by blockchain has been identified: risk reduction, decrease of defaults rates, increase in sales and the higher efficiencies of the platform can be easily converted into lower funding costs. Additionally, the technology, when used to serve well-established financial ecosystems can guarantee integrity of exchanges, lower data vulnerability thank to the immutable nature of recorded data.

Equipment Connect	Application: Equipment Connect	Foundation: 2013	Phase: Seed
https://www.equipmentconnect.co.uk	Head office: UK	Market launch: 2016	Pure SCF solution: Equipment Financing
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up by Scorista, Bank Neutral	Blockchain Type: Permissioned Blockcahin	
Additional Services: 1) Automatize smart asset management system to prove certificates (based on ARMT Token)		Blockchain Protocol: Ethereum	
Additional Services: 2) Lending plaftorm + Blockchain Credit Risk Management platform		Smart contract management: YES	
Secondary Data Analysis			

Appendix 23 - Equipment Connect Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
Double Financing & Fraud Detection	■		■	■			
High Transaction Costs	■	■	■	■		■	

Appendix 24 - Equipment Connect Areas of Impact

13) SYMBIONT

Symbiont is a US-based start-up founded in 2013. Initially, their aim was to offer a DLT-based platform to enable a better connection among business networks and share documents in a more secure and efficient way. Symbiont has developed a tool, called Smart Securities, built on blockchain technology able to solve all the main inefficiencies related to supply chain and supply chain collaboration. Symbiont, allows companies to overcame traditional barriers: credit and suppliers rating, supply chain visibility and data sharing are no longer perceived as pains along business networks, indeed, it helps in increasing coordination and installing trust in cross-border transactions. The main advantage is that assets do not have to move and to be registered on paper form: the blockchain allows to record and maintain on thousand of computers the proof of possession of every specific asset enabling peer to peer exchanges with no constraints of time or location.

As a result, data are shared easily and quickly and the DLT ensures data immutability. In addiction, complex, inefficient and manual back-end activities, often affected by the presence of third-parties, are substituted by a completely automatized and verified record of transactions that ensures cost and risk reduction.

The fast growth of the BCT industry has recently lead Symbiont to create new services to improve the performances of enterprices also from a financial point of view. The traditional inefficiencies in accessing credit have been solve by a the introduction of a second blockchain-based service. Synaps, born as a joint venture wih IPREO, is a platform that issues syndicated loans to SMEs. Smart contracts are able to convert the advantages given by data management into a syndicated loan marketplace.

Symbiont allows owners of existing assets to create liquidity by selling the digitalized assets backed by their physical collaterals. This, in tandem with the P2P nature of the platform provides completely transparent exchanges on global scale, minimizing frozen times and resource wasting activities. By not having to rely on one centralized authority for exchange of information, enterprises are able to participate in financial

transactions at the same level of those financial institutions, that previously companies where relying on for the treatment of financial information.

The platform is hosted by Hyperledger Fabric powered by IBM, that is one of the most common permissioned ecosystems where approved participants can take part to the network. The private nature of the network assures secure and immutable exchanges and transactions, payments and investments profiling and auditing financial assets in real time.

symbiont	Application: Symbiont	Foundation: 2013	Phase: Active
https://symbiont.io/	Head office: USA	Market launch: 2016	Lending
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Bank Neutral	Blockchain Type: Permissioned Blockcahin	
Additional Services: 1) Smart Securities: supply chain collaboration enabler		Blockchain Protocol: Hyperledger Fabric	
Additional Services: 2) Synaps: issues syndicated loans to SMEs Blockchain + Credit Risk Management platform		Smart contract management: YES	
Secondary Data Analysis			

Appendix 25 - Symbiont Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Lack of Efficent Collaboration	█	█	█			█	█
Lack of Accounting Rules and Treatments	█	█	█	█	█		
Supplier On Boarding Problems	█	█	█				
Financing Options for a Limited Number of SMEs	█	█	█		█	█	█

Appendix 26 - Symbiont Areas of Impact

14) ACUDEEN

Acudeen is a Filipino start-up founded in 2015. It is a fintech company with a revolutionary marketplace in order to help small and medium size businesses liquidate the receivables ahead their maturity date, removing the cash burden they have to deal on a montly base.

Recently they have developed a proof of concept to translate their trade finance business for SMEs onto the blockchain, opening their service to a much wider ecosystem, named Assetchain (2018).

Thus, Assetchain, is a decentralized market for micro and SMEs to sell movable assets in order to obtain instant liquidity. The Assetchain platform is powered by the Hyperledger Fabric which executes chain codes to conduct transactions and record information a decentralized infrastructure. Additionally, a direct integration with the Stellar protocol, characterised by its public nature, allows instant transfer of funds between participants involved.

On the platform, tokens cover a critical role and, as in many other use cases, more than one token typology is present in the ecosystem with a completely different role. The ACU Tokens are native utility tokens, used to interact in the ecosystem. For instance, ACU tokens ensure data ownership, and the transfer of movable assets between counterparties. ACU tokens, can be also earned, as an incentive, by actors offering value-added services and validating invoices on the platform.

To protect sensitive data from being visible to potential competitors a permissioned blockchain is used: this makes sensitive data only visible to those with the respective private key, typically related to the parties involved in the asset transaction.

Acuteen has been designed to provide liquidity mostly for companies working in emerging markets. Doing that, they would allow to help SMEs without the requirement of third-parties.

The marketplace, does not include only the marketplace, but also a set of toll to improve KYC procedures and risk assessments.

Invoice factoring is the SCF solution they are leveraging on. It perfectly fits with SMEs cash deficit and allows the investors to get paid quickly and companies to generate cash surplus on a regular basis. Usually, invoice factoring is a practice that is common between trusted parties: this is the reason why blockchain and its trusted ecosystem, appear to be the key to deliver such a service on a much bigger scale.

In order to do assessment procedures, the platform uses the Altman Z-Score formula that classifies businesses according to their default risk. The data used to assess the Z-Score are both related to cash flow analysis and the real-time state of health of the selling company. This automated indicator is used also by Lendflo.

ACUDEEN	Application: Assetchain	Foundation: 2017	Phase: Seed
https://acudeen.com/	Head office: Philippines	Market launch: 2016	Pure SCF solution: Invoice Financing
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Bank Agnostic, Marketplace	Blockchain Type: Permissioned Blockcahin	
Additional Services: 1) Marketplace: matching SMEs needs for funding with investors		Blockchain Protocol: Hyperledger Fabric + Stellar	
Additional Services: 2) Credit Risk Management platform - Z-Altman Score		Smart contract management: YES	
Secondary Data Analysis			

Appendix 27 - Acudeen Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	✓	✓	✓		✓	✓	✓
Lack of Efficent Collaboration	✓	✓	✓			✓	✓
High Transaction Costs	✓	✓	✓	✓		✓	
Lack of Accounting Rules and Treatments	✓	✓	✓	✓	✓		
Double Financing & Fraud Detection	✓		✓	✓	✓	✓	✓

Appendix 28 - Acudeen Areas of Impact

15) INVENTORY CLUB

Inventory Finance was founded in 2017, in England. It is a fintech start-up whose ultimate goal is to enable merchants, operating in the Commnwealth, financing their inventories through a blockchain-based platform.

A general lack of financial resources, with extremely difficult contitions when looking for banks credit is influencing negatively the permormances of companies operating in the geographical area. As a consequence, in order to improve the perfromances of SMEs in the commowealth, InventoryClub has created a marketplace that matches the needs of buyers and sellers thanks to the power of smart contracts. The platform is not available online, but recently, a demo version has been released.

The marketplace is powered by Ventory (VNT) tokens. VNT is the cryptocurrency used to manage the flow of funds of the marketplace. The VNT tokens are built on the Stellar Network guarantee asset tokenization, distributed exchange, advanced security and optimized and faster exchanges. This public nature of the blockchain favours instant payment settlement and financing options on a geographically scale.

Addictionally, the Marketplace is hosted by the MultiChain open-source platforms, one of the most common permissioned ecosystems where approved participants can take part to the network. The private nature of the network assures secure and immutable exchanges and transactions, payments and investments profiling and auditing financial assets in real time. The permissioned ecosystem can be personalised according to the specific requirements of participants, that enables a trustworthy ecosystem completely tailored on actors needs.

Furthermore, InventoryClub has not to be considered only a technology provider, but it also acts as a guarantor of the agreement. The British start-up, through its added-service InvertoryTrace takes charge of goods, controlling them through an IoT-based inventory management system, and, in case of insolvency or default absorbs responsibilities and refunds investors.

From a practical point of view, InventoryClub behaves as agent that directly matches merchants and financial investors, securitizing their business partnership on the rules

dictated by the IFA (Inventory Finance Agreement). The IFA contract a smart contract that take into account all the contractual clauses. Triggering on the IFA smart contracts, InventoryClub assures that the set of pre-determined contractual agreements and workflow operations are turned into completely autonomous processes. As a consequence, IFA contracts enhance liquidity of collateralized assets within the SC by providing new innovative financing solutions aiming at optimizing the impact of account payables and receivables on the working capital.

inventoryclub	Application: Assetchain	Foundation: 2018	Phase: POC
https://inventoryclub.com	Head office: London, UK	Market launch: 2019	Pure SCF solution:
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Bank Agnostic, Marketplace	Blockchain Type: Permissioned Blockcahin	
Additional Services: 1) Marketplace: matching SMEs needs for funding with investors using Ventory (VNT) tokens		Blockchain Protocol: Multichain + Stellar	
Additional Services: 2) InventoryTrace takes charge of goods, controlling them through an IoT-based inventory management system		Smart contract management: YES	
Secondary Data Analysis			

Appendix 29 - InventoryClub Identikit

SCF inefficency \ BCT Features	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	✓	✓	✓		✓	✓	✓
Supplier On Boarding Problems	✓	✓	✓				
High Transaction Costs	✓	✓	✓	✓		✓	

Appendix 30 - InventoryClub Areas of Impact

16) INVOX FINANCE

Invox Finance, founded in 2018, is an Australia start-up that offers a marketplace for invoice financing. Invoice finance provides a service that potentially enables millions of business owners to accelerate and increase cash flows.

Invox Finance is a decentralized peer-to-peer invoice lending platform built on the blockchain. Blockchain technology itself, ensures cheaper financing, more accessibility and unprecedented transparency. They bring participants together to facilitate trust through a dynamic and distributed ledger.

On the platform it is possible segment invoices into smaller once to provide equal access to specific investments opportunities.

The ecosystem is caractherized by the presence of tokens. ERC20 tokens. From the sellers point of view, provide access to the application so they can obtain invoice financing on a blockchain-based platform.

For both buyers and sellers, are also the reward they will receive verifying paying and settling invoices. Additionally, it is possible to buy INVOX Tokens to obtain great bonuses, but only during their ICO. Invox Tokens can be considered also as the proof of verification tokens, turning out to be one of the most important stones when wishing to achive a trustworthy relationship between investors, buyers and sellers.

The platforms ensures multiple advantages for all the actors involved: sellers have the possibility to accelerate their access to liquidity, consequently improving their cash flow; investors can obtain higher interest rates and can mitigate their risk increasing the degree of diversification of their portfolio if investments; while buyers will be able to extend their payments periods and be rewarded when verifying the invoices.

Invox Finance marketplace is hosted by Ethereum open-source blockchain that provides speed and cost reduction thanks to the role of smart contracts that automatically, match seller and buyer, and release payments. Furthermore, Ethereum Blockchain public nature allows full visibility and traceability of transactions, thus

ensures, unprecedented safety and transparency, fraud minimization and unappropriated use of data.

On the platform a set of smart contracts underpin the whole process: they, firstly facilitate the creation and registration of invoices and, secondly, they promotes authenticity and transparent ecosystem to all the counterparties. Invox Finance smart contracts, named Dynamic Invoice smart contracts, thanks to their self-executing nature behave as defence against data corruption and manipulation. Additionally, being built on Ethereum they potentially can be integrated with other software, so it would be possibly translated into a scalable solution in the very next future.

invox FINANCE	Application: InvoxFinance	Foundation: 2018	Phase: POC
https://www.invoxfinance.io	Head office: Australia	Market launch: 2019	Pure SCF solution: Invoice Financing
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Bank Agnostic, Marketplace	Blockchain Type: Permissioned Blockcahin	
Additional Services: 1) Marketplace: matching SMEs needs for funding with investors using INVOX Tokens		Blockchain Protocol: Ethereum	
Additional Services: 2) Credit Risk Management platform		Smart contract management: YES	
Secondary Data Analysis			

Appendix 31- Invox Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
High Transaction Costs	■	■	■	■		■	

Appendix 32- Invox Areas of Impact

17) SOFOCLE TECHNOLOGIES

Sofocle technologies empower technological implementation for market innovation and the creation of new streams of value creation. Sofocle products and services are applicable to a wide range of industries including Finance, , Logistics, Manufacturing and Insurance.

Representing an early adopter of BCT in the Indian market, Sofocle successfully implemented clients POCs, which lead the firm to win the prize, among the others, of the Fintech Valley Blockchain Startup Challenge in 2017.

Relatively to the Supply Chain Management and the Supply Chain Finance are three the most fitting services offered. SofoCap is a BCT based solution aimed to rise the efficiency of the SCF by eliminating manual documents and processes. It consists in a platform run on Hyperledger, connecting trading parties in a transparent ecosystem. On the platform are available real-time and reliable data about every transaction happening in the network, and throught the use of Smart Contracts transactions are automatically executed at predefined triggering events. Traditional SCF solutions such as Purchase Order, Inventory Finance and Factoring can be executed on the network, spilling over benefits for both the investors and the financed firms by tokenizing every kind of asset. The platform in fact eliminate the risks of double-financing, allow to decrease the risks for investors by splitting up payables and streaming in a digital environment all the flows.

SofoPay is the service dedicated to the payment process, eliminating complexity by recurring to smart-contracts and transparency. On the a DLT are recorded all the activities composing the payment process, starting from the PO to the payments execution. Every activities require the confirmation of the counter-part which, once registered on the BC, trigger the following phase, informing all the party involved in the transaction.

The last service is Certiza, an hybrid blockchain already available on the market which provide firms the shared registry of records for continuous storage, retrival and

verification of data in real time. It represent a valid and immutable database potentially containing all the historiy of a firm and thus, reducing effort in the audit process and smart-asset management.

SOFOCLE TECHNOLOGIES	Application: SofoPay, SofoCap, Certiza	Foundation: 2016	Phase: Active
https://www.sofocle.com	Head office: India	Market launch: 2016	Pure SCF solution:
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Bank Neutral MarketPlace	Blockchain Type: Permitioned/ Consortium Permitioned	
Additional Services: 1) Trusted Ecosystem to make automized transaction		Blockchain Protocol: Hyperledger/ Fabric/ Ethereum	
Additional Services: 2) Automated Payment service		Smart contract management: YES	
Secondary Data Analysis			

Appendix 33 - Sofocle Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Supplier On Boarding Problems	■	■	■				
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
Lack of Efficent Collaboration	■	■	■			■	■

Appendix 34 - Sofocle Areas of Impact

18) TRADE FINANCE MARKET

Trade Finance Market aim to provide liquidity to those SMEs excluded by the current financial market. It is based in Singapore, operating worldwide with particular focus on emerging markets, supporting trade finance solution about commodities, finished goods and raw materials. With its two main application, InvoceCheck and CollateralCheck, the primary focus of the firm is to provide liquidity under the form of short term debts, decreasing the cost of financing by eliminating the bureaucracy and the rigidity affecting traditional source of finance.

InvoiceChack consist in a marketplace where every formal or informal investor can access and filter the targeted kind of Invoice to finance with transparency and in short time period -less than 30 seconds-. The transaction data are crypted and recorded in an anonymous way, in every case, the information about the status of the invoice are public and immutable.

CollateralCheck works the same way, focusing on the recipts used to finance a collateral rather than invoices.

InvoiceCheck and CollateralCheck are complementary service which together cover a large portion of SCF solution, both supplyer-led and buyer-led, and post-shipment and pre-shipment.

The DLT on which the two application rely have the role to ensure the entire network visibility on the transaction, with particular emphasis on solving the double-spending problem, thus reducing the risk incurred in each transaction and decreasing the cost of financing. This approach entails a series of other advantages, from a faster provision of liquidity to a lower complexity -and costs- in cross-border transactions, significantly enlarging and strengthen the customer base of a SME, at the date characterized by a lack of resources and network to trade at a word-wide range.

In order to run its infrastructure Trade Finance Market rely on open-source Ethereum modules, with the turning-complete feature which guarantee scalability to any kind of SCF solution and programmability -SMART CONTRACT- of the transactions. The BC

infrastructure is a Consortium Permissioned BC, the most popular choice among the platform of this kind.

TRADE FINANCE MARKET	Application: InvoiceCheck / CollateralCheck	Foundation: 2015	Phase: Active
p://tradefinancemarket.com/blockchain/applications.h	Head office: SINGAPORE	Market launch: 2017	Pure SCF solution: Pre-Shipment / Post Shipment; Buyer-led / Supplyer-Led
Nature of SCF platform: Outsourced	Nature of provider: Fintech Start Up, Bank Neutral MarketPlace	Blockchain Type: Consortium Permitioned	
Additional Services: 1) Avoid Double-Financing Problem		Blockchain Protocol: Ethereum	
Additional Services: 2) Reduce Cross-Boarder transaction costs		Smart contract management: YES	
Interviewed			

Appendix 35 - TradFinMarket Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
High Transaction Costs	🟩	🟩	🟩	🟩		🟩	
Financing Options for a Limited Number of SMEs	🟩	🟩	🟩		🟩	🟩	🟩
Double Financing	🟩		🟩	🟩	🟩	🟩	🟩
Lack of Efficent Collaboration	🟩	🟩	🟩			🟩	🟩
Supplier On Boarding Problems	🟩	🟩	🟩				

Appendix 36 - TradeFinMarket Areas of Impact

19) XINFIN

XinFin is a start-up based in Singapore for global Trade Finance. In Chinese XinFin stand for exchange Infinite and represent the next generation of the global computer network connected by the native BCT called XDC (XinFin Digital Contract). It consists in an Hybrid BC network, combining the power and transparency of a Public BC and the security and speed of a private network. This infrastructure generates a Public State shared by the whole network with the possibility for the nodes to create private sub networks. The Public State can be used to share basics data with transparency, while the private is suitable to share and protect sensible data.

Major focus is on the cross-boarder payments, both in FIAT currency and digital utility Token. Programmability and integration with IoT facilitate also the asset based transactions word wide.

TradeFinex is the proprietary decentralized marketplace for trade finance accessible by buyers, suppliers and informal investors world wide. It is an infrastructure focused on Crowdfunding, aiming to contemporarily rising the visibility of the Buyer Requests, match the Buyers demand with Suppliers and finally financing the Suppliers work. The transaction are automatized via Smart Contract which, together with the cheap payment method made the overall transactional expenses of the operation for the three party extremely cost-efficient, enabling new levels of collaboration between distant entities

At the date a wide number of dAPP are going to be developed, despite no one is live and poor information are available, XinFin expressed the will to lunch an applicative called iFactor to run traditional Factoring and Reverse Factoring programs on BC.

		Application: TradeFinex	Foundation: 2017	Phase: Seed
		Head office: Singapore	Market launch: 2018	Pure SCF solution:
Nature of SCF platform: native		Nature of provider: Nature of provider: Fintech Start Up, Bank Agnostic, Marketplace	Blockchain Type: Hybrid	
Additional Services: 1) Global Trade Finance			Blockchain Protocol: XDC (XinFin Digital Contract	
Additional Services: 2) Cross-Border Payments			Smart contract management: YES	
Secondary Data Analysis				

https://www.xinfin.org/index.php

Appendix 37- Xinfin Identikit

BCT Features SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Supplier On Boarding Problems	■	■	■				
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
High Transaction Costs	■	■	■	■		■	
Double Financing & Fraud Detection	■		■	■	■	■	■

Appendix 38 - Xinfin Areas of Impact

20) CHAINED FINANCE

Chained Finance Financial is FinTech company based in Shenzhen owned by Foxconn International Holdings ltd, world leader in the manufacturing of electric and electronic component. Born in 2017 from the collaboration of Dandong, a Peer-to-Peer lender and Foxconn, Chained Finance over the time it developed an innovative model to offer on the market thanks to cut-edgings technological solutions. The conventional SCF programs includes only the direct suppliers of a large focal firm in a Supply Chain. Those suppliers usually represent only the 15% of the up-stream SC. The remaining 85% are represented for the majority by Small firms, which face the higher risk of lack of liquidity, bringing a series of delays and defects in the material flows along the Sc which potentially reach also the Focal Firm.

Enabled by innovative technologies Chained Finance solutions provide a comprehensive answer to tackle this problem.

Through the tokenization of Account Payables and its conversion in 'eAP' coins the Focal firm and its Large Suppliers -and every actor in the SC with large amounts of residual A/P- can transfer this new currency across the SC to fulfill its operative expenses. The advantage of exchange coins instead of financial flows is in the speed, transparence and safety of the transaction, with at minimal costs-, and being the coins infinitesimally fractionable and immediately convertible from Chained Finance the risks of not using a real currency are neglected.

The expectation of the firm is to cut the average cost of financing of small, distant suppliers from 25% to 10% of the funds and enables SCs to perform real-time transactions.

The company has successfully run a pilot of the network raising $ 6,5 millions of A/P financed with eAP coins, and its preparing to scale up the extent of the network, targeting the manufacturing and electronics industry.

	CHAINED FINANCE	Application: Sofocle	Foundation: 2017	Phase: Seed
	https://www.chainedfinance.com/index	Head office: Shenzhen	Market launch: 2019	Pure SCF solution:
Nature of SCF platform: BankAgnostinc Fintech		Nature of provider:	Blockchain Type: N/A	
Additional Services: 1) Extending the offer to distant suppliers in the SC			Blockchain Protocol: N/A	
Additional Services: 2) Reduction of transaction costs and long executing period in the transaction intra-SC			Smart contract management: YES	
Secondary Data Analysis				

Appendix 39- Chained Finance Identikit

BCT Features SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
High Transaction Costs	■	■	■	■		■	
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
Lack of Efficent Collaboration	■	■	■			■	■
Supplier On Boarding Problems	■	■	■				

Appendix 40 - Chained Finance Areas of Impact

21) AXENS

AXenS is a Panamanian start-up, founded in 2017. AXenS is an innovative B2B platform for supply chain finance activities and distributed global trade services. Through the use of blockchain technology they aim to enable business networks to share documents, do global transactions and track the whole supply chain performances being always compliant with international regulations.

The network, with its distributed nature, is extremely available and scalable. Thus, would allow multiple parties to take part in the ecosystem, including logistical and supply chain networks, financial and insurance players and, potentially governmental agents and authorities attracted by an extremely secure environment.

The AXenS revolutionary blockchain aims to transform global trade. SMEs across emerging markets are dealing with financing gaps and material and their increasingly challenging supply chains. Axens, dynamically combines the financial and physical supply chain. It will be at the forefront of innovation that is accessible and bespoke trade and supply chain finance instrument.

This is made possible by Axens award-winning enterprise-gradeblockchain technology X-Notes. It allows a look through any proposed deal process and full transparency, traceability and immutability to the supply chain processes. The clarity of a deal and its attributes gives Axens the advantage of engaging in transactions by providing loans and trade services where traditional and conventional institutions, such as banks, may shy away.

Furthermore, Axens offers a secondary market for trade finance loans, irrespective of the size of the loan. Thus, providing much-needed liquidity through syndication and crowdfunding of and supply chain loans, Axens can reduce risk for individual lenders on one side, while still providing a way for challenging yet promising export transactions to take place.

The infrastructure is composed by three nodes: SAP, back-end ERP and trade management system, X-Nodes blockchain technology and a bespole front-end web interface.

On the platform, AXS is the native currency of the AXenS platform and its goal is to tokenize every step of the global trade credit chain. The smart asset management represents the primary way to enhance trade finance activities, but, it also represents the means of payments on the platform. AXS transactions are faster and less costly when compared with fiat currencies.

AXenS	Application: Axens.io	Foundation: 2018	Phase:POC
http://axens.io/	Head office: Panama	Market launch: 2019	Pure SCF solution: Invoice Financing
Nature of SCF platform: BankNeutral, Fintech Start-up	Nature of provider: Fintech	Blockchain Type: Permissioned Blockchain	
Additional Services: 1) Financing options to enanche liquidity on Supply Chain scale.		Blockchain Protocol: Proprietary	
Additional Services: 2) Service to enhance collaboration in Supply Chains and to facilitate onboarding activities		Smart contract management: YES	
Secondary Data Analysis			

Appendix 41- Axens Identikit

SCF inefficency \ BCT Features	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Lack of Accounting Rules and Treatments	■	■	■	■	■		
High Transaction Costs	■	■	■		■	■	
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■

Appendix 42 - Axens Areas of Impact

22) JED TRADE

JedTrade is a Singaporean start-up founded in 2017. They are about to release their first platform version. They focus their attention on supply chain finance and financial inclusion projects.

JEDTrade's core business revolves around negotiating better payment terms between suppliers and buyers with mutually beneficial outcomes

The first blockchain-based service offered by JedTrade is Jed Dynamic Discounting. It is a solution designed for buyers and suppliers, in order to enable them to better collaborate. The platform allows actors to better communicate, better secure early payments, improve savings on invoices.

Jed Dynamic Discounting addresses multiple suppliers needs. They usually have to wait months before being paid on their invoices, and, this has a negative impact on cash flows. As a consequence, aiming to reduce cash flow pressure, suppliers seek financing opportunities characterized by high interest rates, limited credit lines and lenghtly documentations and procedures. Additionally, from buyers perspective, they often obtain negligible returns.

According to JedTrade, information asymmetry and low visibility over sensitive contents can be mitigate by the introduction of the BCT. The technology would allow to reshape the SC collaboration, being able to immutably store data, to support self-executed smart contracts. Addressing the lack of trust, a smart contract could pave the way for thought to establish a trustless ecosystem for international trade in which maximum integrity, visibility and transparency are ensured.

The platform is hosted by Hyperledger Fabric powered by IBM, that is one of the most common permissioned ecosystem where approved participants can take part to the network. The private nature of the network assures secure and immutable exchanges and transactions, payments and investments profiling and auditing financial assets in real-time.

Jed	Application: JedDynamic Dyscounting, JupiterChain	Foundation: 2017	Phase:POC
https://www.jedtrade.com/	Head office: Singapore	Market launch: 2019	Pure SCF solution: Dynamic Dyscounting
Nature of SCF platform: Bank Agnostic, Fintech Start-up	Nature of provider: Fintech	Blockchain Type: Permissioned Blockchain	
Additional Services: 1) Dynamic Dyscounting platform to enanche liquidity on Supply Chain scale.		Blockchain Protocol: Hyperledger Fabric	
Additional Services: 2) Service to enhance collaboration in Supply Chains and to facilitate coordination and visibility		Smart contract management: YES	
Secondary Data Analysis			

Appendix 43 - Jed Identikit

BCT Features SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
High Transaction Costs	🟩	🟩	🟩	🟩		🟩	
Financing Options for a Limited Number of SMEs	🟩	🟩	🟩		🟩	🟩	🟩
Lack of Efficent Collaboration	🟩	🟩	🟩			🟩	🟩
Supplier On Boarding Problems	🟩	🟩	🟩				

Appendix 44 - Jed Areas of Impact

23) HIVE PROJECT

The initiative has been developed to answer the needs of SMEs that work in accordance with large corporations' guidelines. For small businesses in particular, it is unacceptable to have to wait several months for invoices to be paid. Enterprises are receiving no payments for their invoices for 90 or 120 days.

With Hive Project, SMEs financing problems are left behind. Using a local ERP or and accounting software providers, enterpreneurs are able to list their invoices on a blockchain-based ecosystem. Hive Projects checks if the invoice details are confirmed by other actors involved and, then, add these invoices. Blockchain elements of the platform assign the invoice to unique fingerprints which prevents suppliers to sell it twice. Oncee the invoice has been processed, the platform matches buyer and seller. Buyers, that are rewarded with HVN tokens to join the ecosystem, are interested in buying invoices due to the favourable conditions that regulate the credit releasing process. All the aforementioned considerations allow businesses to reach the liquidity they need and to ease payment times.

Additionally, on Hive Project it is possible to get rea-time credit scoring and auditing data. ATM tokens are the one required to pay for the services.

The Hive Project Platform is built on the open-source Ethereum project, that ensures compliance with the fundamental design principles of public blockchains: transactions transparency and security, data immutability, data privacy through cryptography, traceability and non-repudiability. Furthermore, Hive Project takes advantage of Ethereum Virtual Machine (EVM).

Hive Project Platform runs self-executing smart contracts, which code and automatically execute the legal conditions agreed between the parties.

For what concerns the validation mechanism, Hive adopts Proof-of-Work as block validation mechanism.

	Application: Hive Project	Foundation: 2017	Phase:POC
https://www.hive-project.net	Head office: Slovenja	Market launch: 2017	Pure SCF solution: Factoring, Invoice Discounting
Nature of SCF platform: Bank Agnostic, Fintech Start-up	Nature of provider: Fintech	Blockchain Type: Consortia, Permissioned Blockchain	
Additional Services: 1) Factoring and Dynamic Discounting platform to enanche liquidity on Supply Chain scale.		Blockchain Protocol: Ethereum	
Additional Services: 2) Credit scoring system that based on the XBRL data and the Altman Z-scores		Smart contract management: YES	
Secondary Data Analysis			

Appendix 45 - Hive Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
High Transaction Costs	■	■	■	■		■	
Double Financing & Fraud Detection	■		■	■			

Appendix 46 - Hive Areas of Impact

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24) BUBI

Bubi was founded in 2015, in China. It is a start-up that leverages on its propietary Blockchain Platform to deliver highly technological financial applications. In particulared, driven by well-established financing programs for SMEs, they have decided to create a blockchain-base SCF platform. Named YinourJr, and launched in 2017, it offers a set of customizable tools to improve working capital performances and to monitor and optimize financing activities.

In accordance with other Asian start-ups the platform is consider the medium that drives the transformation. Thus, as a blockchain provider, Bubi wants to drive a paradigm shift from the lengthy paper-based banks procedures, to a new automated ecosystem that can ensure speed, security, collaboration and trust. As experienced with other Chinese players, the platform does not exclude financial institutions from the network. The system, although being firstly designed to help SMEs, aims to involve financial institutions showing them how significantly different financing activities could be using blockchain.

This neutral orientation towards financial institutions has led Bubi to partner with several Chinese banks that have shown their interest in blockchain-based services, including CICC Payments and CIMC Morgan.

Going deeper in the blockchain platform configuration, Bubichain is the proprietary blockchain that regualtes the network. Its design principles allow to build multiple solutions, all of them characterized by unique performances in terms of reliability, speed and security. More practically, a front-end application software allows to tailor the service on specific needs of partipants. This is a key features to guarantee highly scalable performances to the network.

Additionally, Bubichain is a permissionless ecosystem. It is able to exploit the benefits of public distributed networks such as cost reduction, trust, transparency and collaboration, but also permissioned ecosystems feature such as non- repudiation of actions, data synchronization among network nodes, an self executing smart contracts.

More recently, Bubi launched new applications that allowed the Chinese start-up to enrich its portfolio of blockchain-based services: trade finance, lending, digital assets, Supply Chain traceability, and credit assessment applications lead Bubi to become a player in every area of supply chain management and financing.

![bubi.cn]	Application: Yinuojr	Foundation: 2015	Phase:Active
https://www.bubi.cn	Head office: China	Market launch: 2017	Pure SCF solution: Reverse Factoring
Nature of SCF platform: BankNeutral, Fintech Start-up	Nature of provider: Fintech	Blockchain Type: Permissioned Blockchain	
Additional Services: 1) Reverse Factoring platform to increase liquidity within business networks.		Blockchain Protocol: Propietary	
Additional Services: 2) Digital assets trade, Supply Chain traceability, Public notarization and creditworthiness assessment		Smart contract management: YES	
Secondary Data Analysis			

Appendix 47- Bubi Identikit

SCF inefficency \ BCT Features	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
Lack of Accounting Rules and Treatments	■	■	■	■	■		
Lack of Efficent Collaboration	■	■	■			■	■
Supplier On Boarding Problems	■	■	■				
High Transaction Costs	■	■	■	■		■	

Appendix 48- Bubi Areas of Impact

25) TRADESHIFT

Tradeshift is a US-based company, whose headquarter is set in San Francisco, California. The company, founded in 2009 is active since 2011 offering a set of solutions operating in several field of expertise, such as B2B networks, enterprise software, fintech platforms and trade finance activities.

From a broader perspective, Tradeshift is a cloud-based business network designed to connect buyers and suppliers. Their B2B cloud-based technology helps companies to improve invoice procedures, operating and financing activities.

More recently, due to the fact that more and more attention has been paid towards blockchain technology, they decided to announce TradeshiftPay, a POC of a new cloud-base application software built on blockchain.

They want to provide a new financing platform in which there are no more unapproved invoices for long periods of time making payments painfully slow. Tradeshift would allow to business to do business and getting paid in an easier, faster and more secure way.

The POC highlights a new a end-to-end blockchain-based solution for supply chain payments. On TradeshiftPay it is possible to carry out two main activities: e-invoicing procedures, such as invoice check, payment and schedule and vendor on-boarding processes.

For what concerns the relationship with financial institutions, Tradeshift Pay works with any bank, in order to show how significantly different financing activities could be using blockchain, combines all payment programs and helps companies to keep under control their liquidity.

The blockchain is built according to the Hyperledger Fabric protocol, that is one of the most common permissioned ecosystem where approved participants can take part to the network. The private nature of the network assures secure and immutable exchanges and transactions, payments and investments profiling and auditing financial assets in real time.

TRADESHIFT	Application: Yinuojr	Foundation: 2009	Phase:Active, Blockchain POC
https://www.hive-project.net	Head office: China	Market launch: 2019	Pure SCF solution: Dynamic Discounting
f SCF platform: BankNeutral, Trade Finance and Supply Chain	Nature of provider: Fintech	Blockchain Type: Permissioned Blockchain	
Additional Services: 1) Tradeshift pay: supply chain finance, dynamic discounting, flexible finance and virtual credit cards can help your business		Blockchain Protocol: Hyperledger Fabric	
Additional Services: 2) Digital assets trade, Supply Chain traceability, Public notarization and creditworthiness assessment		Smart contract management: YES	
Secondary Data Analysis			

Appendix 49- Tradeshift Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Financing Options for a Limited Number of SMEs	🟩	🟩	🟩		🟩	🟩	🟩
Lack of Accounting Rules and Treatments	🟩	🟩	🟩	🟩	🟩		
Lack of Efficent Collaboration	🟩	🟩				🟩	🟩

Appendix 50 - Tradeshift Areas of Impact

26) 33.CN

Hangzhou Fuzamei Technology is a Chinese company, whose headquarter is set in Hangzhou. Founded in 2008, is a Chinese IT architecture provider that offers several services for a wide screen of applications ranging from supply chain to trade finance activities. More recently, in 2014, Fuzamei33 started to investigate about blockchain technology and within three years, in 2017, the released their blockchain platform 33.cn.

Hangzhou Fuzamei Technology offers a bSCF platform, which is tailored and developed on every single projects. The main goal is to provide liquidity to SMEs in order to overcome an extremely valuable credit gap in the Chinese market.

Hangzhou, as well the other Chinese use-cases, takes an open view about the role of financial institutions. Banks has to be involved in order to provide not only a secondary market for SMEs looking for liquidity, but also for banks to approach a completely different financing experience. For banks it is possible to resort to all the opportunities provided by joining fintech companies initiatives, testing the alternative and eventually invest in a new scope.

Fuzamei has developed and designed its own proprietary blockchain over years, thanks to a group of highly skilled software developers able to build from sketch a new protocol. More precisely, from a structural point of view, the platform is "permissioned" and focused on the interaction and integration of groups of actors. The platform is characterized by high computing power performances both when executing and validating transactions.

The interview carried out with Jacki has explained in detail the framework developed for trading activities and has highlighted the critical role of tokens. X-Notes can be seen as smart assets, that represent the digital counterpart an asset and can be exchanged in the network and used as unique identifiers of invoice or documents.

As a consequence, non repudiation and data availability, distributed verification, fault-tolerance are fully ensured within the network.

During the interview, an important aspect came out. According to Jack, Fuzamei has developed solution mainly targeted to focal companies and their group of suppliers. Thus, a newly in the market configuration might be the focus of Fuzamei in the next years: "crosschains" (blockchain for groups of companies that can be used in parallel by financial institutions). Distributed ledgers record every cross-chain transaction, keeping an immutable financial record. This is particularly useful for financial institutions in order to manage and store different groups of companies from an aggregated point of view.

33.复杂美 CN	Application: Hangzhou Fuzamei Platform	Foundation: 2008	Phase:Active
https://www.fuzamei.com/	Head office: China	Market launch: 2017	Pure SCF solution: Reverse Factoring, Inventory Finance
ature of SCF platform: BankNeutral, Trade Finance and Supply Cha	Nature of provider: Fintech	Blockchain Type: Permissioned Blockchain	
Additional Services: 1)Reverse Factoring platform to increase liquidity within business networks.		Blockchain Protocol: Propietary	
Additional Services: 2) Digital assets trade, Supply Chain traceability, Public notarization and creditworthiness assessment		Smart contract management: YES	
Interviwed			

Appendix 51- Fuzamei Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset management)
Financing Options for a Limited Number of SMEs	🟩	🟩	🟩		🟩	🟩	🟩
Lack of Accounting Rules and Treatments	🟩	🟩	🟩	🟩	🟩		
Lack of Efficent Collaboration	🟩	🟩	🟩			🟩	🟩
Supplier On Boarding Problems	🟩	🟩	🟩				
High Transaction Costs	🟩	🟩	🟩	🟩		🟩	

Appendix 52 - Fuzamei Areas of Impact

27) EDGEVERVE

Edgverve is an Indian start-up founded in 2016, whose headquarter is set in Bangalore. According to Edgeverve the credit gap for SMEs and the high cost of IT standard infrastructure are the barriers affecting the most every industry on a global scale. They consider the blockchain as the medium to drive the transformation to a new way of doing business: more secure, faster and easier.

The edgeverve blockchain framework is tailored exclusively for financial services. The platform accellerates the creation of blockchain power networks by offering a broad range of services. Leveraging on smart contracts, which is the most distruptive feature of BCT according to Edgeverve allows to revutionalise trade finance activities, payments and syndicated loans. The application aims to support international, cross-border transactional activities

Their services have been designed to deliver banks new value-generating solutions to finance a huge market represented by those companies unable to satisfy banks terms.

Edgeverve is a permissioned ledger, so SMEs are able to run their business with utmost security. A permissioned configuration best suits to minimize operating costs for financial services company while improving data sharing and visibility without compromising integrity and security.

Additionally, banks would be able to reshape their KYC procedured by exploiting jointly identity properties, secure document services, digital asset protocols and smart contracts offered by the BCT.

As it can be seen by the services offered by the Indian company, the platform it is not an altenative solution to financial institutions. They still consider banks as the most efficient source of liquidity for SMEs but, they require a new blockchain-based framework.

For what concerns the network providers, Edgeverve it is not hosted by open-source networks but, it relies on a proprietary blockchain that better fits with banks requirements and regulations.

	Application: Trade Connect, Finacle Payments Connect	Foundation: 2014	Phase: Seed
https://www.edgeverve.com/	Head office: Bangalore, India	Market launch: 2017	Pure SCF solution: Invoice Financing
Nature of SCF platform: ForBanks, Fintech Start-up	Nature of provider: Fintech	Blockchain Type: Consortia, Permissioned Blockchain	
Additional Services: 1) Marketplace for banks to direct finance SMEs		Blockchain Protocol: Propietary	
Additional Services: 2) Finacle Trade Connect: tool to digitalize and automatize trade finance process and accounting treatments		Smart contract management: YES	
Secondary Data Analysis			

Appendix 53- Edgverve Identikit

BCT Features / SCF inefficency	distributed trust mechanism	fully peer-to-peer	data immutability	fault tolerant	security	smart contract	tokenization (smart asset manag)
Lack of Accounting Rules and Treatments	■	■	■	■	■		
High Transaction Costs	■	■	■	■		■	
Financing Options for a Limited Number of SMEs	■	■	■		■	■	■
Lack of Efficent Collaboration	■	■	■			■	■

Appendix 54- Edgverve Areas of Impact

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