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"The Directives of Innovation and Development of Blockchain and Distributed Ledger Technologies through a Comprehensive Analysis of the Startup Ecosystem"

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ABSTRACT

Blockchain and Distributed Ledger Technologies (DLT) have the potential to disrupt many business models across diverse industries. Indeed, they are now object of research of many academics. However, because of the novelty of the theme, the extant literature is mainly at a conceptual level, focused on specific industries, and only a few empirical studies have been carried out. Moreover, there is no clear understanding of the comprehensive landscape of solutions the technologies are offering.

The objective of this dissertation is to investigate which are the directives of development and innovation of the Blockchain and DLT and their main business applications.

Blockchain and DLT are at an early stage of adoption, and innovative firms may take the lead of the directives of development. Hence, startups are strategic players. Consequently, an empirical investigation of globally operating Blockchain startups and their raised amount of investment is used to make inferences about the future of the technologies. The sample has been collected from datasets "Crunchbase" and "Coindesk," and, after a filtering process, 1287 startups have been considered. A descriptive analysis of the ecosystem of startups has been performed to identify trends and strengthen hypotheses. Furthermore, A multiple linear regression model has been developed to test hypotheses and predict the innovation path of Blockchain and DLT.

Results show that Blockchain and DLT may mainly evolve as General Purpose technologies. However, they are also likely to be more developed in Finance, Virtual Currency and Media & Arts. While there is no evidence of which business processes are more likely to be impacted from a general perspective, there are some business solutions across specific industries, that may represent the future of the technologies. Among them, the development of improved platforms to overcome the actual limitations stands out, proving how Blockchain and DTL are still in a fluid phase. A two-sided platform market has more chances to be targeted than a B2B or a B2C one thanks to disintermediation opportunities. Finally, Initial Coin Offering (ICO) may have a greater impact on the innovation path of the technologies compared to other funding sources.

The comprehensive analysis of the ecosystem of startups and the inferential analysis to predict the innovation path of Blockchain and DLT grant the uniqueness of this dissertation. Nonetheless, the research is not free from limitations: startups are potential representatives of the future of the technologies, but also incumbents are, nowadays, launching Blockchain and DLT projects. Hence, the findings of this study may result more valuable if combined with other researches focused on these use cases.

ABSTRACT (Italian version)

Le tecnologie Blockchain e Distributed Ledger (DL) hanno il potenziale per influenzare molti modelli di business in diversi settori industriali. Infatti, sono ad oggi oggetto di ricerca di molti studiosi. Tuttavia, per la novità del tema, la letteratura esistente è principalmente a un livello concettuale, focalizzata su settori specifici e solo pochi studi empirici sono stati condotti. Inoltre, non c'è una chiara comprensione dell'ampio panorama di soluzioni che le tecnologie offrono.

L'obiettivo di questa tesi è quello di indagare quali sono le direttive di sviluppo e di innovazione della Blockchain e DLT e le loro principali applicazioni di business.

Le tecnologie Blockchain e DL sono ancora in una fase iniziale di adozione e sono dunque le aziende innovative ad assumere la guida delle loro direttive di sviluppo. Le startup rappresentano quindi attori strategici. Di conseguenza, un'indagine empirica sulle startups Blockchain operanti a livello globale e sugli investimenti ricevuti rappresenta la base utilizzata per fare inferenze sul futuro delle tecnologie. Il campione è stato raccolto dai set di dati "Crunchbase" e "Coindesk" e, dopo aver applicato dei filtri, sono state prese in considerazione 1287 startup. Un'analisi descrittiva dell'ecosistema delle startup è stata effettuata per identificare interessanti tendenze e rafforzare le ipotesi sviluppate. Inoltre, è stato sviluppato un modello di regressione lineare multipla per testare le ipotesi e prevedere il percorso di innovazione delle tecnologie Blockchain e DL.

I risultati mostrano che Blockchain e DL potrebbero evolvere come tecnologie General Purpose. Allo stesso tempo, è anche probabile che si svilupperanno di più nei settori Finanza, Virtual Currency e Media & Arts. Mentre non ci sono risultati significativi su quali processi generici hanno maggiori probabilità di essere influenzati dalle tecnologie, ci sono alcune soluzioni, in settori specifici, che potrebbero rappresentare il futuro delle tecnologie. Tra queste, spicca lo sviluppo di piattaforme che mira a superare gli attuali limiti delle tecnologie, a dimostrazione di come Blockchain e DTL siano ancora in una fase fluida. Inoltre, le opportunità di disintermediazione hanno reso un mercato di tipo "two-sided platform" più probabile rispetto al B2B o B2C. Infine, l'Initial Coin Offering (ICO) come fonte di finanziamento può avere un impatto maggiore sul percorso di innovazione delle tecnologie rispetto alle fonti tradizionali.

L'analisi descrittiva dell'ecosistema delle startup e l'analisi inferenziale per prevedere il percorso di innovazione delle tecnologie Blockchain e DL garantiscono l'unicità della tesi. Tuttavia, la ricerca non è esente da limitazioni: le startup sono potenziali rappresentanti del futuro delle tecnologie, ma anche le aziende del settore stanno avviando progetti. Pertanto, i risultati di questo studio potrebbero risultare più preziosi se abbinati con altre ricerche focalizzate su questi casi d'uso.

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CHAPTER 0
EXECUTIVE SUMMARY

THE OBJECTIVE OF THE RESEARCH

Blockchain and Distributed Ledger Technologies (DLT) have been gaining increasing attention in the last years. Undoubtedly, the first explanatory reason is related to the incredible market value reached by Bitcoin, their most famous application. Even if, lately, the concept of cryptocurrencies went under debate because of the social and economic instability they may bring, the disruptive potential of Blockchain and DLT has been widely recognized and studied across different industries. Indeed, they are now object of research of many academics, governments, managers, investors, and practitioners. While Blockchain and DLT are a relatively new concept, venture capital funding for the technologies was already up to one billion dollars in 2017 (McKinsey 2018). World Economic Forum considered Blockchain and DLT as one of the top 10 emerging technologies and suggested that 10% of global GDP may be stored on distributed ledgers by 2027.

Therefore, the main objective of this research is "*To investigate which are the directives of development and innovation of the Blockchain and Distributed Ledger Technologies and their main business applications*."

LITERATURE REVIEW: Investigation Strategy and Research Questions

The extant knowledge about Blockchain and Distributed Ledger Technologies has been reviewed for two primary purposes.

First, it was needed to define an *investigation strategy* to reach the identified objective. Hence, the current state of innovation of the technologies is depicted.

Additionally, the second purpose was to outline what is missing in the literature, and which *research questions* have been left open related to the objective of the dissertation. Therefore, an analysis of their disruptive potential is carried out.

An Investigation of the Emergence of a New Technology

The emergence of Blockchain and DLT and their current state of innovation are analysed from three different points of view: diffusion of innovation (adoption curves), technologies' performances (S-curved models), and lifecycle perspective (emergence of the dominant design). Accordingly, different models are used to outline where Blockchain and DLT should be positioned:

- *Diffusion of innovation.* While most of the studies agree on the great potential of Blockchain and DLT, the current level of adoption of the technologies is considered at an early stage, between the "innovators" and the "early adopters" categories.
- *Technology performances and lifecycle models.* The level of investment has been identified as a key driver in the study of the emergence of new technologies. Focusing on Blockchain and DLT, the actual level of investment and interest gives good reasons to hope that the performance of the technology will improve in a reasonable time window, overcoming the technical limitations encountered. This should lead to the emergence of a certain level of standardization that will ensure the achievement of technological maturity and mass adoption. Nevertheless, it is not yet clear whether the standardization process has already started and how long it will take.

The investigation of the innovative path of new technology led to some important deductions:

- Given the current rate of acceptance of Blockchain and DLT, innovative firms are representatives of the category and may influence the innovation path of the technologies.
- The amount of investment is a principal element when considering the effort to increase technologies' performances. Therefore, it may affect the directives of development of Blockchain and DLT.

The above considerations led to the decision to investigate the innovative firms that may take the lead in the adoption of Blockchain and DLT, the startups. The novelty of the technologies is a breeding ground for these organizations. Furthermore, the focus moves on the amount of investment raised that, in turn, represents a mean to outline the development of the technologies.

Investigation Strategy: Blockchain Startups and Funding Sources

On one hand, startups are generally considered as potential leaders of directives of development of new technologies. Their characteristics, such as agility and flexibility, allow them to explore a new technology without the limits of an incumbent (Downing, 2018). Therefore, they may represent the *innovative firms* that influence the innovation path of Blockchain and DLT.

On the other hand, when considering the amount of investment, the analyses of startups are generally combined with an investigation of the Venture Capitals (Florida and Kenney 1988; Davila et al. 2003; Ghosh and Nanda 2010). Accordingly, focusing on Blockchain and DLT, Friedlmaier and colleagues (2019) analysed the ecosystem of startups considering only Venture Capital investments.

However, Blockchain and DLT brought a new source of investment that cannot be underestimated: Initial Coin Offering (ICO). The total amount of ICO reached a value of $ 22.5 billion at the end of 2018 (Coindesk 2019). Furthermore, they are considered as an alternative to traditional funding sources (Diemers et al. 2018) and have been already object of different studies (e.g., Giudici and Adami 2018; Fisch 2019; Giudici et al. 2018; Benedetti and Kostovetsky 2018; Fenu et al. 2018; De Jong et al. 2018).

Consequently, ICO will be considered, together with traditional sources of investment, the means through which make inferences about the directives of the development of Blockchain and DLT. Nonetheless, the differences between the sources of the investment may lead to diverse results that will be investigated.

To conclude, *an empirical investigation of globally operating Blockchain startups and their raised amount of investment, from different sources, is used to make inferences about the directives of the development of Blockchain and DLT and their future use in diverse industries*.

Research Question

Certainly, the novelty of the theme had an impact on the extant literature on Blockchain and DLT that is mainly at a conceptual level, lagging at a descriptive one. To date, few empirical studies have been carried out, and even less have analysed the comprehensive landscape of solutions the technologies are offering (Zhao et al. 2016; Risius and Spohrer 2017). Consequently, many research gaps have been identified. The dissertation aims at fulfilling two of them, answering the following *Research Question*:

RQ: *What are the directives of development and innovation of Blockchain and Distributed Ledger Technologies? How the ecosystem of startups is implementing them? What are their main business solutions?*

THEORETICAL BACKGROUND AND HYPOTHESES DEVELOPMENT

Given the objective and the identified research questions, the theoretical background of the directives of development of Blockchain and DLT is analysed. According to the focus of the literature, it is divided in four main areas

The impact of Blockchain and DLT on business models

First, the impact of Blockchain and DLT on business models from a general perspective is reviewed. Briefly, it is considered that the technologies have the potential to impact diverse dimensions of business models in different industries (Nowinski and Kozma 2017; Friedlmaier et al. 2018). The Blockchain and DLT have been labelled as catalysts for business model innovation; the context, in which an organization operates, and the business model appear to be significant elements in how the technologies will potentially evolve in the next years.

The impact of Blockchain and DLT in the diverse industries

From the previous analysis, it emerged how researchers have come to assume that most industries could benefit from the use of distributed ledgers. At a large, every service that requires trust between buyer and seller should focus on the impact of these technologies (Cohen et al. 2017). The financial industry appears as the most developed one. First, because the technologies reached global knowledge as a mean for payments; second, because large inefficiencies in internal processes historically characterize the sector. However, Blockchain and Distributed Ledger Technologies, not only have the potential to transform the financial industry, but also other sectors (Nofer et al. 2017). Because of the complexity and novelty of the theme and its wide range of possible applications, most of the studies are focused on the impact that technologies have on the specific sectors (e.g. Yuan and Wang 2016; Zhang et al. 2016; Montecchi et al. 2019). Consequently, a first hypothesis has been developed.

*HYPOTHESIS 1: Blockchain and Distributed Ledger technologies are likely to develop more in some **sectors** than in others.*

Blockchain ventures' characteristics

Blockchain and Distributed Ledger Technologies have the versatility to create value in different industries, offering different product/service categories, bringing benefits to different processes. Friedlmaier et al. (2018) identified "Echange & Trading" and "Payment" as two of the main processes, without stating where it is more likely to see Blockchain and DLT applied in the future. Moreover, the technologies can be applied at various levels, depending on their methodology of use. Generally, in the literature reviewed, articles tend to focus only on industries, few on processes, without giving a panoramic of the possible applications.

From the combination of these considerations, other hypotheses have been developed.

*HYPOTHESIS 2: The Blockchain and Distributed Ledger technologies are more likely to develop to improve some **processes** than others.*

*HYPOTHESIS 3: Some **business solutions** are more likely to be representative of the future of Blockchain and Distributed Ledger Technologies than others.*

*HYPOTHESIS 4: Blockchain and Distributed Ledger technologies are more likely to develop for some **methodologies of use** of Blockchain technology than others.*

Besides, given the capacity to disintermediate existing services, another primary use of Blockchain and DLT is the development of multi-target platforms. Therefore, the research will test another hypothesis.

*HYPOTHESIS 5: Blockchain and Distributed Ledger technologies are likely to progress in the development and management of **platforms**.*

ICO and traditional funding methods

Finally, the fundraising method, which allowed the startups to grow, might have an impact on the amount raised and, consequently, on the future development of Blockchain and DLT. Moreover, the analysis of the distribution of different types of investments in the Blockchain startup ecosystem is a new field (Friedlmaier et al. 2017). Among them, ICOs have received significant interest from researchers and practitioners in the domain.

*HYPOTHESIS 6: The **ICO funding method** is likely to have a more significant impact on the future development of Blockchain and Distributed Ledger technologies compared to other **funding sources**.*

As aforementioned, the differences between the sources of the investment may lead to diverse results. Therefore, the last hypothesis has been developed:

*HYPOTHESIS 7: The **sector** in which the startup operates might have a significance in which type of **funding method** is received.*

RESEARCH METHODOLOGY

According to the identified investigation strategy, the methodology that has been followed is divided into two main activities.

- *DATABASE:* Data collection and categorization of the Database of Blockchain and DLT startups
- *ANALYSES:* section in which it is explained how the research questions have been answered:
    - *Descriptive analysis* of the startup ecosystem: it gives an overview of the ecosystem of startup studied with particular attention to the research questions identified. Furthermore, it aims at identifying trends and confirming the significance of the hypotheses tested.
    - *Inferential analysis* to predict the directives of developments of Blockchain and DLT: test of hypotheses.

Database

The activity of data collection and categorization of the database has been made in collaboration with "Osservatorio Blockchain and Distributed Ledger" from Politecnico di Milano. They provided a sample of startups, a framework for data categorization and support in the research.

The database has been collected from Crunchbase and CoinDesk datasets by using the keywords "Blockchain", "Distributed Ledger" and others related to the field. The filtering process started by considering only those startups born from January 2014 to March 2019. Overall, 1467 startups had been found. Each startup extracted was bounded to already available business and financial information, which have been checked during the data gathering process.

Moreover, additional information had been gathered in accordance with the objective of the study: Sector, Process, Methodology of use of Blockchain and DLT, Blockchain and DLT platform, Platform's access typology, Type of client, Headquarter Continent &

Nation, and Brief description. Since this information was not available through Crunchbase, it has been collected through different secondary sources: whitepapers, startups' websites, social networks, news websites, and ICO-focused websites. Once completed the data collection phase, 180 startups have been discarded because of failures, scams, not enough information available, or absence of correlation to the domain. The final result is a census of 1287 startups.

Descriptive analysis

The way the analysis is conducted recall the points that were raised in the literature review. Each topic is analyzed, considering both the occurrences of startups and their level of investment.

- Diffusion of innovation: rate of adoption
    - Yearly distribution
    - Geographic distribution
- Business application
    - Industries
    - Processes
    - Business Solutions: cross-analysis of Sector and its main processes identifies which are the main solutions for which startups are leveraging Blockchain and DLT.
- Technology-focused
    - Type of usage of Blockchain
    - Platform
    - Type of client
- Comparison of ICO and Traditional source of investments
    - Industries
    - Processes

Inferential analysis

For this research, the multiple linear regression model will be used. It compares one dependent variable with a set of independent variables (continuous or categorical). All the steps of the analysis will be performed by combining the use of Microsoft Excel and Minitab. The main results have been transferred from Minitab to Microsoft Excel to provide better visibility.

- *Dependent variables:* The first one considers the total amount raised in dollars by each startup. The second considers the observations where the amount raised came exclusively from ICO campaigns. The last one considers the startups, which had been funded exclusively through funding sources different from the ICO. All of them are continuous variables.
- *Data filtering:* The startups which did not receive funding have not been considered in the analysis. Block.One (one of the observations) has not been included as it received $ 4,2 billion in ICO, which represents 32.4% of the total amount of funding of all startups. Furthermore, all those startups which did not explicitly use Blockchain and Distributed Ledger Technologies have been removed. The analysis is carried out on there are three distinctive databases for each dependent variable.
    - Total funding amount: 951 observations
    - ICO: 186 observations
    - Traditional sources: 765 observations
- *Independent variables:* The independent variables selected to enter in the model followed the hypotheses development of the literature review. They are all categorical variables: sector, process, the methodology of use of the Blockchain, type of client and type of funding.
- *Control variables:* Some macroeconomic factors are considered (to reduce the negative impact of omitted variables), and potential control variables included: the location and the number of funding rounds undertaken by the startups.
- *Multicollinearity:* Tested using the correlation matrix and analysing the Variance Inflation Factors.

- *Heteroscedasticity:* Tested checking the normality of the distribution of the residuals.
- *Best fitting model:* Decided analyzing the R-squared to develop a high-quality model. Comparing the different combinations of variables.
- *Hypotheses testing:* Comparing the regression coefficients of the single variables with the reference levels, together with the significance displayed through the P-Values.

FINDINGS: Multiple linear regression analysis

As aforementioned, the results of the descriptive statistics aim at identifying trends and confirming the significance of the hypotheses tested. They represent the basis on which the model is built and, thus, are highly related to the inferential analysis. Therefore, to avoid repetitions, descriptive results are presented in the discussion section, and, here, only the main findings of the multiple linear regression analysis are reported.

They are divided into three sections.

- *Main model.* Multiple linear regression model to test the hypotheses 1,2,4,5 and 6.
- *Sector: ICO vs. Traditional.* Multiple linear regression model to test hypothesis 7.
- *Business solutions.* Multiple linear regression model to test hypothesis 3.

Main model

The table below (*Table 0.1*) shows the descriptive statistics of the 951 observations in the analysis.

Variable	N	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
TOT_funding	951	14,52	0,0643	1,983	7,601	13,305	14,509	16,118	19,271
Funding_rounds	951	1,7171	0,0393	1,2117	1	1	1	2	10
Sector_Finance	951	0,1767	0,0124	0,3816	0	0	0	0	1
Sector_General Purpose	951	0,2597	0,0142	0,4387	0	0	0	1	1
Sector_Media & Arts	951	0,10305	0,00986	0,30418	0	0	0	0	1
Sector_Virtual Currency	951	0,2471	0,014	0,4316	0	0	0	0	1
Process_Capital Markets	951	0,122	0,0106	0,3274	0	0	0	0	1
cess_Data & Document Managemen	951	0,2082	0,0132	0,4062	0	0	0	0	1
Process_Payment	951	0,1441	0,0114	0,3513	0	0	0	0	1
Process_Software development	951	0,2145	0,0133	0,4107	0	0	0	0	1
Process_Tracking & Supply chain	951	0,0326	0,00576	0,17767	0	0	0	0	1
Process_Wallet & Exchange	951	0,1767	0,0124	0,3816	0	0	0	0	1
Methodologies_bc_DLT	951	0,2198	0,0134	0,4143	0	0	0	0	1
ologies_bc_Smart Contract/ Dapp	951	0,5489	0,0161	0,4979	0	0	1	1	1
Type_Client_B2B	951	0,2923	0,0148	0,4551	0	0	0	1	1
Type_Client_B2C	951	0,3249	0,0152	0,4686	0	0	0	1	1
Type_funding_BOTH	951	0,05994	0,0077	0,23749	0	0	0	0	1
Type_funding_ICO	951	0,1819	0,0125	0,386	0	0	0	0	1
Location_North America	951	0,3964	0,0159	0,4894	0	0	0	1	1
Location_Regulated countries	951	0,3523	0,0155	0,4779	0	0	0	1	1
Location_Rest of Asia	951	0,08202	0,0089	0,27454	0	0	0	0	1
Location_Rest of Europe	951	0,1167	0,0104	0,3213	0	0	0	0	1

Table 0.1 - Descriptive statistics of the variables in the model

Each categorical variable (with the categories as dummy variables) has been tested in combination with the control variables, as shown in *Table 0.2.* Model 7 will be used for hypotheses testing. The R-pred is 31,93% in this case, hence higher than in Model 6. The VIFs, for what concerns the independent variables are largely below the threshold value 10; therefore, the multicollinearity can be excluded to have an impact in this model.

The independent variables "Process" and "Methodology of use" have been removed from the model due to the lack of significance and to avoid the overfitting of variables in the model. Inferences about their effect on the future development of the technologies in comparison to the reference levels cannot be developed. Consequently, *hypothesis 2* and *hypothesis 3* cannot be tested in this research. Space is left for future researches.

All the sectors are significant and show a positive correlation with the dependent variable. The financial sector is highly significant; moreover, the coefficient shows a positive correlation with the dependent variable, and it is the highest among all the sectors. The last sentence confirms *hypothesis 1*. For what concerns *hypothesis 4*, the reference level is represented by the category "Platform." In this way, the direct comparison between purely B2B and B2C startups could not have been presented.

	MODEL 1				MODEL 2				MODEL 3				MODEL 4				MODEL 5				MODEL 6				MODEL 7			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
Independent Variables																												
Sector																												
Sector_Finance	0,891	0,196	0	1,51																	0,66	0,197	0,001	2,05	0,818	0,172	0	1,56
Sector_General Purpose	0,71	0,178	0	1,64																	0,758	0,176	0	2,14	0,713	0,163	0	1,86
Sector_Media & Arts	0,629	0,231	0,007	1,34																	0,444	0,206	0,031	1,41	0,41	0,201	0,042	1,35
Sector_Virtual Currency	0,341	0,181	0,06	1,64																	0,179	0,2	0,373	2,7	0,345	0,185	0,062	2,3
Process																												
Process_Capital Markets					0,313	0,261	0,232	1,95													0,297	0,254	0,242	2,5				
cess_Data & Document Management					-0,416	0,236	0,078	2,45													-0,04	0,205	0,844	2,51				
Process_Payment					-0,09	0,252	0,721	2,09													0,225	0,233	0,335	2,43				
Process_Software development					-0,313	0,233	0,181	2,45													-0,084	0,211	0,69	2,72				
Process_Tracking & Supply chain					-0,542	0,39	0,165	1,28													-0,047	0,348	0,893	1,38				
Process_Wallet & Exchange					-0,059	0,242	0,807	2,28													0,43	0,245	0,08	3,17				
Methodologies_bc																												
Methodologies_bc_DLT									0,292	0,183	0,112	1,55									0,311	0,198	0,115	2,42	0,186	0,19	0,33	2,25
ologies_bc_Smart Contract/ Dapp									-0,31	0,152	0,042	1,53									-0,134	0,165	0,417	2,43	-0,234	0,159	0,143	2,27
Type_Client																												
Type_Client_B2B													-0,764	0,149	0	1,25					-0,489	0,143	0,001	1,52	-0,556	0,139	0	1,44
Type_Client_B2C													-0,469	0,145	0,001	1,25					-0,319	0,139	0,022	1,52	-0,293	0,136	0,032	1,48
Type_funding																												
Type_funding_BOTH																	1,971	0,236	0	1,08	1,805	0,233	0	1,11	1,833	0,232	0	1,1
Type_funding_ICO																	2,256	0,145	0	1,07	2,114	0,144	0	1,12	2,121	0,143	0	1,11
Control variables																												
Location																												
Location_North America	1,019	0,283	0	5,18	1,11	0,287	0	5,27	0,972	0,285	0,001	5,2	1,084	0,282	0	5,16	1,269	0,251	0	5,18	1,286	0,248	0	5,34	1,228	0,246	0	5,24
Location_Regulated countries	1,556	0,285	0	6,01	1,619	0,289	0	5,09	1,478	0,287	0	5,05	1,583	0,285	0	5,01	1,337	0,253	0	5,02	1,327	0,251	0	5,2	1,282	0,249	0	5,1
Location_Rest of Asia	1,069	0,341	0	2,36	1,168	0,345	0,001	2,39	0,989	0,343	0,004	2,38	1,11	0,34	0,001	2,36	0,984	0,302	0,001	2,36	0,96	0,297	0,001	2,41	0,923	0,296	0,002	2,38
Location_Rest of Europe	0,509	0,321	0,113	2,88	0,65	0,326	0,046	2,92	0,5	0,323	0,121	2,87	0,594	0,319	0,063	2,85	0,482	0,283	0,089	2,85	0,475	0,281	0,091	2,95	0,432	0,279	0,122	2,89
Funding rounds																												
Funding_rounds	0,36	0,051	0	1,02	0,365	0,051	0	1,01	0,343	0,051	0	1,02	0,357	0,05	0	1,01	0,348	0,046	0	1,08	0,323	0,046	0	1,12	0,324	0,046	0	1,11
R2	0,115				0,1038				0,1047				0,1153				0,3028				0,3464				0,3417			
R2-adj	0,1066				0,0933				0,0981				0,1087				0,2977				0,3316				0,3312			
R2-pred	0,0954				0,0802				0,0884				0,0996				0,2911				0,3155				0,3193			

Table 0.2 - comparison between different regression model combinations

Both B2B and B2C startups show a negative correlation with the dependent variable. These findings mean that the multi-target startups, developing and/or managing platforms, will more probably represent the future of the Blockchain and Distributed Ledger Technologies. Finally, for *hypothesis 5*, the reference level is represented by traditional funding sources. In this way, the comparison between ICO and different funding methods would have been straightforward. Both the dummy variables present a very highly positive coefficient, showing a strong correlation with the dependent variable. The variable of most considerable interest is "Type_funding_ICO," which shows a coefficient of 2,121. It confirms the hypothesis. From this research, the ICO funding appears to be much more representative of the future of entrepreneurial finance in the domain of the Blockchain and Distributed Ledger Technologies than other fundraising methods.

The categorical variable "Location" has been introduced to mitigate potential problems coming from omitted variables. The aim has been to control the presence of different regulations across the countries. The dummy variable "Rest of Europe" is not significant, thus, not analysed. For what concerns the other categories, all of them show a strong positive correlation with the dependent variable. In particular, North America and the so-called "Regulated countries." The continuous variable "Funding_rounds" appears to have a highly significant moderate positive correlation with the dependent variable. The results are summed up in the following framework (*Figure 0.1*):

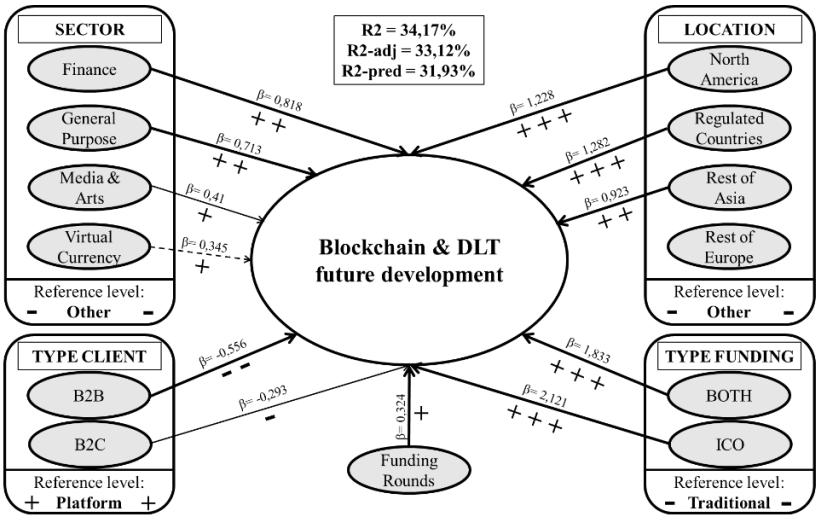


Figure 0.1 - Framework of the multiple linear regression model

Sector: ICO vs Traditional

The tables below (*Table 0.3* and *Table 0.4*) show the descriptive statistics of the 186 observations in the analysis of the ICO and the 765 observations in the analysis of the traditional funding database.

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
TOT_funding_ICO	186	0	16,156	0,0992	1,352	10,127	15,425	16,476	17,039	18,933
Sector_Finance	186	0	0,1828	0,0284	0,3875	0	0	0	0	1
Sector_Media & Arts	186	0	0,1344	0,0251	0,342	0	0	0	0	1
Sector_Other	186	0	0,1882	0,0287	0,3919	0	0	0	0	1
Sector_Virtual Currency	186	0	0,2151	0,0302	0,412	0	0	0	0	1

Table 0.3 - Descriptive statistics: ICO

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
TOT_funding_Traditional	765	0	14,123	0,069	1,907	7,601	12,834	14,219	15,425	19,271
Sector_Finance	765	0	0,1752	0,0138	0,3804	0	0	0	0	1
Sector_Media & Arts	765	0	0,0954	0,0106	0,294	0	0	0	0	1
Sector_Other	765	0	0,2196	0,015	0,4143	0	0	0	0	1
Sector_Virtual Currency	765	0	0,2549	0,0158	0,4361	0	0	0	1	1

Table 0.4 - Descriptive statistics: Traditional Funding

To compare how the different types of funding methods have an impact on the development of the technologies. The multiple linear regression has been performed between the independent variable "Sector," and the two dependent variables "ICO funding" and "Traditional funding."

	ICO				Traditional			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
Sector								
Sector_General Purpose	0,183	0,298	0,54	1,82	-0,247	0,21	0,24	1,83
Sector_Media & Arts	0,229	0,356	0,521	1,5	-0,581	0,273	0,034	1,4
Sector_Other	0,154	0,325	0,637	1,65	-1,032	0,217	0	1,76
Sector_Virtual Currency	0,625	0,315	0,049	1,71	-0,801	0,21	0	1,83
R2	0,0246				0,0395			
R2-adj	0,003				0,0344			
R2-pred	0				0,0267			

Table 0.5 - Regression results comparison in sectors: ICO vs. Traditional

From the comparison between the sectors with the reference level Finance (*Table 0.5*), the only significant category is Virtual Currency, P-Value 0,049. The regression coefficient shows a positive correlation with the dependent variable (0,625), whereas, for "Traditional funding," the coefficient is negative (-0,801). The result confirms *hypothesis 7*.

Business solutions

The tables below show the descriptive statistics of the 951 observations in the analysis (*Table 0.6*).

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
TOT_funding	951	0	14,52	0,0643	1,983	7,601	13,305	14,509	16,118	19,271
Business solution_FIN_Capital	951	0	0,05573	0,00744	0,22952	0	0	0	0	1
Business solution_FIN_Data	951	0	0,01788	0,0043	0,13257	0	0	0	0	1
Business solution_FIN_Lending	951	0	0,02419	0,00498	0,1537	0	0	0	0	1
Business solution_FIN_Payment	951	0	0,03049	0,00558	0,17203	0	0	0	0	1
Business solution_GP_Data	951	0	0,05258	0,00724	0,2233	0	0	0	0	1
Business solution_GP_Identity	951	0	0,01472	0,00391	0,1205	0	0	0	0	1
Business solution_GP_Software	951	0	0,1462	0,0115	0,3535	0	0	0	0	1
Business solution_H_Data	951	0	0,02313	0,00488	0,15041	0	0	0	0	1
siness solution_M&A_Advertising	951	0	0,01367	0,00377	0,11618	0	0	0	0	1
Business solution_M&A_Data	951	0	0,04837	0,00696	0,21466	0	0	0	0	1
Business solution_M&A_Payment	951	0	0,01472	0,00391	0,1205	0	0	0	0	1
Business solution_M&A_Software	951	0	0,01052	0,00331	0,10206	0	0	0	0	1
Business solution_Other	951	0	0,3817	0,0158	0,4861	0	0	0	1	1
Business solution_VC_Data	951	0	0,01262	0,00362	0,11168	0	0	0	0	1
Business solution_VC_Exchange	951	0	0,08623	0,00911	0,28084	0	0	0	0	1
Business solution_VC_Lending	951	0	0,00841	0,00296	0,09138	0	0	0	0	1
Business solution_VC_Payment	951	0	0,05889	0,00764	0,23553	0	0	0	0	1

Table 0.6 - Descriptive statistic business solutions

The table below displays the parameters of the regression model (*Table 0.7*). The first column shows the regression coefficients, in bold the ones corresponding to significant values of the P-Value.

	MODEL			
Variable	Coeff.	SE	P-Value	VIF
Sector				
Business solution_FIN_Capital	**0,797**	0,29	0,006	1,08
Business solution_FIN_Data	0,558	0,489	0,254	1,03
Business solution_FIN_Lending	**0,846**	0,424	0,046	1,04
Business solution_FIN_Payment	0,081	0,38	0,832	1,05
Business solution_GP_Data	0,391	0,297	0,189	1,08
Business solution_GP_Identity	0,196	0,537	0,715	1,02
Business solution_GP_Software	**0,682**	0,197	0,052	1,18
Business solution_H_Data	-0,408	0,433	0,346	1,04
siness solution_M&A_Advertising	0,806	0,556	0,148	1,02
Business solution_M&A_Data	0,02	0,308	0,949	1,07
Business solution_M&A_Payment	0,246	0,537	0,647	1,02
Business solution_M&A_Software	0,29	0,632	0,647	1,02
Business solution_VC_Data	-0,916	0,578	0,113	1,02
Business solution_VC_Exchange	**-0,493**	0,241	0,041	1,12
Business solution_VC_Lending	-0,058	0,704	0,934	1,01
Business solution_VC_Payment	0,18	0,283	0,525	1,09
R2	0,0293			
R2-adj	0,0127			
R2-pred	0			

Table 0.7 - Regression results of business solutions

Looking at the results, considering that the reference level is the category "Other," thus all the less frequent business solutions, it is possible to confirm *hypothesis 3*. Four business solutions present a high level of significance, and three of them (General Purpose – Software development, Finance – Capital Markets, Finance – Lending/Crowdfunding) display a strong positive correlation with the positive variable. Therefore, they are business solutions that might drive the future development of the Blockchain and DLT. On the other hand, Virtual Currency – Exchange & Trading will be less likely to develop as a type of business applications in the next years.

DISCUSSION and CONCLUSION

From the literature review, few academic papers contained a comprehensive analysis of a Blockchain organization database (Friedlmaier et al. 2018; Momo et al. 2019), and only one was focused on startups (Friedlmaier et al. 2018). The empirical analysis and the inferential analysis that predicts the innovation path of Blockchain and DLT grant the uniqueness of this dissertation.

The basis of the analysis has been a database of 1287 startups that raised in total $ 12,96 billion from different funding sources. The startup Block.one (EOSIO), which was able to raise alone more than $ 4 billion, will not be considered in the financial analyses.

Startup financed by traditional source of investment	Startup financed by both traditional source of investment and ICO	Startup financed by Initial Coin Offering
744 startup (57%)	55 startup (4%)	173 startup (13%)
3.817 mln $ in total	1.634 mln $ in total	3.311 mln $ in total
5,1 mln $ on average	29,7 mln $ on average	19,1 mln $ on average
1,3 mln $ median	17,0 mln $ median	14,0 mln $ median

Tot. startup financed			
972 startup	8.762 mln $ in total	9,01 mln $ on average	2 mln $ median

Table 0.8 - The total distribution of investment when excluding the outlier Block.one (EOSIO)

The discussion is divided into two main sections: Diffusion of innovation and Directives of Development.

Diffusion of innovation

When considering the *rate of acceptance* of Blockchain and DLT for startups (*Chart 0.1*), it is arguable that it resembles an S-shaped curve (Nieto et al. 1998) and that the technologies have surpassed the point of inflection.

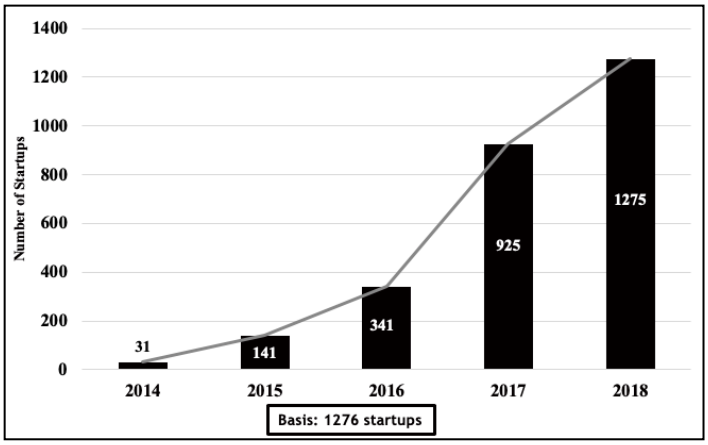


Chart 0.1 - The cumulative amount of Blockchain and DLT startups operating from 2014 to 2018

This trend is in contrast with the conclusions of different studies that identify Blockchain and DLT as still in their early phase of adoption (Woodside et al. 2017; Friedlmaier et al. 2018). As previously done by Luu (2018), the focus has been moved on the distribution of funding during the years, and a different trend was identified (*Chart 0.2*).

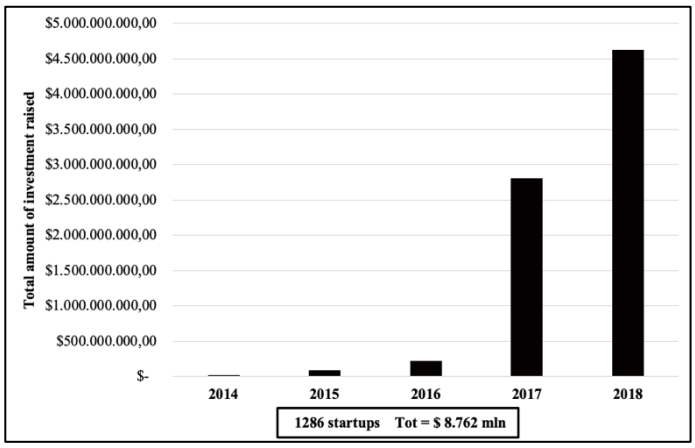


Chart 0.2 - distribution of investment during the years

Moreover, the exceptional growth registered in the number of startups in 2017 may be explained by the hype towards Blockchain and DLT coming from the market value of Bitcoin that surged from less than $ 20 billion to more than $ 200 billion during that year.

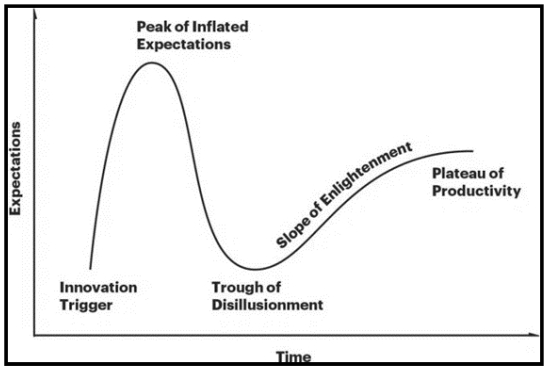


Figure 0.2 - Gartner hype cycle for the emergence of a new technology

Therefore, the rate of adoption of Blockchain and DLT is better represented by the Gartner's Hype Cycle. Indeed, the researchers stated that Blockchain and DLT had passed the trough of disillusionment, a point reached after having inflated expectations, and they are approaching the slope of enlightenment. To conclude, in the next years, further growth in the number of startups operating with Blockchain and DLT may be expected.

The figure below displays the ***geographical distribution*** *(figure 0.3).*

Figure 0.3 - The geographical distribution of startups and investments by continent

From the analyses, the location appeared as a significant potential directive of innovation of the technologies (*Table 0.9*). Moreover, some countries are particularly relevant both in terms of the presence of startups and the amount of investment raised.

Variable	Coeff.	SE	P-Value
Control variables			
Location			
Location_North America	**1,228**	0,246	0***
Location_Regulated countries	**1,282**	0,249	0***
Location_Rest of Asia	**0,923**	0,296	0,002***
Location_Rest of Europe	0,432	0,279	0,122

Table 0.9 - Regression results: location

The research demonstrated that countries presenting special regulations for ICO and business applications of the Blockchain and Distributed Ledgers Technologies, displayed a positive regression coefficient (1,282). This result was expected, as Niforos (2018) stated, to provide stability and space to innovate to organizations, the presence of appropriate regulations and governance for business applications of Blockchain and DLT is essential. The regression model showed how North America would be likely to be in the frontline for the development and innovation of Blockchain and DLT. United States has also been leading the number of ICO campaigns (Giudici et al. 2018; Fisch 2019). The countries in "Rest of Asia" also presented a significant positive regression coefficient, which is driven by the presence of Japan and South Korea. The two neighbor countries are considered two Blockchain hubs in Asia and are quickly developing regulations and patents, and their ICO and cryptocurrencies trading activities are increasing (Lim 2019).

Directives of development

Sectors

When performing an analysis based on ***sectors*** *(chart 0.3), Cross-sectorial* solutions appear as the most funded. Moreover, when considering the specific sectors, those that resulted in more relevant, both in terms of occurrences and investment, are *Virtual Currency*, *Finance*, and *Media & Arts*.

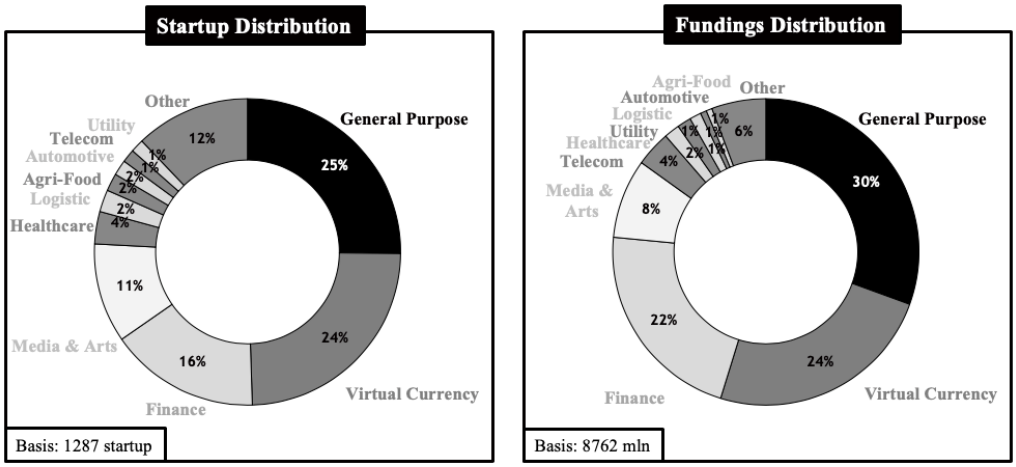


Chart 0.3 - Distribution of Blockchain and DLT startups and funding by sector

Testing *hypothesis 1*, it was confirmed that Blockchain and DLT are likely to develop more in some sectors than others (T*able 0.10*).

Variable	Coeff.	SE	P-Value
Sector			
Sector_Finance	**0,818**	0,172	0***
Sector_General Purpose	**0,713**	0,163	0***
Sector_Media & Arts	**0,41**	0,201	0,042**
Sector_Virtual Currency	**0,345**	0,185	0,062*

Table 0.10 - Regression results: sector

General Purpose displayed positive regression coefficients, validating the trends presented above. It confirms how Blockchain and DLT can be considered as general-purpose technologies. Hence they can pervade many different sectors (Kane 2017).

Moreover, the *financial sector* has already been addressed as one of the most suited sectors for Blockchain and DLT adoption because of the inefficiency in internal processes and transactions (Nofer et al. 2017). Not surprisingly, Finance seems to be the sector in which the technologies will grow the most, according to the positive results obtained in the multiple regression model. This result is in line with what was concluded by Friedlmaier (2017), who identified the financial industry as already exploiting more advanced applications of the technologies, attracting more investments than other sectors.

Furthermore, Blockchain and DLT have been for long, associated with the concept of cryptocurrency. However, already Huges and colleagues (2018) showed how these technologies have a more significant potential to disrupt all sorts of business operations. Accordingly, Momo (2019) considers the usage of cryptocurrencies as only the first era of Blockchain and DLT. Nonetheless, the results are showing that the technologies are more likely to develop in *Virtual Currency* than other sectors, highlighting that there is still a strong link with the usage of cryptocurrencies.

A less popular business application of Blockchain and DLT is in the *Media & Arts* sector, which comprises Gaming, Music, Social Media, and Arts. From 2015, the industry has gained popularity. Furthermore, it might experience further development in technological applications, displaying a positive regression coefficient. In the music sector, the management of digital rights has always represented a critical issue (O'Dair 2016). Whereas, in the Gaming industry, Osservatori Digital Innovation (2018) already identified the development of decentralized applications and the true digital ownership of digital content as the main opportunities of the sector.

Processes

Moving the focus on ***processes***, they are first analysed from a general perspective and then declined in the various sectors, resulting in the business applications. The following charts (*Chart 0.4*) display the descriptive statistics, showing the distribution of the startups and the funding received.

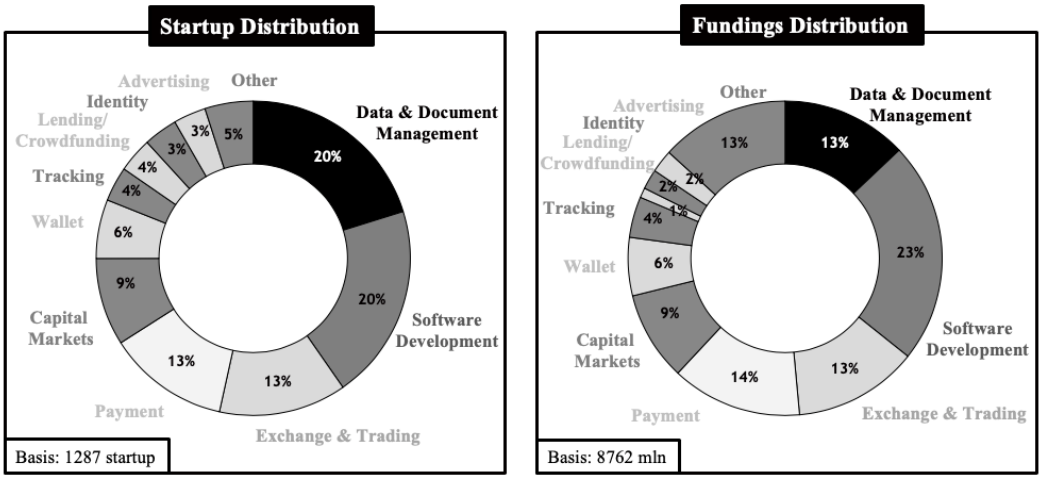


Chart 0.4 - Distribution of Blockchain and DLT startups and funding by process

Hypothesis 2 was tested to infer conclusions on which processes Blockchain and DLT will be primarily used. However, as shown in model 2 in *Table 0.2*, the results obtained showed no significance. Therefore, there is no evidence that Blockchain and DLT are more likely to develop to improve some processes than others.

Basis:1287 startups	Data & Document Management	Software Development	Exchange & Trading	Payment	Capital Markets	Wallet	Tracking & Supply Chain	Lending & Crowdfunding	Identity	Advertising Management	Other
General Purpose	63	181	6	10	11	1	7	1	17	8	19
Virtual Currency	14	23	99	67	23	69	1	11	1	1	4
Finance	19	10	22	33	71	4		30	8		7
Media & Arts	50	13	6	16	1	2		2	2	22	21
Healthcare	37	3		1		1	1				1
Logistic	8	2		2			16				2
Agri Food	5		3	4			12				
Automotive	7	3	2	5	2		2				
Telecom	3	5	5	3			2				
Utility	8	5	1	1					1		2
Other	46	14	25	19	8	1	5	2	16	12	8

Table 0.11 - the distribution of Blockchain and DLT startups considering Industries against Processes

Business Solutions

The *Table 0.11* clarifies how the different Sectors are mainly focused on some particular processes, highlighting the need to investigate the main crossings that, in turn, will identify the leading ***business solutions*** (see *Table 0.12* below).

Testing *hypothesis 3*, there is evidence that Blockchain and DLT are likely to be implemented more in some business solutions than others. (*Table 0.7*)

The positive result of *General Purpose* - *Software Development* is giving important insights on Blockchain and DLT and their state of innovation. Indeed, these solutions are represented by the development of new platforms or the improvement of extant ones in order to overcome the limits that the technologies are experiencing, such as scalability,

throughput, cost, privacy, etc. This situation is confirming other studies that considered Blockchain and DLT as still in the fluid phase (Habbestad and Karde 2017, Ughetto and Levis 2018), in which there is still no evidence of standardization, and a Dominant Design has not yet emerged. The high number of possible combinations of the main pillars, the different needs and the different usage identified across the diverse industries led to confirm the conclusion of Habbestad and Karde (2017) that argued that "dominant designs have the potential to emerge for Blockchain platforms, but will probably differ across use areas, industries, and value network levels."

For what concerns the *Financial* sector, solutions that bring enhanced transparency and reliability in credit and lending, enabling reduction of costs and open access to microcredit, are those who showed significant chances of growth. Indeed, thanks to Blockchain and DLT, it is possible to reach 31% of the global population, the so-called "unbanked," that, currently, does not have access to financial services (Network Digital360 2018; Morkunas et al. 2019). With a similar positive coefficient, the crossing *Finance - Capital markets* show good chances to grow more than others. These solutions include the tokenization of real assets and investment funds and allow users to invest with their fiat money or cryptocurrencies.

Finally, the business solution *Virtual Currency - Exchange & Trading*, which is one of the most frequent, has a negative regression coefficient compared to the less frequent solutions. This finding is in countertendency with common sense; the market is highly interested in investing in cryptocurrencies, attracted by the potential exchange returns (Huges et al. 2018). Probably, this result is due to the high concentration of this market that is making it less attractive.

Table 0.12 - Blockchain and DLT main applications in the diverse industries and processes

INDUSTRY	PROCESS	BRIEF DESCRIPTION	Number of Startups	% on the tot num of startups	Funding amount raised	% on the tot funding amount
General Purpose	*Software development*	overcoming Blockchain & DLT limits and proposing innovative protocols	180	13,47%	$1.837.384.783,00	20,97%
	Data & Document Management	optimization of management of any kind of data & overcoming data privacy issues	63	4,12%	$365.929.694,00	4,18%
	Identity	creation of self-sovereign identity to decentralize the management of documents	17	1,20%	$101.108.201,00	1,15%
	Advertising Management	connecting advertiser, publishers and users without the need of intermediaries	8	0,62%	$29.449.599,00	0,34%
Virtual Currency	*Exchange & Trading*	trading solutions and conversion in fiat currencies for cryptocurrencies	99	7,88%	$600.553.556,00	6,85%
	Wallet	management and storage of cryptocurrencies	69	6,38%	$509.437.528,00	5,81%
	Payment	let users pay for services and goods with their cryptocurrencies	67	4,48%	$545.518.531,00	6,23%
	Software development	the aim is to improve the actual performance of virtual currencies	23	1,65%	$193.524.941,00	2,21%
	Lending/Crowdfunding	borrowing and lending cryptocurrencies	11	1,01%	$74.420.000,00	0,85%
Finance	*Capital Markets*	tokenization of real assets and investment funds	71	4,99%	$669.919.329,00	7,65%
	Payment	cross-border and inter-bank transactions	33	2,44%	$380.498.611,00	4,34%
	Lending/Crowdfunding	connecting lender and borrower without the need of intermediaries	30	2,05%	$332.947.745,00	3,80%
	Data & Document Management	reducing the operational bueucracy for financial institutions	19	0,92%	$111.451.137,00	1,27%
Media & Arts	*Data & Document Management*	protection of copyrights and property rights with true digital ownership	50	3,09%	$339.462.655,00	3,87%
	Advertising Management	connecting brands and influencers and/or advertiser and publisher	22	1,83%	$121.260.000,00	1,38%
	Payment	cash-back, frictionless and more secure payment option	16	1,00%	$69.342.537,00	0,79%
	Software development	creation of decentralize applications such as gaming platform	13	0,95%	$91.012.784,00	1,04%
Healthcare	*Data & Document Management*	optimize the management of health data and sharing between patient and doctors	37	3,56%	$125.416.138,00	1,43%
Logistic	*Tracking & Supply chain*	certification of provenance and traceability of products	16	1,58%	$18.575.804,00	0,21%
	Data & Document Management	digitalization of documents related to the movement of goods	8	0,62%	$57.372.866,00	0,65%
Agri-Food	*Lending/Crowdfunding*	certification of provenance, quality and traceability of food products	12	1,04%	$18.207.263,00	0,21%
Automotive	*Data & Document Management*	make mobility data valuable	7	0,83%	$6.448.024,00	0,07%
	Payment	combination of more mobility-related payment in a single one	5	0,35%	$42.377.200,00	0,48%
Telecom	*Data & Document Management*	protection of data when using telecom services	8	0,26%	$167.860.300,00	1,92%
	Software development	democratization of internet access	5	0,50%	$42.195.000,00	0,48%
Utility	*Tracking & Supply chain*	tracking of renewable energy to sell in P2P exchanges	12	0,93%	$86.226.462,00	0,98%

Typology of usage

As far as concerned, the ***typology of usage*** of Blockchain and DLT, **Smart Contracts,** and Decentralized application are the most widespread solutions.

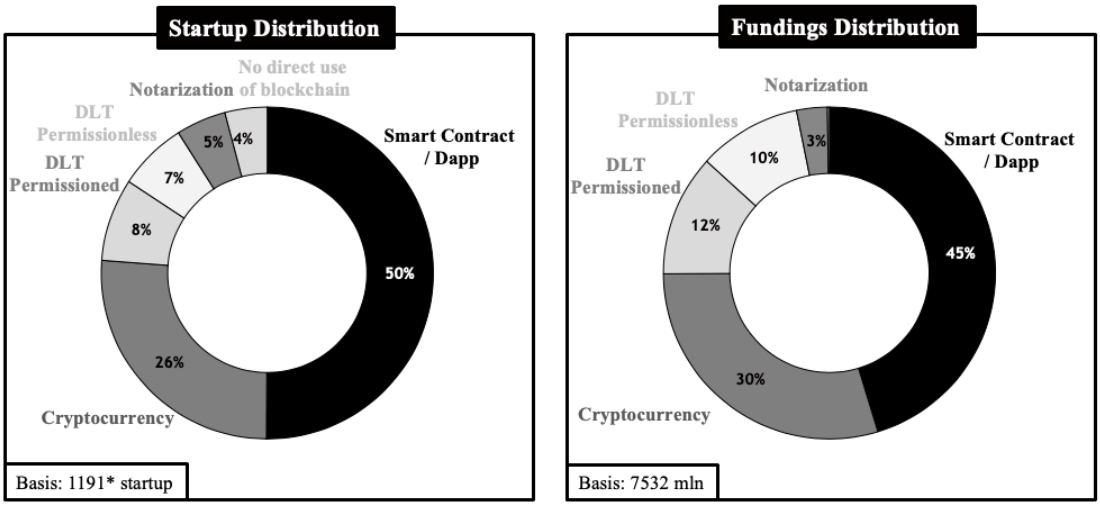


Chart 0.4 - Distribution of Blockchain and DLT startups and funding by platform usage

Testing *hypothesis 4*, there was no evidence that Blockchain and DLT are likely to develop more for some methodologies of use than others (see model 3 in *Table 0.2).*

Moving the focus on the ***type of client*** that the startups are addressing, the results show that Platform-based solutions are the most widespread. A similar share is represented by solutions that are targeting the final customers and a lower one for the B2B market.

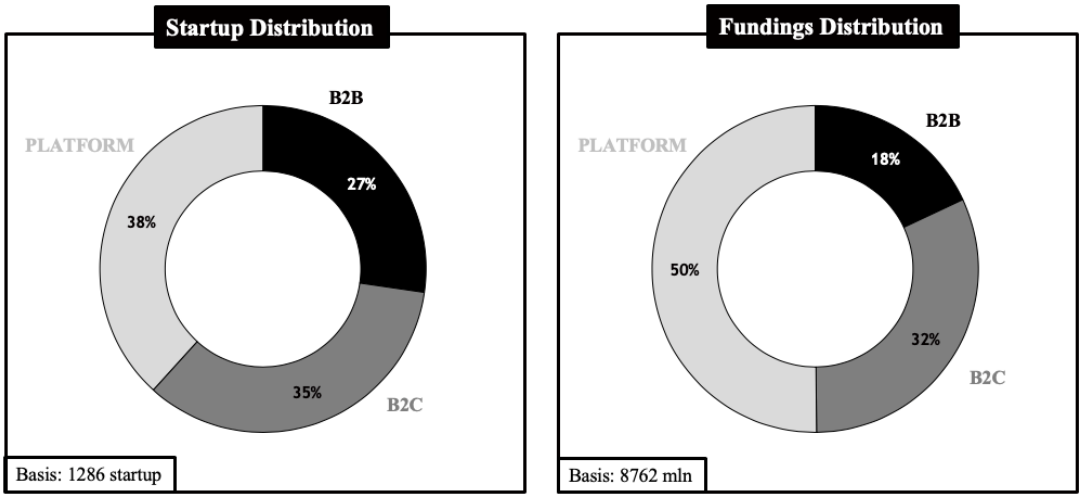


Chart 0.5 - Distribution of Blockchain and DLT startups and funding by type of client

Testing *hypothesis 5*, B2B, and B2C markets have negative coefficients. These results are exhibiting that there is evidence that Blockchain and DLT are likely to progress in the development and management of platforms.

Variable	Coeff.	SE	P-Value
Type_Client			
Type_Client_B2B	**-0,556**	0,139	0***
Type_Client_B2C	**-0,293**	0,136	0,032**

Table 0.13 - Regression results: type of client

Finally, a discussion concerning the ***fundraising methods*** is displayed. Specifically, the discussion focuses on the ICO phenom and different sources of investments (mainly venture capitals). The analysis of the distribution of different types of investments in the Blockchain startup ecosystem is a new field (Friedlmaier et al. 2018).

Variable	Coeff.	SE	P-Value	VIF
Type_funding				
Type_funding_BOTH	**1,833**	0,232	0***	1,1
Type_funding_ICO	**2,121**	0,143	0***	1,11

Table 0.14 - Regression results: type of funding

ICO funding presented a very highly positive coefficient of 2,121 (logged coefficient) in comparison to the baseline category represented by traditional investors. This result confirms *hypothesis 6.* Hence, in line with the report issued by Strategy& in June 2018 (Diemers et al. 2018), it is shown how, for Blockchain startups and other technology companies, the ICOs tend to raise more funds compared to traditional investments.

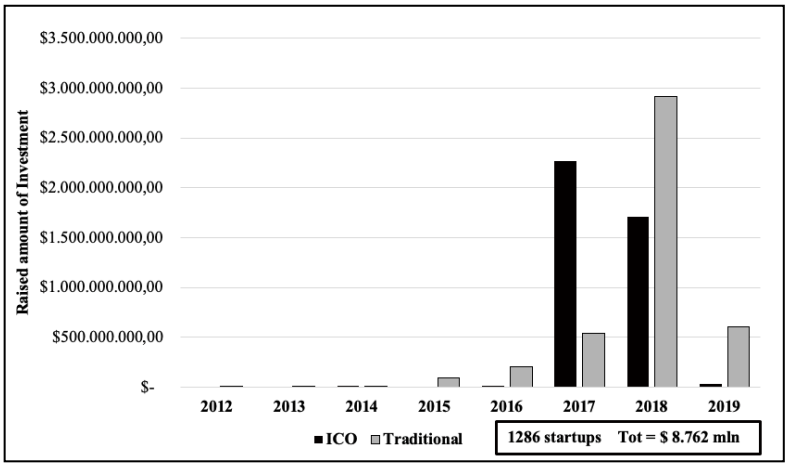


Chart 0.6 - Percentages of Investments by the typology of funding over the years

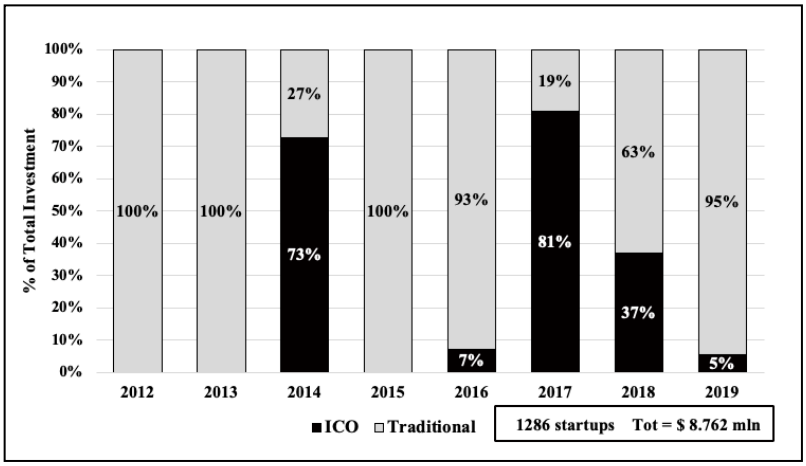


Chart 0.7 - Distribution of Investments by the typology of funding over the years

ICO is one of the primary sources of investment for Blockchain startups. However, traditional investments are still more widespread than ICOs, representing more than half of the sample. The innovation in entrepreneurial finance brought by the development of the Initial Coin Offering allowed Blockchain startups to exploit this new fundraising method. Ethereum Foundation started the trend in 2014. However, the peak was reached in 2017.

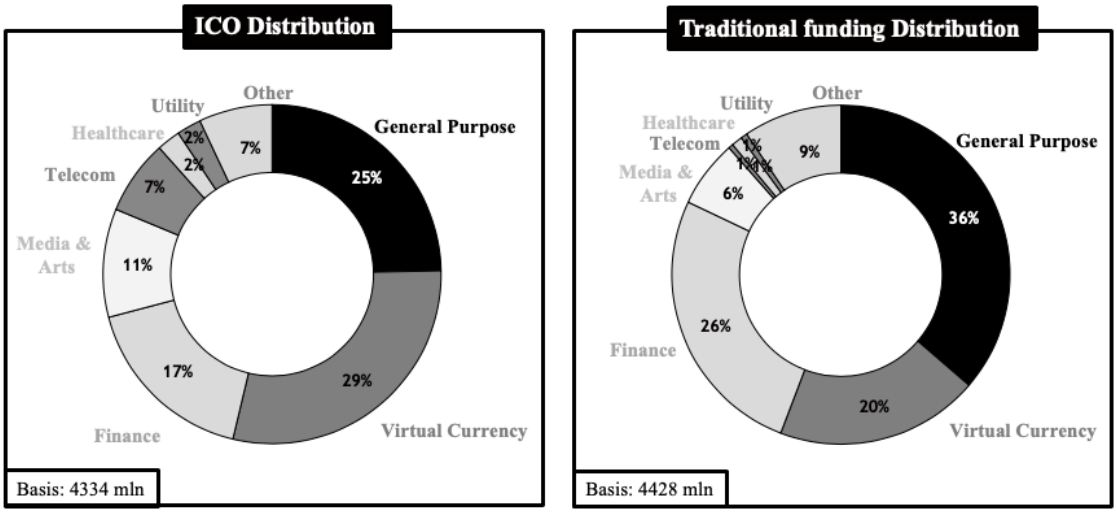


Chart 0.8 - Distribution of Investments by the typology of funding in the diverse industries

When comparing the distribution of Traditional funding against ICO by sectors, it is evident how venture capitalists prefer more established industries, such as the financial sectors and startups oriented at the development of software or IT infrastructures. On the other hand, ICO campaigns are developed by innovative startups, highly related to the usage of tokens. Two regression model has been developed to compare how the future evolution of Blockchain and DLT might vary according to the typology of funding received.

	ICO				Traditional			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
Sector								
Sector_General Purpose	0,183	0,298	0,54	1,82	-0,247	0,21	0,24	1,83
Sector_Media & Arts	0,229	0,356	0,521	1,5	-0,581	0,273	0,034	1,4
Sector_Other	0,154	0,325	0,637	1,65	-1,032	0,217	0	1,76
Sector_Virtual Currency	0,625	0,315	0,049	1,71	-0,801	0,21	0	1,83
R2	0,0246				0,0395			
R2-adj	0,003				0,0344			
R2-pred	0				0,0267			

Chart 0.9 - Regression results comparison in sectors: ICO vs. Traditional (RL: Finance)

From the comparison of the regression results, the sector might have a significance in which type of funding method is received, confirming *hypothesis 7*. The result goes against what has been stated by Fisch (2019), who, in his study on the factors influencing the total amount received from ICO campaigns, suggested that there were no evident variations between industries. The regression coefficients difference shows the divergence

in the investment approach of ICO investors and venture capitals. The negative coefficients in comparison to Finance as a reference level demonstrated that the financial sector is likely to be the preferred target, being one of the first in exploiting the technologies in business processes. This finding confirms what stated in the literature; for instance, Bucovetchi (2018) predicted that in the future, the investments in the financial sector would sharply increase. On the other hand, the only inference that can be drawn about ICO investors is that they tend to prefer the Virtual Currency sector compared to the Financial one. This finding may be biased by the fact that the token is the foundation of the operation of both the ICOs and the Virtual Currency industry (Fisch 2019).

Conclusion

Briefly, the contribution of this thesis has been to analyze a comprehensive database of a globally operating startup within the Blockchain and DLT ecosystem and to predict the innovation path of these technologies with an inferential analysis. Overall, the concept of Blockchain and Distributed Ledger Technologies and their business applications appears to be recent. From 2016 to 2018, the number of citations in the academic field had gone from 57 to 1246, and, only recently, they are starting to gather the attention of different industries.

The results of this research can be used by managers and entrepreneurs to understand whether their understanding of the future innovation path of Blockchain and Distributed Ledger Technologies is in line with the direction taken by the startups or not.

The unexpressed potential of Blockchain and DLT is enormous, and despite not all institutions have understood the real benefits that these technologies can bring in the business world, many have realized their disruptive capabilities, both in the professional and academic domains. However, a critical question remains unanswered. When will Blockchain and DLT scale-up?

CHAPTER 1
INTRODUCTION & OBJECTIVE OF RESEARCH

The first section of the thesis provides an overview of what are Blockchain and Distributed Ledger Technologies (DLT), which are their main characteristics and how they emerged. Therefore, the historical background is first presented, followed by a description of the key definitions and aspects of these technologies. It was realized that to gather a comprehensive understanding of the theme, it is needed to study it from different angles. Consequently, Blockchain and DLT have been described from different perspectives. Next, an overview of the actual benefits and limitations is carried out. Finally, the research objective of the thesis is presented.

1.1 A historical background

On October 31, 2008, a mysterious author (or a group of authors) with the pseudonym of Satoshi Nakamoto published the article "Bitcoin: A Peer-to-Peer Electronic Cash System." Nowadays, the whitepaper is famous worldwide, and the potential implications of the underlying technologies have not been clearly defined yet. One thing is certain, it represented a breakthrough moment from which possible disruptive technologies have emerged: Blockchain and Distributed Ledgers. Bitcoin, the name given to the first digital currency ever trade, has been gaining loads of attention in the years following its birth. Throughout 2017, the market value of the cryptocurrency surged from less than $ 20 billion to more than $ 200 billion, even if it suffers from high volatility (Carson 2018).

Nonetheless, the concept of cryptocurrencies is under debate. There are doubts about the possibility of using them as a substitute for fiat currencies because of the potential economic and social instability they could bring (Piazza 2017; Williams 2014). Moreover, the presence of scammers and the usage of cryptocurrencies as a form of payment in the black market created confusion and disillusion. The same story does not include the technologies underpinning the Bitcoin, Blockchain and Distributed Ledgers. Indeed, their

potential has been widely recognized, and it is currently an object of study of academics, practitioners, and entrepreneurs (Pazaitis et al. 2017; Takahashi 2017). A Blockchain has been defined in different ways. The widely accepted description defines a Blockchain as a distributed public ledger (Evans 2014; Kim and Laskowski 2018; Zhao et al. 2016).

While Bitcoin is merely a new concept, the roots of Blockchain and DLT are more than 20 years old (Binance 2019). Indeed, already in 1991, a couple of scientists used a technique that was based on encryption for timestamping digital files. The next year, it was also discovered a method to collect several documents in one block. Only 13 years later, the idea of digital currencies based on a "proof-of-work" consensus form was invented by the computer expert Hal Finney. He was able to create a token that could have been used in peer-to-peer transactions. Indeed, it was considered as a prototype of the Bitcoin since it was able to solve the problem of double spending that regarded most of the virtual currencies already invented. Hal Finney was also the first to receive the first Bitcoins ever transacted in 2009 through the technique of mining.

From that moment, cryptocurrencies and, at large, Blockchain and DLT remained under the magnifying glass. Plenty of projects have emerged, and many different possible applications have been analyzed. Among them, a solution, developed by the computer scientist Vitalik Buterin, gained attention, Ethereum. It is a programmable Blockchain, which not only provides predefined and standardized operations but also allows users to create their ones. It is a platform through which users can create different types of decentralized Blockchain applications (Dapps), not necessarily limited to cryptocurrencies. According to the creator of Ethereum, Blockchain and DLT are converging to a "world computer," giving a sense of the global applicability that the technology has.

Nowadays, "Blockchain has surged from a technology with narrow applications related to digital currencies, to one with important applications in many domains, drawing attention to policymakers at different levels" (Holotescu 2018). Blockchain is considered in the top 10 emerging technologies by the World Economic Forum (WEF) (Cann 2016).

1.2 The novelty of the theme and the increasing attention

As previously done by Zhao and colleagues (2016), by using Google Trends, the search volumes of the words “Blockchain” and “Bitcoin” have been analysed. The time window is ten years.

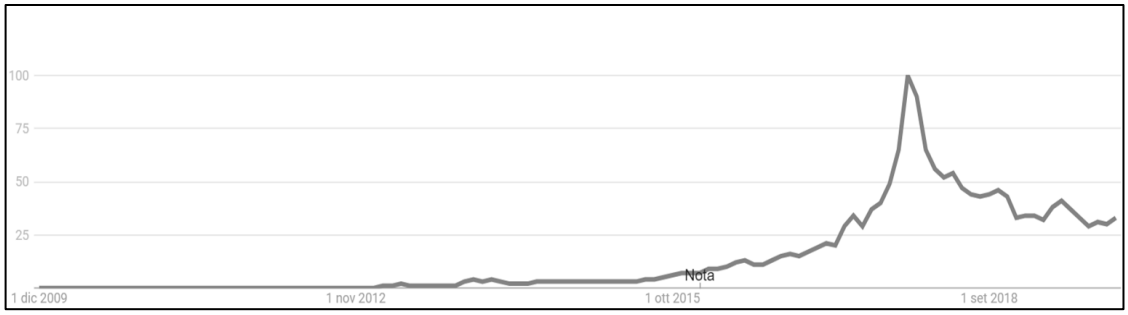


Figure 1.1 - Google Trend: word "Blockchain"

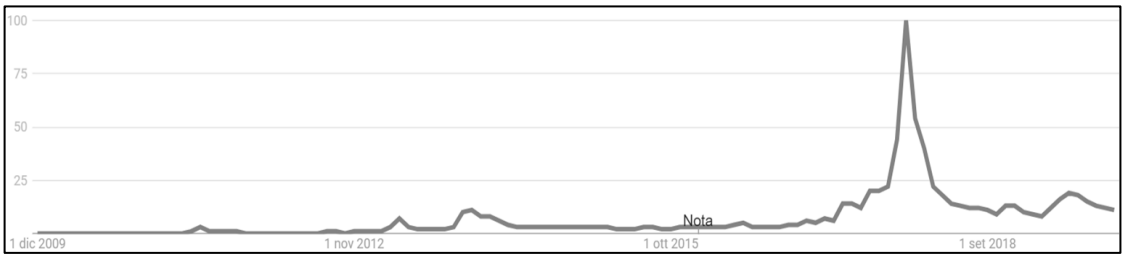


Figure 1.2 - Google Trend: word "Bitcoin"

According to the search volumes of the word “Blockchain,” shown in *Figure 1.1*, the worldwide interest in technologies had started in 2012. For what concerns the word “Bitcoin” (*Figure 1.2*), the excitement started earlier. “While Blockchain was not very well recognized with the wave of Bitcoin, it is getting more and more attention from people in many industries recently” (Zhao et al. 2016).

After having highlighted the novelty of the theme, an analysis of the bibliography was required to understand which is the current existing labour that has been done by academics and researchers. The most comprehensive and updated review of the literature has been done by Dabbagh and colleagues (2019) in the paper “The evolution of Blockchain: A bibliometric study.” The authors performed a bibliometric analysis of all

Blockchain's conference papers, articles, and review papers that have been indexed by "Web of Science" from 2013 to 2018. Some key results are here reported giving interesting insights about the trends of the technologies (*Figure 1.3* and *Table 1.1*).

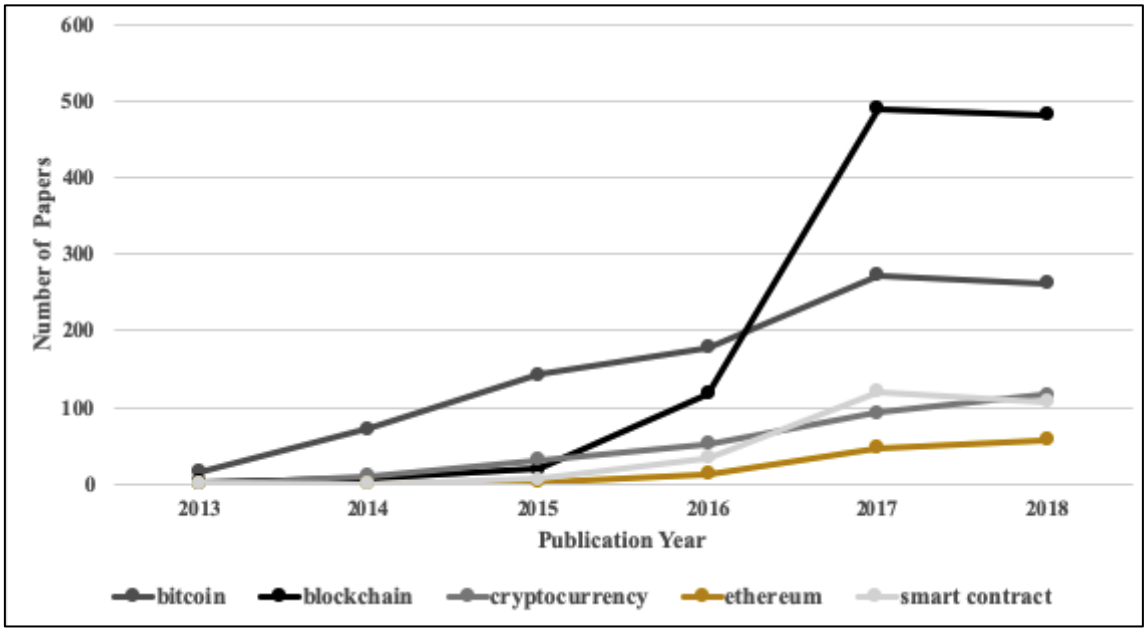


Figure 1.3 - Yearly publication trends of different topics (Dabbagh et al. 2019)

	2013	2014	2015	2016	2017	2018	Total
bitcoin	16	72	143	176	273	262	942
blockchain	2	7	19	118	491	483	1120
cryptocurrency	0	10	31	52	93	117	303
ethereum	0	0	3	13	47	57	120
smart contract	1	0	7	34	120	108	270

Table 1.1 Yearly publication trends of various topics (Dabbagh et al. 2019)

They concluded that "the number of publications related to Bitcoin has been growing continuously since proposing Nakamoto's paper in 2008". Besides that, it is interesting to notice how, recently, from 2016 to 2018, there has been a significant change in the publication trends. Indeed, Blockchain has started to receive more attention from researchers compared to the other topics. They were also able to show how the overall interest is growing in the field using the number of citations as a driver. It resulted in having a consistent growth from 2016 to 2018, going from 57 to 1246 quotes. Finally,

another key result is that Blockchain and DLT is attracting attention in many different sectors, from telecommunications to government and healthcare.

Overall, the concept of Blockchain and Distributed Ledger Technologies and their business applications appears to be recent. This consideration led to the decision to review not only research papers but also high-tech magazines, reports done by consultancy firms, and specialized websites.

1.3 Blockchain and Distributed Ledger Technologies: definitions and characteristics

After having analyzed the historical background and the novelty of the theme, a more detailed description of the Blockchain and Distributed Ledger Technologies and how they work will be presented. The purpose of the thesis is deeply related to the managerial implications of the technologies. Therefore, they are analyzed from a business perspective. Thus, the description of the technologies is high-level, without going in-depth with technicalities. However, to better describe functionalities, advantages and limits some technical details are essential. As stated before, because of the novelty of the theme, there is still no unique definition of Blockchain. Moreover, because of the different aspects and reading keys, it is essential to describe it from different perspectives (Bellini 2017). Mougayar (2016) argued that "to fully understand the Blockchain, you need to look at it simultaneously from a business, technical and legal perspective." To date, the most widely accepted definitions are distributed public or *meta-technology* ledgers (Kim and Laskowski 2018; Zhao et al. 2016).

1.3.1 Blockchain as a subset of Distributed Ledger Technologies

Blockchain must be considered as a subset of the broader group of Distributed Ledger technologies. Distributed Ledgers are technologies in which all the nodes of a network possess the same copy of a database that can be read and modified independently from the single nodes. Changes to the registry are regulated by algorithms that allow consensus to

be reached between the various versions of the registry, although they are updated independently from the network participants (Osservatori Digital Innovation 2018).

Distributed ledger systems are standing on five different main foundations: network, consensus algorithm, transactions, and assets. For each foundation, different options are available resulting in various platforms, with different characteristics and performances. Transactions and assets are the distinctive features of Blockchain when compared to Distributed Ledger technologies.

1. *Type of network*:
   - Permissioned: for accessing the network, you must register and present identification. It is, indeed, required authorization from a central entity or from the network itself.
   - Permissionless: the access is open to everyone.
2. *Consensus Algorithm:* The consensus mechanisms are more complex in the second case to avoid malpractices, such as the creation of numerous fake identities (e.g., Proof-of-Stake, Proof-of-Work). In a permissioned system, the algorithm is simpler. The modifications must be validated and then approved by most of the nodes.
3. *Structure of the database:* Blockchain solutions are those in which the registry is structured as a chain of blocks containing multiple transactions, and the blocks are linked together by encryption (e.g., Bitcoin or Ethereum platforms). There are also solutions in which the register is formed by Tangle, where transactions are processed in parallel (e.g., IOTA) or other cases in which the register is formed by a chain of transactions (e.g., Ripple).
4. *Transactions*: Blockchain systems, generally, allow users to make transactions. These transfers can be simple or more advanced depending on the level of programmability allowed by the platform. For example, the Ethereum platform will enable users to manage smart contracts that enable arbitrarily complex transfers.
5. 5.*Assets*: Finally, the last feature of Blockchain systems is the fact that there is a unique asset to be transferred that can be a cryptocurrency or a token. Such an asset can be natively digital or physical with a digital counterpart. The Internet of Things technologies can help to create a correspondence between physical and digital assets.

Therefore, a Blockchain is an open, shared, and distributed register containing data and information, such as transactions, without the need for a central entity for control and verification. A computer network of nodes allows users to manage and update the ledger, uniquely and securely. As defined by Risius and Spohrer (2017), "Blockchain technology refers to a fully distributed system for cryptographically capturing and storing a consistent, immutable, linear event log of transactions between networked actors."From this perspective, Blockchain can be considered the foundation of the "Internet of Value" defined as "a set of platforms and solutions, based on digital networks of nodes, that enable the transfer of valuable assets, in an environment where there is no trust nor the presence of an intermediary, through systems of algorithms and cryptographic rules that allow reaching consensus on the changes of a distributed ledger". (Osservatori Digital Innovation 2018)

1.3.2 Blockchain mechanism and its main pillars

A comprehensive and summarized description of the mechanism has been given by Hughes and colleagues (2019):

> *"While the blocks themselves are highly encrypted and anonymized, the transaction headers are made public and not owned or mediated by any specific person or entity. The headers are publicly available to those who would like to scrutinize transactions, as long as they have the wallet information details, also known as the hash, available. Every time a new transaction takes place on a Blockchain, a new block is resolved by a miner: an individual in the network whose job it is to verify each operation. In the case of Bitcoin, miners create new blocks and add them to the chain on the network every 10 minutes by solving cryptographic puzzles; this process is known as proof of work. The new blocks include immutable timestamps, which provide proof of work of what has happened before. Timestamps and immutability ensure that the chain of transactions cannot be tampered with as each sequential block references the prior block. Simply put, Blockchain and DLT are tamper-resistant since earlier blocks in the chain validate the transactions up to the present moment. If prior block information does not validate, the new blocks cannot form*

new parts of the existing chain and are rejected. As a result, a transparent and distributed accounting ledger of every transaction ever made on the network engenders trust. "

Overall, the technology has been identified as based on three main pillars (Nakamoto 2008; Friedlmaier et al. 2018).

- *Decentralization*: the database is shared among the participants in the system. Thus, the system is tamper-proof since a hacker should be able to manipulate the whole system.
- *Consensus*: since it might be possible that more copies of the same database exist, the consensus mechanism is guaranteeing the unicity of it. All the participants have to agree on a correct source of truth with some voting rights. The consensus mechanism can be built on different proofs, of which the most famous is the "proof of work." It consists of solving a computational puzzle using computational power. The solver, called miner, has the right to add the block updating the new version of the Blockchain.
- *Cryptography*: the technique is essential to guarantee data integrity and digital signatures. The participants use public and private keys to ensure their authenticity. Public keys are used to correctly identify accounts and private keys to authenticate the user of digital currencies.

1.3.3 Blockchain as a meta - technology

Another interesting perspective is the one that defined Blockchain as a *meta-technology* because "it is made up of several technologies itself" (Mougayar 2016). In fact, when examining the architecture of a Blockchain, it is notable that it is composed by: "a database, a software application, a number of computers connected to each other, clients to access it, a software environment to develop on it, and tools to monitor it" (Mougayar 2016). Similar consideration has been done by Williams and colleagues (2016) that argued that distributed ledgers are innovative recombination of existing technologies:

- *Blockchain*: a chain of blocks, bounded in a chronological order, which contains all the transactions registered. It is a database distributed among different servers. Consequently, the system is highly secure, and the transactions are traceable.
- *Digital signatures*: encrypted digital keys are based on hashing algorithms. They can be used to control transactions and authorize them.
- *A consensus mechanism*: since the database is distributed, each transaction must be validated. A consensus mechanism is a set of techniques and rules which guarantee the goodwill of the transactions. The participants must agree on the validity of each transaction.
- A *digital currency*: "a cryptographic token that represents actual value." The most well-known example is Bitcoin.

Moreover, Hughes and colleagues (2019) asserted that "Blockchain are novel combinations of multiple computer engineering paradigms that have existed for decades. […] However, the combination of hash algorithms, private and public keys, and the decentralized ledger are what makes Blockchain powerful in modern internet architecture".

1.3.4 An architectural view of the Blockchain

To briefly describe the technical aspect of the technology, Yuan and Wang (2018) presented a reference model of a distributed ledger as composed of six layers: Data layer, Network layer, Consensus layer, Incentive layer, Contract layer, and Application layer (*Figure 1.4*).

Data Layer: Layer that provides the techniques for managing the data. Focusing on Blockchain, it is composed of a chain of blocks in which the data will be collected and stored in all the full nodes of the network "using the data structure of asymmetrically encrypted, hashed, and time-stamped Merkle trees" (Yuan and Wang 2018). To decide which data should be bundled in a block, there is a competition, and the winner is empowered to package the data and create a new block with a timestamp on it.

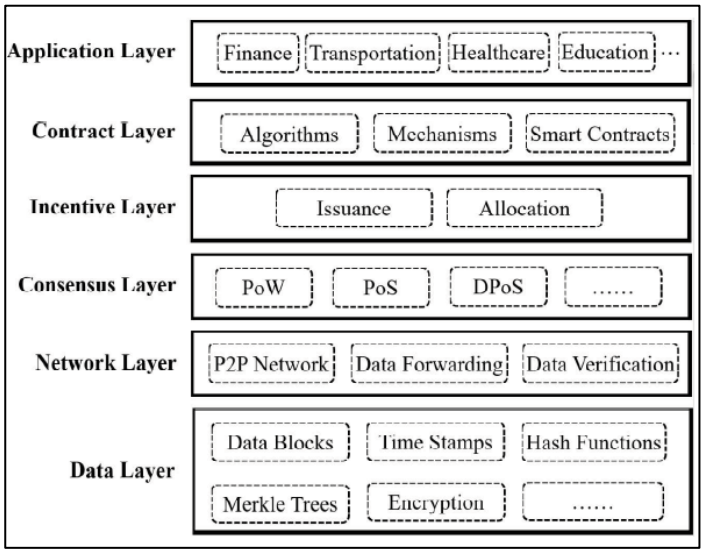


Figure 1.4 - Layers of Distributed Ledger (Yuan and Wang 2018)

The timestamp is necessary to link the transaction to a precise moment in time; this means that the Blockchain is transparent; it is always possible to trace back in time a transaction. As shown in *figure 1.5*, a Bitcoin block comprises a header and a body part. The previous contains all the meta-data while the last stores a Merkle tree of confirmed and hashed information. The blocks are tied one by one, framing the whole history from the beginning to the previous block created. The Merkle tree provides the verification of the integrity and existence of the information.

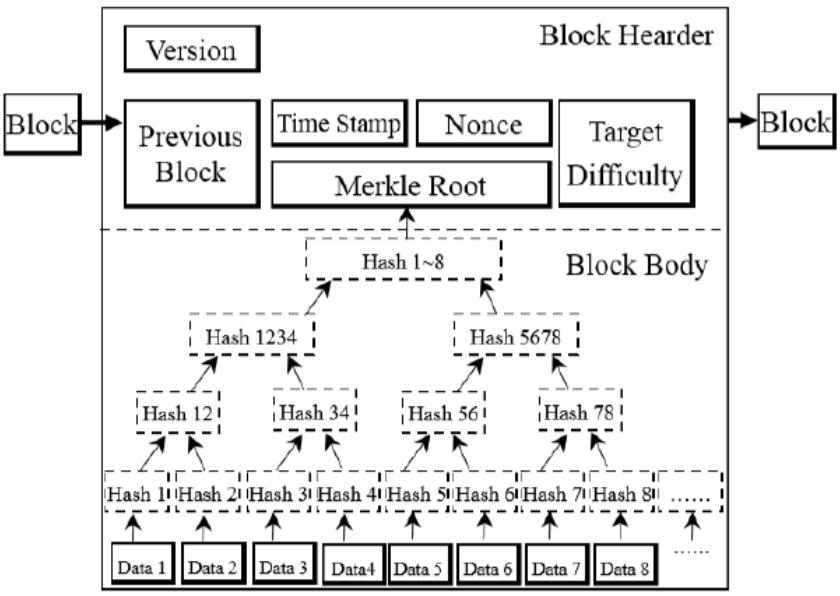


Figure 1.5 - Bitcoin block (Yuan and Wang 2018)

Network layer: This layer determines the communication, transactions, and verification models of the network. It can be labelled as a Peer-to-Peer (P2P) network since there are no centralized authorities, and the decisions are undertaken through a bottom-up approach. The information on the distributed ledger is stored in every node of the network. Therefore, even though a significant failure happens in the system, the data can be restored.

Consensus layer: As previously presented, the distributed ledger technology utilizes different techniques to provide the verification and validation of transactions, and to avoid misconducts. The distributed ledger network can be subject to Byzantine failures; hence, the system should be Byzantine fault tolerant. The "Bizantine general problem" had been developed as a metaphor by Lamport and colleagues (1982): "Communicating only by messenger, the generals must agree upon a common battle plan. However, one or more of them may be traitors who will try to confuse the others. The problem is to find an algorithm to ensure that the loyal generals will reach an agreement". Moreover, for public Blockchain are necessary PoX (Proof-of-X) consensus mechanisms. Proof-of-Work is the most widespread, the nodes begin a competition to solve a highly complex mathematical problem, which requires a substantial amount of computational power, to validate the transactions. The node which will come out as a winner will be able to append the bundle of transactions to the new block. Another typical example is Proof-of-Stake. In this case, the probability of being the one who is validating the transactions grows with the number of stakes (e.g., coins, tokens) that the node possesses.

Incentive layer: The Blockchain is a trustless ecosystem. As described before, there are consensus algorithms that play a role in making the system autonomous in spotting misbehaviors. However, the nodes must also be incentivized to participate in the ecosystem, especially for what concerns the validation mechanisms (e.g., Proof-of-Work requires computational power). This layer incorporates economic incentives. "The data verification and block creation process driven by consensus competitions can be considered as a crowdsourcing task to participating nodes that contribute their computing power" (Yuan and Wang 2018). The purpose is to make the individual objectives of revenue maximization compatible with the ecosystem objective of security and trust. An

example is Bitcoin Blockchain, in which the Bitcoin itself represents the economic incentives for the validators. This layer is compulsory for permissionless Blockchain; however, for what concerns permissioned distributed ledger is not mandatory. Since, often, the incentives of participating in the system are external factors.

Contract layer: This represents the programmable layer of the system. Not all the Blockchain and DLT are programmable, a typical example of programmable Blockchain is Ethereum. It means that algorithms and smart contracts can be written through a programming language. Smart contracts can be used to activate a transaction autonomously once predetermined conditions are verified. As Risius and Spohrer (2017) stated: "it allows even parties who do not fully trust each other to conduct and reliably control mutual transactions without relying on the services of any trusted middlemen."

Application layer: This layer concerns the use cases and applications of the Blockchain. At this level, the business functions are performed, the user interface is developed, and products/services are delivered.

1.3.5 An evolving perspective: Blockchain ages

Finally, the last perspective through which it is possible to analyze Blockchain and DLT is considering it as an evolving process made of 3 different ages (Angelis and Da Silva 2019).

Blockchain 1.0: the era of cryptocurrencies.

The focus is mainly on transactions and, particularly, on the reduction of their cost. This reduction has not only to be considered in a financial sense. It also has the purpose of shifting, in a frictionless way, to a system in which transactions do not need a central authority.

Blockchain 2.0: the era of Smart Contracts.

It encompasses privacy, smart contracts, and the emergence of non-native asset Blockchain tokens and capabilities (Schuster, 2018). This era was born thanks to the

founders of Ethereum that realized that the Blockchain could also benefit other kinds of assets.

Blockchain 3.0: the era of Decentralized Applications

It expands the concept of Blockchain to one of the decentralized applications (dApp) and computing. A dApp consists of a back-end code that runs on a decentralized peer-to-peer network connecting users and providers directly. This open-source software platform is implemented on decentralized Blockchain and DLT using cryptographic tokens. For instance, an established distributed ledger may act as a platform for application developers to make their transactions possible. The dApps are designed to be flexible, transparent, distributed, resilient, and have a clear incentivized structure (Raval 2016). The possibility of creating decentralized storage and decentralized computing enables greater scalability for dApps. Indeed, it may enhance the service innovativeness or speed to market of new products (Angelis and Da Silva 2019).

1.3.6 Benefits

Some advantages are here summarized and considered in different categories according to the aspect of the Blockchain they rely on (Ismail and Materwala 2019; Bellini 2017).

Some characteristics are a direct consequence of being a distributed ledger:

- *Transparency*: transactions made through the Blockchain are visible to all participants, thus ensuring transparency in operations. Moreover, all the changes in the network are visible from the public since the ledger is updated only when a consensus is reached.
- *Immutability*: the information already inserted in the Blockchain cannot be modified in any way. Indeed, all transactions are stored in immutable blocks. In this way, the information contained in the Blockchain is all more solid and reliable, precisely because they cannot be altered and therefore remain as they were inserted the first time. Indeed, “Any attempt to modify the content of a block will affect the subsequent blocks in the chain. Consequently, a malicious attacker needs to

change all the succeeding blocks in the chain to modify a particular block, which is computationally difficult because the chained blocks are replicated over multiple nodes". (Ismail and Materwala 2019)

- *Reliability*: since any central authority does not govern it and the control of the entire chain is given to all the participants, the Blockchain can be considered safer and more reliable than a centralized system. If only one of the nodes in the chain suffers an attack and is damaged, all the other nodes in the distributed database will continue to be active and operational, soldering the chain and not losing valuable information.
- *Convenience*: since there are no third-party intermediaries, which are necessary for all conventional transactions that occur between two or more parties (e.g., banks and other similar entities), transactions through the Blockchain are convenient and cheaper.
- *Traceability*: The transactions are irrevocable, and, at the same time, more easily traceable. This mechanism ensures that transactions are final, without any possibility of being modified or canceled. Thus, users can trace down back the origin of any update.

Whereas, other features are more related to the consensus mechanism:

- *Decentralization*: The transactions in Blockchain are processed and validated by the consensus of most network nodes. They are replicated on the nodes in a ledger, eliminating the need for an intermediary to share and maintain the database of transactions.
- *Trustless*: Blockchain and DLT allow users who do not trust each other to transact assets. The consensus mechanism ensures the legitimacy of transactions in the environment.

Finally, an additional characteristic of some system (e.g., Ethereum) is the programmability:

- *Programmability*: Blockchain and DLT may be programmable, allowing for automation of transactions and controls through the development and deployment of smart contracts.

It is essential to highlight that these characteristics may vary according to the typology of Blockchain. For instance, the level of decentralization in permissioned Blockchain is significantly lower when compared with the public ones.

1.3.7 Limits

Even if Blockchain and Distributed Ledger Technologies proved to bring significant advantages, they are not exempt from the limits of different nature. Ismail and Materwala (2019) summarized the main technical limits that Blockchain is experiencing. They have been here summarized and divided into different groups.

Some limits consider the actual performance of Blockchain and DLT and their usage:

- *Scalability*: This is, without doubts about, the major problem that is limiting the mass adoption of Blockchain. The rapid increase of the network in terms of nodes and data is, in turn, increasing the number of transactions to be processed. This trend is, of course, putting a burden on the network scalability. Several solutions have been found for this problem, but they are still under development.
- *Throughput*: to be processed, every transaction needs to be verified by the participants of the network, making the process of verification intensively time-consuming especially with a high number of users. Consequently, most of the existing Blockchain and DLT are relatively slow in processing transactions.
- *Cost*: the adoption of technology is also very limited by its cost of implementation. Building and deploying a Blockchain is a complex process, and this is the reason why many companies are trying to offer it as a service.

Then, there are limits connected to the safety and privacy of data and assets:

- *Safety*: a limited number of participants make the Blockchain less safe since there is a chance for a group with malicious intentions to coordinate and reach the majority (over 51%). The node can dominate all other nodes, manipulate the records in the Blockchain (Yli-Huumo et al. 2016). This mechanism may force the system to update the data on the Blockchain according to what the malicious group stated.
- *Loss of private key*: assets and data on the Blockchain are deeply related to the usage of the keys. To date, if the possessor of the private key loses it, then he will also lose control over his wallet. This problem represents a critical issue. Many users have lost significant amounts of money.
- *Data Privacy*: public and private keys are carrying with them the problem of pseudo-anonymity. On the one hand, this represents an advantage for participants who want to reserve their privacy, but it can become a huge limit when dealing with sensible data.

Next, other limits relate to the lack of standardization:

- *Standardization and Interoperability*: because of the already mentioned limits, different high-tech companies are developing their model of Blockchain, leading to a situation in which there are many different Blockchain and DLT, with different architectures and programming languages. To date, there is a significant lack of standardization that is, of course, limiting the evolution of the technologies.
- *Lack of Governance*: mostly in open access Blockchain, there is a huge problem of filtering the entrance because there is no filter. Access may be given so to any possible hacker or user with malicious intent. Up to now, organizations and companies moved to different kinds of solutions that consider the usage of a private Blockchain, where the participants are all trusted. However, this is not coherent with the true spirit of the Blockchain movement.
- *Regulation*: the attitude of governments and countries towards cryptocurrencies and Blockchain is a significant concern. There is still considerable confusion, and most of the states still lack regulations about the theme. The presence of them is

already representing a great advantage for companies, making the market safer and more reliable.

Finally, some limits are associated with the interaction with the "external world":

- *High Energy Consumption*: the computational power needed to solve the mathematical problems in the Proof of Work consensus mechanism is huge, and it is becoming an issue for the environment. The environmental impact is so high that it is comparable to global warming and carbon footprints (Holthaus 2017). Several alternative proposals have been carried out, and new "Proof of X" are available. However, there is still no unique solution nor a standard.
- *Access to external data*: with the second era of the Blockchain and with the advent of smart contracts, different solutions have been made possible. For many of them, a connection to an external source of data is essential to make the smart contract run properly. However, there is still great concern about how to gather these data. The synergy with the IoT system carries for sure a great potential, but also here the system is still immature, and many questions are still open.

It is important to highlight that, even if classified in different clusters, the limits are deeply connected, and, commonly, they are having an impact on each other. As an example, the lack of technical standardization is also explained by technical limits of the "proof of X" that, in turn, are impacting on the high energy consumption. Furthermore, the same concern that has been raised for the characteristics is still valid: the relative impact of the limit depends on the type of protocol and its features.

1.4 Objective of research

In the previous paragraphs, it appears clear that Blockchain and DLT are gaining increasing attention in the last years. Undoubtedly, the first reason of their increase in popularity is related to the incredible market value reached by Bitcoin. However, the level of knowledge is increasing, and people start to realize their true value other than the development of cryptocurrencies. Indeed, they are the object of research of many academics, governments, managers and investors.

Most tellingly, considerable investments in Blockchain and DLT are being made. In 2017, venture capital funding for Blockchain was already up to one billion dollars (Carson et al. 2018). As aforementioned, the World economic forum considered Blockchain and DLT as one of the top 10 emerging technologies and suggested that 10% of global GDP may be stored on them by 2027.

Furthermore, leading technology firms are highly investing in Blockchain and DLT. Among others, IBM has invested more than 200 million dollars in the development of Hyperledger, and Microsoft is working on Azure Blockchain. Other major companies are testing Blockchain solutions such as Visa and Wal-Mart. Furthermore, new ventures with innovative business models are emerging. The disruptive potential of Blockchain and DLT has been widely recognized and studied both in general terms and across different industries. At Harvard Business School, Blockchain is considered even more than a disruptive technology: "Blockchain is not a disruptive technology, which can attack a traditional business model with a lower-cost solution and overtake incumbent firms quickly. Blockchain is a foundational technology. It has the potential to create new foundations for our economic and social systems" (Iansiti and Lakhani 2017)

Given the importance that this theme has revealed, the objective of this study is the following:

To investigate which are the directives of development and innovation of the Blockchain and Distributed Ledger Technologies and their main business applications.

CHAPTER 2
LITERATURE REVIEW: Investigation Strategy & Research Question

In this section, the extant knowledge about Blockchain and Distributed Ledger Technologies has been reviewed for two main purposes.

1. to define an *investigation strategy* to reach the dissertation's objective
2. to outline which *research questions* have been left open related to the objective.

Accordingly, the paragraph is divided in four main parts.

The first part aims at identifying the *current state of innovation* of Blockchain and DLT from three different perspectives: diffusion of innovation, technologies' performances and lifecycle perspective.

Based on the results of the previous study, the ecosystem of *Blockchain Startups* and their characteristics are analysed and addressed as potential leaders of directives of development.

Next, the focus moves on the *sources of investment* that have been identified as good means through which make inferences on the innovation path of Blockchain and DLT.

Finally, combining the considerations of the previous analyses, the *investigation strategy* is outlined, and *research gaps* are presented.

2.1 An investigation of the emergence of a new technology

It is possible to study the innovation path of technology with three different model families:

- Diffusion of innovation models
- Technology performance models
- Life cycle models

Somehow, all these models are deeply correlated. Therefore, future considerations will be likewise presented.

2.1.1 Diffusion of Innovation

First, it is interesting to understand where the technologies are perceived to be in their innovation path from an adoption perspective. Although the enormous hype that surrounds them, there is also great disillusions about their real potential. As Roubini (2018) stated, "in reality, Blockchain is one of the most overhyped technologies ever". Therefore, the debate about the current state of innovation of the technologies is analyzed through different models and perspectives in the following sections. Questions have already been moved on whether Blockchain and DLT will ever reach the point of mass adoption (Davidson et al. 2016).

An adoption perspective focuses the attention on the current rate of acceptance of the technology, which is intended as the number of firms that are currently adopting it as part of their business model. Mansfield (1961), based on the study of Kuznets (1930), proposed the logistic curve as the representation of the temporal evolution of the number of firms that adopt a new technology. Moreover, the author identified three separated phases.

1. The first one is characterized by a high uncertainty in the results and risky investments. The number of firms that adopt the technology is still low, and this is resulting in a slow diffusion process. The learning process starts with the rate of technological performance that increases slowly.
2. The second phase begins when the technology reaches a point in which its utility has been demonstrated. The diffusion accelerates, and so does the understanding, resulting in higher technological performance.
3. The last phase begins when a large part of firms adopts the technology and it is about to reach its full potential.

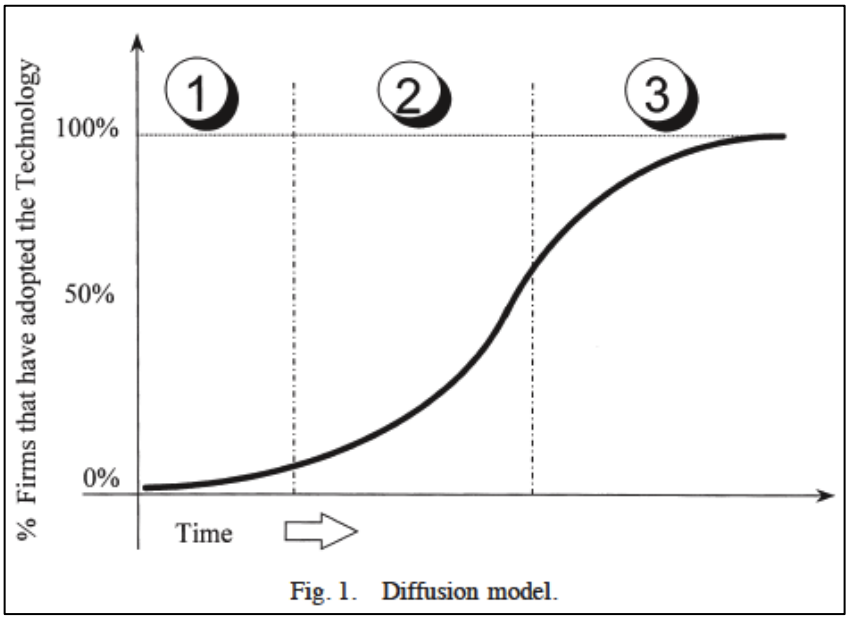


Figure 2.1 - Diffusion of Innovation (Nieto et al. 1998)

An additional perspective was added (Bass 1969) when considering that also the number of firms adopting the technology itself was influencing the growth of its adoption. The idea of Bass was used to shift to businesses the model developed by Rogers Everett (1995), "Diffusion of innovation". The main idea is that new technology is, at first, autonomously adopted by innovative firms, named "innovators". "Early adopters" will follow, creating a contagion that is influencing the other imitative firms, incurring in the mass adoption.

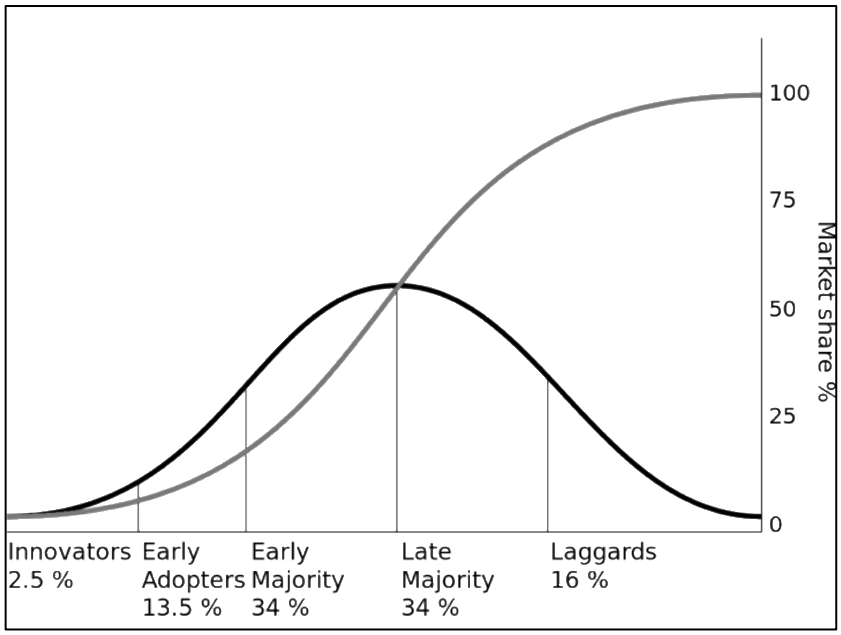


Figure 2.2 – "Diffusion of Innovation" (Rogers 1995)

Moving the focus on Blockchain and DLT, Buterin (2015) argued that "there is no killer app for Blockchain," suggesting that the innovation path is still florid. Moreover, Davidson and colleagues (2016) stated that that the Blockchain and DLT "will likely unfold along a logistic adoption-diffusion trajectory," confirming the model of Mansfield (1961) about the introduction of new technology.

In 2017, Woodside and colleagues (2017) studied the diffusion of innovation with the triangulation method based on a secondary environment analysis, text analysis, and financial analysis. What they realized was that, in each case, the adoption was still stuck in the "innovator" category (the first 2.5%) besides the financial one that, because of the consistent fluctuations of the Bitcoin in the same year, expanded to the "early adopter" category. In the same year, Friedlmaier and colleagues (2018) analyzed the diffusion of innovation from a different perspective. The authors considered the attributes defined by Everett Rogers (1995) for its model: relative advantage, compatibility, complexibility, trialability, and observability. However, they came to a similar conclusion stating that: "the Blockchain landscape mirrors the still early stage of the technology but concurrently also identifies its huge potential. The development during the upcoming years will reveal its potential as a merely incremental innovation or a truly disruptive technology".

Concurrently, Iansiti, and Lakhani (2017) developed a different framework, for foundational technologies, to investigate the Blockchain adoption (*Figure 2.3*). It maps the innovation against two dimensions:

- Novelty: the degree to which the technology is new to the world.
- Complexity: the level of ecosystem coordination involved.

Based on them, innovation is expected to be in one of four different areas. Notably, the authors unpackaged the Blockchain and DLT and identified "which kinds of applications will gain traction first and how Blockchain's broad acceptance will eventually come about" (Iansiti and Lakhani 2017).

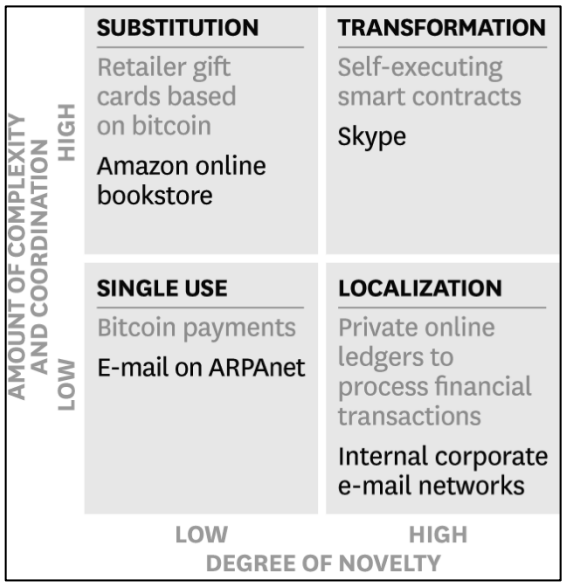


Figure 2.3 - Framework for foundational technologies (Iansiti and Lakhani 2017)

1. *Single use*: innovations that create better, cheaper and highly focused solutions. Bitcoin is considered here since it offers an easy and, in some cases, a more efficient alternative of payment.

2. *Localization*: high-innovative solutions that only need a low number of users to create value. The authors consider Blockchain in this area, arguing that "if Blockchain follows the path network technologies took in business, we can expect Blockchain innovations to build on single-use applications to create local private networks on which multiple organizations are connected through a distributed ledger" (Iansiti and Lakhani 2017).

3. *Substitution*: low-novelty solution with high coordination. Other cryptocurrencies, other than Bitcoin, are considered here. They may face high barriers of adoption because they want to replace the process of the first mover, the Bitcoin protocol. Furthermore, processes that, in most of the cases, they "hope to replace may be full-blown and deeply embedded within organizations and institutions" (Iansiti and Lakhani 2017).

4. *Transformation*: novel applications that, if successful, could change the very nature of economic, social, and political systems. The authors considered Smart contracts to be here.

Finally, they conclude the analysis by stating that "Localized applications are a natural next step for companies" (Iansiti and Lakhani 2017), opening high chances to see broader adoption of the Blockchain and DLT.

Additionally, a peculiar perspective has been highlighted by Luu (2018), who advised to investigate the current level of adoption of the Blockchain from two different angles: technology and investment. Indeed, if considering only the actual and extraordinary level of investment, Blockchain should already be considered in the stage of early majority: venture capital investment in Blockchain solutions reached 1 billion dollars (Carson et al. 2018). However, from a technological perspective limits need still to be overcome, and there is a global lack of knowledge. Overall, considering the relative weights of the two elements, Luu (2018) still considered the Blockchain to be in the middle of the "early adopter" and the "innovator" categories.

Finally, Gartner, one of the world's leading research and advisory companies, developed a "Magic hype" quadrant (*figure 2.4*). The tool provides a graphic representation of a qualitative analysis of the maturity and the adoption of a technology, in general, and its applications. Panetta (2017) clearly explained the trend of the curve by showing that when a disruptive technology comes to the market at its early stage is not yet ready for the market. Nonetheless, the consumers are excited about the innovation and, most of the time, attribute to it an even more significant potential than it has. After that, there is a moment in which people realize they overestimated the technology and interest towards it fall in the "through of disillusion." However, over time, the technology reaches its maturity, and it is ready to be on the market. From that moment on, the innovation will reach the plateau of productivity, passing by the slope of enlightenment. According to Panetta (2017), every technology follows this path, and Blockchain seems to be no exception. After the innovation triggered in 2008 with the Nakamoto paper, the expectations were inflated because of the absurd market value of the Bitcoin, that for long has been associated with the Blockchain itself. The extreme volatility of the cryptocurrency, its association with the black-market activity, and the lack of real uses cases application had a side effect on Blockchain and DLT in general and made them drop in the "through of disillusionment".

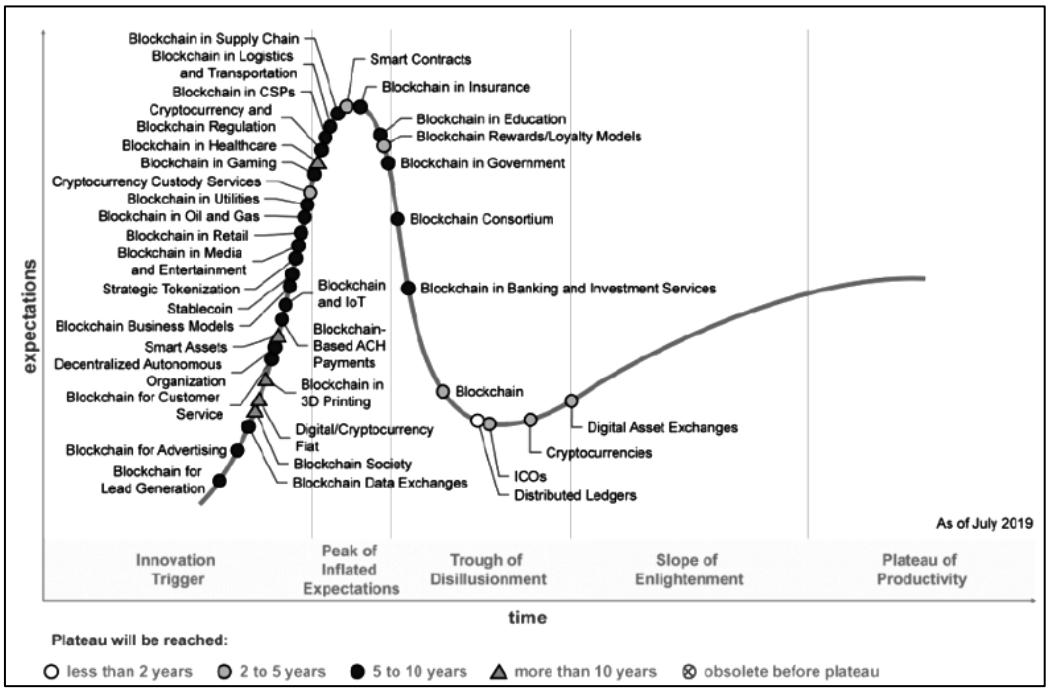


Figure 2.4 - Hype Cycle for Blockchain and DLT (Gartner 2018)

However, from that moment on, the knowledge about the technologies has been increasing, and its connection with the cryptocurrency starts to be understood. Thus, people begin to realize the real potential Blockchain and DLT hide, and the technologies are approaching the "slope of enlightenment".

The analysis is notably relevant because it is not considering Blockchain and DLT as a single object of the study. Whereas, they have been broken up in their numerous and various applications. Avivah Litan, analyst and research vice president at Gartner, in October 2019, stated that "Blockchain and DLT have not yet lived up to the hype and most enterprise Blockchain projects are stuck in experimentation mode. It is not yet enabling a digital business revolution until at least 2028".

All the above studies converge on considering Blockchain and DLT still in an intermediate state between the categories "innovators" and "early adopters."

While most of the studies agree on the enormous potential of Blockchain and Distributed Ledger Technologies, their current level of adoption is considered at an early stage, between "innovators" and "early adopters" categories.

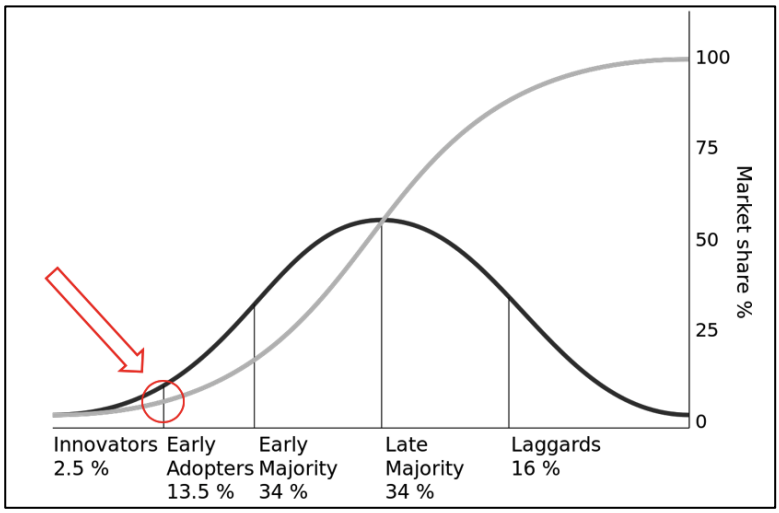


Figure 2.5 - perceived position of Blockchain and DLT in Rogers' diffusion of innovation

2.1.2 Technology performances

Here, the focus moves on technologies: performances. Foster (1986) developed an S-curved model, similar to the logistic-adoption curve, that relates the accomplished efforts with the obtained results in the development of a technology. With the term "effort", it is considered the actual level of investment in the technology (measured in monetary units, number of researchers, hours worked, workers per year, etc.).

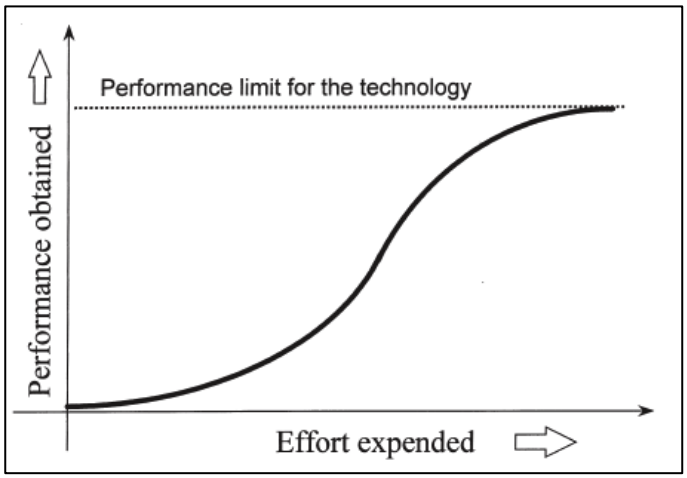


Figure 2.6 - performance improvement of technology against the effort invested

This model is showing how, in the early stages, high effort is needed to obtain only a few results in performance improvements (*figure 2.6*). Then, the technology starts to be fully

understood, and minor increases of efforts lead to significant enhancements in performance.

Verified some conditions, it is possible to consider the performance obtained as a measure of the different elements that reveal the technical aspects of the technology. If this is true, what the S curve "is demonstrating, in reality, is the speed at which incremental innovations in a given technology are produced." (Nieto et al. 1998)

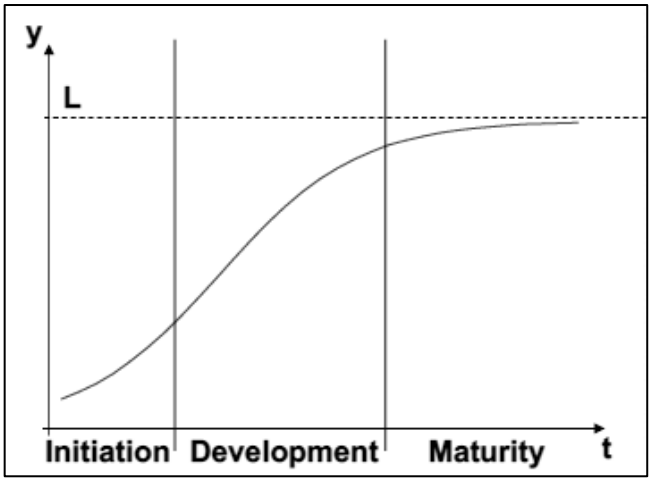


Figure 2.7 innovation path of a new technology depending on the investment (Adner and Kapoor 2016

$$\frac{dy}{dt} = b \cdot y \cdot \left(1 - \frac{y}{L}\right) \quad \Rightarrow \quad y = \frac{L}{1 + a \cdot e^{-b \cdot t}}$$

Figure 2.8 - the steepness of the S curve in mathematical terms

The mathematical function behind this curve is showing how, with a higher level of the variable *"a"* (amount of effort), the shape of the curve becomes more convex, resulting in a lower time needed to reach a high level of performance (*figure 2.8*).

This consideration is opening to a perspective in which the level of investment and effort in technology is impacting on the time it needs to exploit its potential and its rate of adoption. Foster (1986) already specified how technology advancements must be measured through investment in its development. Nieto and colleagues (1998) also showed how the S-curve models are related to the life cycle models that represent the evolution of technologies (Utterback and Abernathy 1975; Ford and Ryan 1981; Roussel

et al. 1991). Moreover, “in large part, they complement the diffusion models in that, while these models enable us to predict the speed of technological changes, life cycle models reveal their impact on markets and products” (Nieto et al. 1998).

The investments on the development of a technology are good measures for predicting its advancements. Focusing on Blockchain and Distributed Ledger Technologies, the actual level of investment and interest gives good reason to hope that the performance of the technologies will improve in a reasonable time window, overcoming the technical limitations encountered

2.1.3 Lifecycle models

Utterback and Abernathy (1975) developed a **life cycle model** that can be used to describe, which are the three main phases in the evolution of innovation (*figure 2.9*). Briefly, the fluid phase is marked by uncertainties and experimentations, and it is still not clear which are the potential applications of the technology. The emergence of the dominant design characterizes the transitional phase. Companies and users become more aware of the technology and the technicalities leading to the emergence of a standardized architecture. Finally, in the specific phase, companies focus the attention on product effectiveness and efficiency, increasing the competitiveness of the markets.

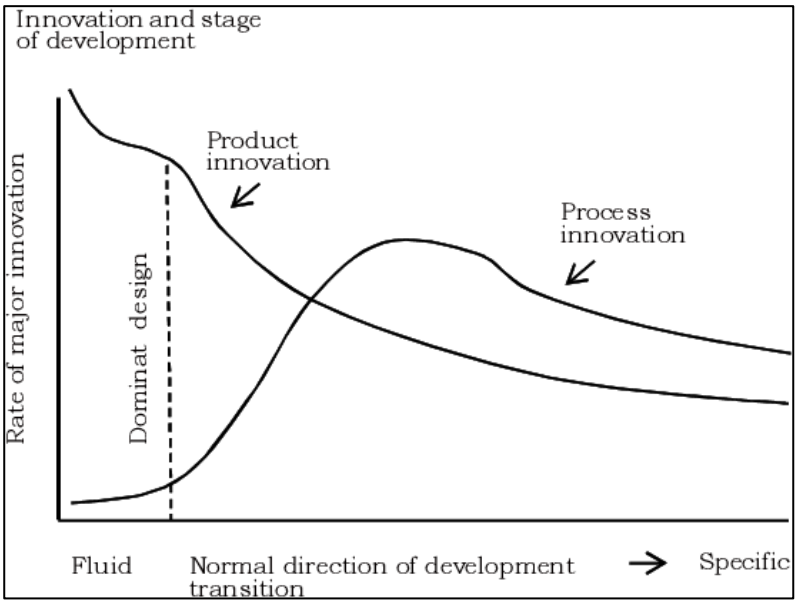


Figure 2.9 - Life cycle model (Abbernatty and Utterback 1975)

Focusing on Blockchain and DLT, Roiena (2016), argued that they are still in a fluid phase: “there is a lack of clear ideas of the potential applications for the technology.”

To date, only a few studies have been conducted to analyse whether dominant designs for Blockchain and Distributed Ledger Technologies are emerging. Habbestad and Karde (2017) investigated if standardization was emerging in the banking industry. They found that Blockchain and DLT are still in their early stages and that “dominant designs have the potential to emerge for Blockchain platforms, but will probably differ across use areas, industries, and value network levels”. Harris and Wonglimiyarat (2019) found that most banks still compete to create their Blockchain banking systems, converging to a similar conclusion and showing how the technology is still in the fluid phase. Moreover, Ughetto and Levis (2018), through the usage of the Delphi method, concluded that “the new portfolio of products and services that the technology allows is not defined yet and we’re still in the fluid phase of the evolution. However, the pace at which innovation is carried on suggests that dominant designs of the offerings will soon reach large adoption since many goals have been defined, but how to get them and achieve the desired outcomes still needs to be fine-tuned”. Moreover, although it is clear how the combination of the different technical aspects may lead to numerous possible solutions, no analyses about the technological life cycle from a purely technical perspective have been found.

The lack of standardization is also having an impact on the fact that the mass does not yet adopt the technology. The presence of a standard model of governance and applications make an innovation ready for mass adoption.

The innovation path of Blockchain and DLT should lead to the emergence of a certain level of standardization that will also ensure the achievement of technological maturity and mass adoption. Nevertheless, it is not yet clear whether the standardization process has already started and how long it will take.

2.1.4 The output of the investigation

The investigation of the innovative path of new technology, from both an adoption and a performance perspective, led to some important deductions:

1. The *current state of adoption* of Blockchain and DLT are still at an early stage. Precisely, they are in the middle between “innovators” and “early adopters”. Moreover, *innovative firms* may influence their evolution path.

2. The *amount of investment* is one of the main aspects to consider when investigating the directives of the development of new technologies.

The above considerations led to the decision to investigate the reasons why startups may be the innovative firms that can take the lead in the adoption of Blockchain and Distributed Ledger Technologies. Furthermore, the focus moves on the amount of investment raised that represents a mean to outline the development of the technologies.

Therefore, the following sections of the literature review are focused on:

- Blockchain Startups
- Sources of Investment

2.2 Blockchain Startups

In the above sections, the potential of Blockchain and DLT has been widely recognized. However, it has also been made clear that the current level of research, because of the novelty of the theme, is lacking many aspects, particularly descriptive ones. The choice to analyze what startups are doing to foster the directive of innovations of the technologies seems ideal. As shown before, Blockchain and DLT have started to take off in 2016, reaching a peak in 2017 and continuing developing till the present days. Since a few years have passed, most of the companies founded with these technologies as cornerstones are at their early stages. Many of them are startups. According to Steve Blank (2011), a startup is a "temporary organization designed to search for a repeatable and scalable business model." A Blockchain startup is a startup that involves the Blockchain technology in its business model, exploiting it for the creation and the delivery of value.

Startups

First, the startups can explore a new technology without the limits of an incumbent (Downing, 2018):

- *No legacy system*: there are no constraints in developing new ideas.
- *Speed and agility*: the startups are quicker in experimenting with seeing results.
- *Internal bias*: the startups can focus entirely on product innovation, without having to focus on meeting budgets in marketing and sales.
- *Visionaries lead startups*: usually, incumbents tend to focus on investing in the Blockchain technology to improve the process efficiency, whereas startups are more willing to explore new domains and to innovate the way the business is operating radically.
- *Limited budget*: limitations push the team to think more creatively to harness the benefits of exploiting the technology.
- Startups embrace *failure*: usually, startups have an innovative culture. It pushes the team to try different combinations, to fail often, and to learn from mistakes.

The outcome is a more robust solution, which has a higher probability of succeeding.

All these characteristics highlight the potential of the startup ecosystem in being an optimal sample to describe how the technologies are developing and to infer how the technologies will develop, where the innovation is going.

Blockchain Startups

Moving the focus on Blockchain startup, Zhao and colleagues (2016) stated that the actual state of the research concerning Blockchain and DLT had been mainly at a conceptual level or a prescriptive level. That means that the research was lagging at a descriptive level. In the literature, there are few empirical analyses in aggregate of Blockchain companies. An example is the analysis of Momo and colleagues (2019), who analysed a database of 810 organizations (extracted from Crunchbase, searching the keyword "Blockchain"). This set of organizations comprises companies born before 2014, 110 organizations. An interesting result of the data gathering process had been the ten companies born before 2008. They are showing that the technologies, as they are known today, started to develop later, but that it has been used (even though in very few cases) for years. As previously mentioned in the introduction, Blockchain and DLT are just a bundle of different technologies.

A specific analysis of the Blockchain startup ecosystem had been instead performed by Friedlmaier and colleagues (2018). The research aimed to understand the distribution of the Blockchain startups across industries, how the venture capital investments are spread in the sectors in which the startups operate, and last, they showed how the startups are distributed geographically. The researchers developed a database of 1140 Blockchain startups.

However, the research is still stuck to 2018, so an updated analysis may be needed. Furthermore, the investigation was limited to the sector and process for which the Blockchain and DLT were used, the geographical distribution, and the venture capital

distribution. Nothing was said about the Blockchain platforms, their particular usage, nor on the characteristics of Blockchain and DLT.

An exception is the work of the “Osservatorio Blockchain and Distributed Ledger” of “Osservatori Digital Innovation” in 2018, for which this research will represent progress and an update to 2019.

The importance of funding for startups

One of the main problems of startups is finding sources of funding that will allow them to be born, grow and become successful businesses. Startups by their very nature 'burn cash', and even when they start billing and have good revenues, they may need capital injections to scale.

The characteristics of a startup are:

- *Temporariness*: being a startup is a transitional phase; the ambition is to become a great enterprise.
- *Experimentation*: startups are looking for a business model. At first, they don't know exactly if what they are doing will be successful; they must make many attempts to discover it and find the right formula to be profitable by innovating.
- The business model must be *scalable* and *repeatable* in its processes.

The startup is a company obliged to find alternative sources of financing that will allow it to go ahead in the search for the business model and to grow quickly once it has found it. The potential growth is the real characteristic that distinguishes this type of innovative enterprise from all the others. And growth needs funds. (Network Digital360, 2018b)

Startups are generally considered as potential leaders of directives of development of new technologies. Their characteristics, such as agility and flexibility, give them the opportunity to explore a new technology without the limits of an incumbent. Therefore, they may represent the innovative firms that influence the innovation path of Blockchain and Distributed Ledger Technologies.

2.3 Sources of Investment

As described in the above sections, analyzing the amount of investment may represent a mean to investigate the innovative path of new technologies. Therefore, the traditional sources of investment are here introduced. However, considering that the focus is on Blockchain and DLT, the innovative source of financing that they initiated could not be excluded: Initial Coin Offering (ICO).

2.3.1 Traditional sources of investment

The first significant distinction to be made is between equity and debt financing. In the first, there is direct participation in the shareholding of the innovative startup, assuming the relative risks. The second is represented by debt bank loans (Network Digital360, 2018a).

Self-funding, Bootstrapping, 3F

The “self-funding” refers to the assumption of full responsibilities in funding the startup. The term “Bootstrapping” refers to the ability of the startup to finance itself thanks to paying customers.

“3F: Family, friends, and fools”. It is quite clear who the first two categories are and why they invest in a startup, fools are people who 'fall in love with the project' and give credit to the startup for entirely personal reasons, and that is beyond the objective criteria.

Awards, public grants, and subsidies

They are often non-repayable capital in whole or in part. In the case of awards, they also provide visibility and validation of the idea. In the case of grants and public subsidies, they may present a specified complexity that is not suitable for a startup in its early stages. In all cases, the cost/benefit ratio should not be underestimated.

Incubators and business accelerators

Their contribution has, often, not only economic value. It consists of services (space, connection, administrative assistance, etc.), mentoring, training and network. Sometimes the support of the incubators includes a small part of capital financing.

Business Angels

The business angels are wealthy individuals who invest their own money, for a sense of philanthropy or passion for innovative enterprise, and decide to support the startup by acquiring shares. The business angel also provides the company with mentoring, networks, and managerial skills. More business angels together can make a syndicated loan to distribute the risk.

Venture Capital

Venture capital (VC) is a high-risk form of investment but can also provide exceptional economic returns. People who found or manage a VC fund are called venture capitalists. Venture capital funds are generally useful in the growth stages of a startup. While business angels invest their financial resources in startups, venture capital funds raise capital, mainly turning to institutional funds. Therefore, it must also respond to its investors making Venture Capital more demanding and wiser in the choice of investments. It needs objective references (metrics) to be convinced in offering support. When a venture capital invests, it acquires shares in the company and, depending on the case, helps the start-up also at an operational level, providing managerial, technical and relationship skills that will lead to improvement. Generally, venture capitals require a presence in the company's management.

Corporate Venture Capital

Corporate Venture Capital or Corporate Investing (CVC in short) is the venture capital investment activity carried out through a dedicated fund by large corporations. It is, therefore, an activity that allows the company to acquire shareholdings in innovative

companies, such as startups. The reasons why corporations have begun to become venture capitalists is to maintain a competitive advantage, to grow, to enter new markets, and to make open innovation.

Debt and convertible note

One of the most common ways of setting up a business is through traditional bank lending, but many banks are somewhat reluctant to use it to finance start-ups, as their business plans are often classified as riskier than traditional business models. Another reason why banks do not lend to many start-ups is the lack of guarantees from the founders. Companies must decide a level (debt to equity ratio) which they are comfortable with. The convertible note is an investment tool often used by seed investors investing in startups who want to postpone the evaluation of the startup to a new round of financing or to reach a milestone. They are structured as loans but can be converted into equity at a later stage. A condition is that there is a time limit for converting the note.

2.3.2 Initial Coin Offering (ICO)

The definition provided by Giudici and colleagues (2018) is: "Initial Coin Offerings (ICOs) can be defined as open calls for funding promoted by organizations, companies, and entrepreneurs to raise money through cryptocurrencies, in exchange for a "token" that can be sold on the Internet or used in the future to obtain products or services and, at times, profits."

"Initial coin offerings (ICOs) constitute a novel mechanism for funding highly innovative ventures that use distributed ledger technology" (Fisch 2019). ICOs are a very recent phenomenon. Mastercoin had been the first ICO issuer in 2013. It is a new cryptocurrency built on the Blockchain Bitcoin (Shin, 2017). Since then, the number of ICO increased slightly till 2017, where, as it is evident in *figure 2.10* and *2.11*, data gathered from the ICO tracker of Coindesk.com, the number of ICOs has experienced a rocket rise, reaching a total of USD 22.5 bn at the end of 2018 (Coindesk, 2019). To have a term of comparison, Kickstarter has raised a total of USD 4.6 bn from the beginning (2009) until November 2019 (Kickstarter, 2019).

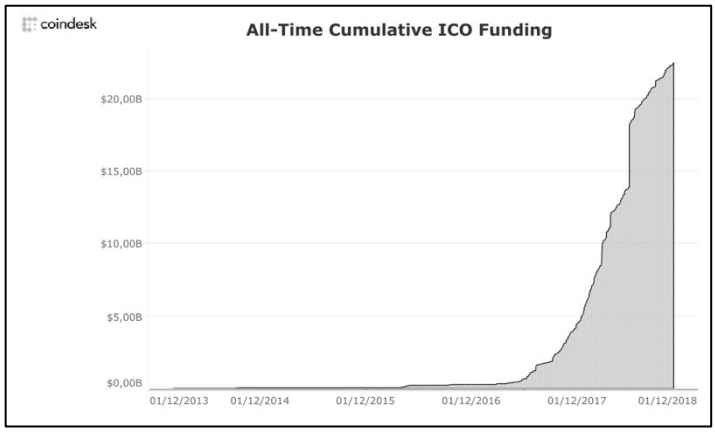


Figure 2.10 - all time cumulative ICO Funding (Coindesk 2019)

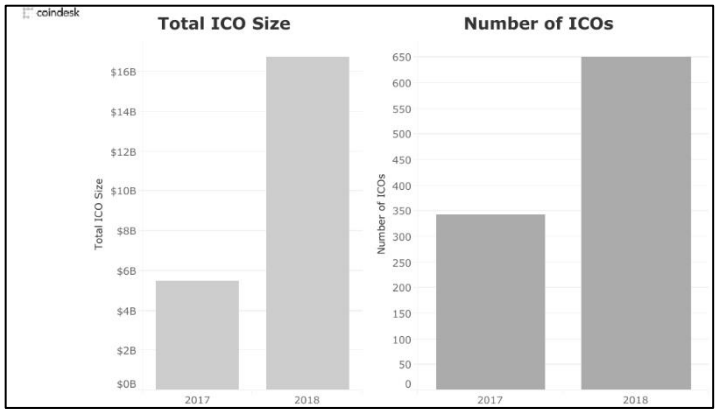


Figure 2.11 - Total ICO size and Number od ICOs (Coindesk 2019)

An ICO is a type of funding using cryptocurrencies. During an ICO, a stake of the startup or company is sold to raise money for the entity's operations. The ICO is allowed by the adoption of innovative technologies that are based on Blockchain and DLT. Hence, the benefits of Blockchain platforms are reflected in this fundraising method. First, the absence of intermediaries and payment actors lead to a dramatic reduction in the cost of raising capital. Second, the mechanisms underlying the ICO (decentralization and open-source development) drive the creation of an ecosystem of customers and the consequent network effect. ICO is similar in some respects to crowdfunding. However, the first use of Blockchain and DLT was to ensure the issuance of tokens, which is a distinctive element of the ICO (Fisch 2019).

The financial return of investors, or instead of those who first believe in the potential of the startup, is intrinsically linked to how much the value of the new cryptocurrency, issued by the startup itself, will rise over time. The mechanism, is therefore very similar to that

of a traditional IPO (Initial public offering) with two significant differences: the first is that the ICO occurs at the beginning of the life of the startup and then is able to bring financial value immediately; the second is that it does not require, being unregulated, the time and financial and bureaucratic costs typically associated with an IPO. It should be stressed that this tool is applicable by very specific startups and that it is at high risk of investment and management. The value of the traditional IPO remains because it happens when the company has already achieved a consolidation, on average it has lower risk factors (and even lower potential returns) and brings financial resources to a company that must grow, while the ICO brings them to a company that is just born. The transformation of the FinTech industry has no longer only an impact on banks or financial institutions that deal with savings, payments, investments, asset management, but also on those who are already close to the world of startups such as venture capital.

Empirical investigations on ICO

ICO is a disruptive and revolutionary innovation and represents a compelling topic for researchers and practitioners in the entrepreneurial finance field (Fisch 2019).

Although receiving significant interest from companies, regulators, and investors, the understanding of ICOs' dynamics as a source of funding is still little. For example, it is not clear what are the determinants which impact the amount of funding raised with this method or if the ICO works accordingly to other aspects of entrepreneurial finance (Fisch 2019). Furthermore, the interest of the literature is furtherly increasing, focusing on all the details of the ICO campaigns. Such as, what would be the best fitting design of an ICO, both to be more attractive for investors and to be more robust as a code (Giudici et al. 2018). Or, how the fundraising method fit in the regulation ecosystem in the different parts of the world.

In this paragraph, previous examples of empirical and quantitative analysis are presented. They are showing a synthesis of the objective of the study, the set of analyzed data, and the results.

Giudici and Adhami (2019) studied a sample of 935 ICOs. The purpose of the analysis was to examine the governance signals impacting on fundraising success. The involved variables in the inferential analysis had been token rights, institutional settings, and team quality. The investigation proved a correlation between the size of the team and the advisory committee and the success of the fundraising process. Furthermore, when the tokens are also retained by an internal member of the team and when there are proven past managerial experiences the probability of success increases.

Florysiak and Schandlbauer (2018) collected 4053 ICO campaigns. The focus of the study was on the information content of the white papers, seen as the most important source of information for investors. The quantitative analysis aimed at "observing empirical associations between ratings, fraud probability, ICO success, funding volume, token exchange listing probability, underpricing, cumulative returns, and trading volume" and to analyse the effect of the information asymmetry between the proponents and the participants. A surprising result of the research showed how low quality and potential scammers could raise funds successfully and list on exchanges their tokens.

Fisch (2019) used a sample of 423 ICOs. The research question defined by the authors is, "What factors determine the amount of funding raised in ICOs?". The independent variables, focus of the research, are related to the signals for technological capabilities: the presence of a patent, of a white paper, and open-source code on Github. Furthermore, the author decided to test the correlation between the amount raised by the ICO and other variables related to the characteristics of the campaign and the venture. The main results showed how the patents and the open-source code on Github have no significant correlation with the amount raised, while the presence of a technical white paper shows a highly significant positive correlation.

Giudici and colleagues (2018) analysed a sample of 253 ICO campaigns. It is a quantitative analysis to assess which are the factors that impact the success of the fundraising process. The variables range from the availability of information to the structure of the ICO and the characteristics of the token. Besides, the industry has been taken into consideration. The results show that the probability for an ICO to be successful

increase if the tokens let the investors access to a service, when the presale of the token is structured and when the code is open.

Benedetti and Kostovetsky (2018) analysed a database with 4003 executed and planned ICOs to discuss the return on investment in ICO. The results showed a significant underpricing in the value of the tokens released, with an average return on investment of 82%. Therefore, they studied the factors determining the underpricing and those impacting on the success of the ICO. The variables involved in the analysis are mainly connected to the characteristics of the token and the campaign and the usage of Twitter. Among the many results, they showed that there is a correlation between the amount of capital raised and the number of Twitter users, the intensity in Twitter usage, the usage of the new, unproven platform (although the risk of scam) and the insertion of the token in an exchange platform.

Fenu and colleagues (2018) examined 1287 ICOs. The research aimed at understanding what the success factors of an ICO are. The variables gathered are the headquarter location, the number of employees, the length of the campaign, the rating, the amount raised (in the number of tokens), the category to which the token belongs, the platform, and the industry. The results show evidence of the correlation between the success of the fundraising process, and the Ethereum platform (negative correlation), the country of origin, the rating on IcoBench, and the industry.

De Jong and colleagues (2018) analysed a database composed of 360 ICO campaigns. The purpose was to find out which are the elements that impact on the success of an ICO. The factors studied were connected to the presentation of the campaign, the presence of a presale, characteristics of the campaign, and the team. The results brought to light that the most important suggestion for entrepreneurs is to make the ICO the more transparent as possible. Furthermore, having a high rating online is a positively correlated factor and the same is for the presence of a presale and the uploading of the code on Github.

2.3.3 Choice of the means to outline the innovation path

In his book "Innovation: The Attacker's advantage," Foster (1986) specified how the advancement of technology must be measured through the investment in its development.

As we have seen previously, the fundraising process is crucial for a startup. It allows the company to grow and become a successful business (Network Digital360, 2018b). The investors themselves decide to invest where their analysis and business acumen warn that there will be a growth in the next months or years. Davila and colleagues (2003) analysed the correlation between the receipt of venture capital funding and the growth of the startups, stating that "the growth of startups increases before but mainly after they receive new funds." Furthermore, "thin capitalization at the beginning of business activity is a major reason for the failure of ICT-start-ups. Approximately two-thirds of all failed ICT-start-ups attribute their failure to missing seed capital or no" (Taraba et al. 2014).

Finally, the depth of the research in the factors impacting an ICO campaign highlights the significance of the fundraising process for a Blockchain startup. Many of the studies were focused on the amount of funding raised and on the success of the campaign (Giudici and Adhami, 2019; Fisch 2019; Giudici et al. 2018; Fenu et al. 2018; de Jong et al. 2018). Moreover, the ICO can be considered as an alternative to the traditional funding sources (Diemers et al. 2018). The amount raised from a fundraising process has been recognized as a dependent variable also in another study in the entrepreneurial finance field (e.g., Mollick, 2014).

The above analyses led to the decision of considering the distribution of Initial Coin Offering, together with the traditional source of investment, the means through which the innovation path of Blockchain and Distributed Ledger Technologies will be drawn

2.4 Investigation Strategy and Research Question

Through the comprehensive analyses of the literature review, essential takeaways have been gathered and are here summarized:

- Blockchain and DLT are still at the early stage when considering the rate of acceptance. Hence, startups are strategic players and possible leaders of the evolution of the technologies.
- The level of investment raised from startups may be the mean through which it is possible to make inferences about the directives of the development of Blockchain and DLT. Because of their exceptional value, ICOs cannot be excluded from this analysis. However, the differences between the traditional sources of the investment may lead to different results that have to be investigated.
- To date, few empirical studies have been carried out about Blockchain and DLT, and even less have analyzed the comprehensive landscape of solutions the technology is offering.

Given these considerations and the objective of the study, the **investigation strategy** has been developed:

An empirical investigation of globally operating Blockchain startups and their raised amount of investment is used to make inferences about the directives of development of Blockchain and Distributed Ledger Technologies and their future use in diverse industries

This strategy, in turn, is answering the following main **Research Question**:

RQ: *What are the directives of development and innovation of Blockchain and Distributed Ledger Technologies? How the ecosystem of startups is implementing them? What are their main business solutions?*

It is important to highlight that the managerial orientation of the study influences the forthcoming variables of interest. Therefore, they are related to the business applications of Blockchain and DLT rather than their technicalities and architecture.

CHAPTER 3
THEORETICAL BACKGROUND & HYPOTHESES DEVELOPMENT

In this chapter, the theoretical background concerning the research questions to be addressed is outlined. According to the managerial orientation of the study, the variables of interest are related to the business applications of Blockchain and DLT.

The extant literature on Blockchain and DLT and their impact on business models across diverse industries and processes is reviewed. Precisely, it outlines what is missing in the literature, and which research questions have been left open. From these considerations, hypotheses will be developed.

First, the studies on the impact of the technologies on Business Models from a general point of view are investigated. Next, the focus moves on the diverse industries that may be affected by the diffusion of Blockchain and DLT, followed by an analysis of the processes and characteristics of Blockchain ventures. Finally, the focus is on the fundraising method that might have an impact on the amount raised and, consequently, on the future development of Blockchain and DLT.

3.1 The impact of Blockchain and Distributed Ledger Technologies on Business Models

Companies are always seeking continuous business model innovation. It can be a source of competitive advantage and guarantee growth and prosperity to the company (Mitchell and Coles 2003). "Business model innovation demands a firm to consider the uncertainty

within its environment as a potential source of opportunities that need to be explored and exploited" (Schneider and Spieth 2013). Hence, there are external drivers for business model innovation; changes in technology can represent a driver to transform the business model (Nowinsky and Kozma 2017). Technology has always been one of the main drivers to foster business model innovation, but, alone, it can only guarantee six to twelve months of advantage (Mitchell and Coles 2003). On the contrary, a proper business model that is leveraging on technology can be an advantage that lasts for years. From this consideration, it is essential to understand how Blockchain and DLT can shape the actual business models and how they can create new ones.

Already in 2015, Atzori (2015) states that the Blockchain and DLT are a "disruptive innovation with a wide range of applications, potentially able to redesign our interactions in business, politics, and society at large." Two years later, Nowinski and Kozma (2017) showed how Blockchain and DLT could affect diverse dimensions of business models in different industries. Notably, they identified three main ways in which Blockchain and DLT are impacting business models: authenticating trading goods, facilitating disintermediation, and improving operational efficiency. Well established companies are exploring or operating projects involving the technologies. For example, every company that provides a particular service or product based on the relationship of trust between buyer and seller should focus on the impact offered by Blockchain and DLT in business, not only for market disruption, but also by providing new opportunities to create value in an appropriate business model to explore these technologies (Cohen et al. 2017). Nofer and colleagues (2017) made statements about the fact that researchers in the information systems and business areas should focus on the analysis of the choice of adopting or not the technology in business processes, market design, the concept of trust and privacy and on the impact of the Blockchain and Distributed Ledger Technologies on business model innovation and improvement. Hence, “the research at the intersection of technology, markets, and business models is certainly valuable” (Nofer et al. 2017). Friedlmaier and colleagues (2018) discuss the lack of standardization in different industries, in terms of the technology underlying the platforms. For instance, should they be private or public? Permissioned or permissionless? They suggest comparing the evolution of the internet in

its early days (1990) and the potential evolution of Blockchain technology. It is required to define a standard for the basic layer (e.g., the internet had TCP or ITP). Afterward, the different markets will experience the competition focusing on upper layers, on the applications on the Blockchain. The technology, leveraged in this way, will potentially bring disruption to current business models if its benefits are harnessed. In the same year, Risius and Spohrer (2017) stated that a comprehensive understanding regarding terms of application and use-cases was generally missing, meaning that there was no clear idea of the impact that the technologies have on existing business models. Morkunas and colleagues (2019) analysed the impact that the technologies could bring on the different blocks of the business model canvas, a framework developed by Osterwalder and Pigneur (2010). *Figure 3.1* shows a summary of their findings, the different impacts of the technologies on the business model. However, they confirmed that "unfortunately for businesses, there is little guidance on the different Blockchains and solutions in existence today and how these might affect businesses and business models."

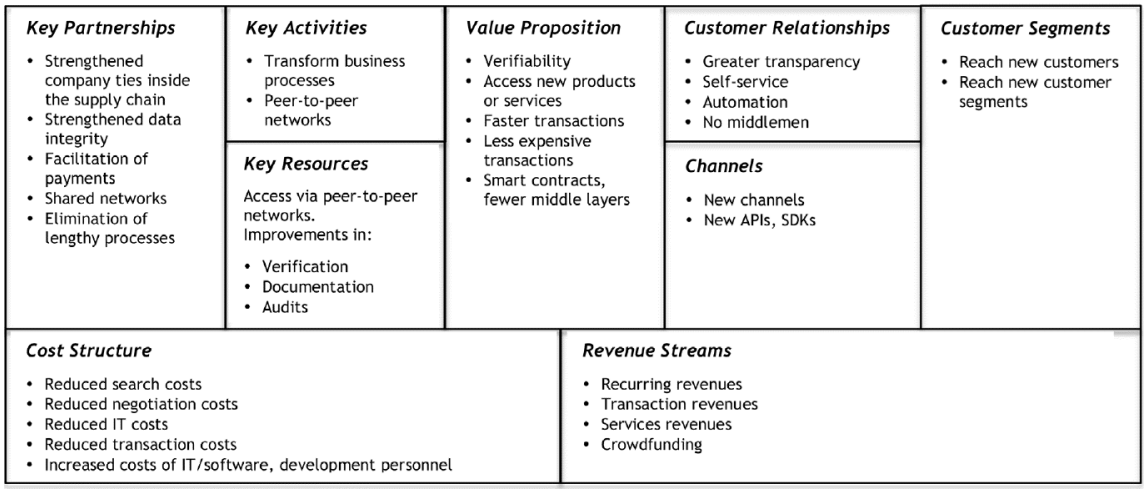


Figure 3.1 - the impact of Blockchain and DLT on the business model canvas (Morkunas 2019)

Hughes and colleagues (2019) give an overview of the applications of Blockchain and DLT, presenting the social and legal challenges that it is facing. The paper claims that the world is "currently living the first iteration of the Blockchain: the cryptocurrencies." However, the real-world use cases are more diverse, and they seem to have the disruptive potential necessary to transform different industries. The authors conclude giving suggestions to managers. To try to look at the technologies creatively, thinking about

process innovation and business model innovation. “Any transaction, product life cycle, workflow, or supply chain could, in theory, use Blockchain and DLT” (Takahashi, 2017).

The analysis of the disruptive potential of Blockchain and DLT labelled them as catalysts for business model innovation. However, their impact may differ according to the industry in which they are implemented.

Therefore, in the next paragraphs, a further overview of the literature will support the development of hypotheses connected to the context in which an organization operates and to its business model.

3.2 The impact of Blockchain and Distributed Ledger Technologies in the diverse industries

“Which markets, industry branches, business models, or corporate divisions are more likely to be affected by Blockchain?” (Risius and Spohrer 2017)

Virtual Currency

As aforementioned, Blockchain and DLT have been for long, associated with the concept of cryptocurrency. Indeed, before recognizing their potential and applicability to diverse industries, the exchange of these new digital currencies was considered the main innovation brought by the technologies. When performing the triangulation method to assess the rate of adoption of the technologies, Woodside and colleagues (2017), estimated that the market value associated with the circulation of 921 cryptocurrencies was around $91 billion. Moreover, many diverse applications are related to this sector other than trading, such as to offer digital space where to store cryptocurrencies or to make spendable or convertible in fiat. However, in the last years, many critics have been moved to their usage as a mean for trading because of their high volatility. They have also been addressed potential causes of economical and, at a glance, social instability. Hughes and colleagues (2019) stated that the benefits associated with this market are relatively simple and easy to implement, but the underlying technologies (Blockchain and Distributed Ledger) have a more significant potential to disrupt all sorts of business operations. To conclude, the

prevailing thought toward this market is that it represents only a small portion of what Blockchain and DLT can exploit, and it is considered only as of the first era (Momo 2019). Therefore, it is expected to see the application of Blockchain and DLT in many other industries other than the mere usage of cryptocurrencies.

General Purpose

Blockchain and DLT have been identified also as General-Purpose Technologies (Kane 2017). Bresnahan and Trajtenberg (1995) argued a General-Purpose technology should pervade most sectors, make it easier to create, and lead to the innovation of other technologies. Lipsey and colleagues (2005) added that a technology that is general purpose could develop and evolve and can diffuse into a wide variety of market segments. Furthermore, they can only be identified retrospectively since general purpose technologies may differ from their first iteration. Kane (2017) made parallelism between this definition and Blockchain and DLT, considering Bitcoin and cryptocurrencies the first iteration of these technologies.

Moreover, the author showed how Blockchain and DLT can be already applied in many different sectors, concluding that they are General Purpose technologies. Analysts, in recent years, have come to assume that most industries could benefit from the use of distributed ledgers. There are several cases of commercial use of Blockchain and DLT, with transactions that are automatically verified and organized by a decentralized platform that does not require the supervision of an entity or a central subject, while ensuring resistance to tampering and fraud (Network Digital360, 2019).

Finance

The **financial** sector is seen as the number one adopter of Blockchain technology. First, it is because Bitcoin cryptocurrency is one of the most popular applications. Second, the industry is characterized by inefficiency in internal processes and transactions (Nofer et al. 2017). Also, Friedlmaier and colleagues (2018), analysing the descriptive statistics of their Blockchain startups database, state that "the highest funding is in financial services; it is a result of the already advanced and proven applicability of Blockchain technology

within the industry." In finance, the applications are various from cross-border transactions to an increase in the efficiency of data sharing among different banks.

Healthcare

The **Healthcare** sector is currently overwhelmed with information siloes and a data interchange between actors that is highly inefficient. Moreover, patient data are usually stored, exchanged, and potentially sold without their knowledge. This led to a significant shift that the sector has been experiencing in the last years where traditional interoperability that was focused only on businesses, such as the exchange of data between different hospital systems, has to switch to a new orientation in which data are patient-driven. Thus, data property and values should come back to the patients. This trend is opening interesting opportunities for Blockchain and DLT applications. Gordon and Catalini (2018) identified five different mechanisms through which these technologies may exploit this trend: data aggregation, data liquidity, patient identity, and data immutability. However, the authors realized that, before their applicability, it is needed to overcome some existing limitations of Blockchain and DLT, such as scalability and regulations.

Media & Arts

Media and Arts sector includes Gaming, Music, Social Network and Arts. For different reasons, Blockchain and DLT may be implemented in these industries. As far as concerned the Music sector, the management of digital rights has always represented a critical issue. O'Dair (2016) identified some critical activities through which Blockchain and DLT may be helpful: "determining the authorship and attribution of recorded music; enabling asset transfers and the tracking of provenance; allowing artists to determine their pricing and terms of use for their music; facilitating licensing through metadata; introducing frictionless, near-instant micropayments for streaming and downloads". Whereas, in the gaming industry, the development of decentralized applications and the true digital ownership of digital content are the main opportunities identified (Osservatori Digital Innovation 2018).

Logistics

In the Logistic industry, one of the main applications is represented by the automation of the payment once a product has been received and the tracking of the provenance of goods. The former, when combined with IoT technologies, "works by ensuring each party with a private key writes a confirmation to the blockchain that they have received a product. This secure chain of custody allows for high confidence verification of where and how a product was handled and allows each member of the supply chain to identify and inspect where any mishandling might have occurred" (Hughes et al. 2019). Whereas, as far as concerned the tracking of the provenance of products, New ventures have born offering this service as the core of their business model (Montecchi et al. 2019). Provenance may be a key issue for certain businesses that leverage on the evidence of their source of good and for consumers that want to ensure companies are aligned with their values.

Agri-food

In the agri-food industry, traceability and transparency main drivers of the sector and may represent a source of competitive advantage (Armstrong 2016). Therefore, Blockchain and DLT may find interesting applications in certifying the provenance of foods and ensuring the reliability of data (Network Digital360 2019). The blockchain allows the creation of open supply chains in which all actors can provide data and information and control with maximum transparency.

Automotive

The automotive industry will experience a transformation in the next years. The increase of vertical integration and the advancements of the sharing economy and autonomous vehicles are shaping the sector. Blockchain and DLT are attractive to the industry. However, most of the companies are following a "wait and see" approach. The most transformative projects are related to supply chain integration, connection services, ride sharing, and services on-demand (Deloitte 2018). In the industry, the creation of wealth depends on contracts and transactions of goods and services in a network. The assets are exchanged in this network between the stakeholders. Therefore, the automotive sector can

benefit from the technologies to improve the cybersecurity system to maintain privacy and security in the transactions (Fraga-lamas and Fernàndez-Caramès 2019).

Telecom

Although traditional telecom operators have not so far significantly embraced Blockchain and DLT, these technologies could offer new and profitable services for their customers, improve the operation of networks and increase the security of transactions in telecommunications networks. in particular, much of the investment in this sector comes from innovative providers that offer applications directly to customers.

Utility

Companies are exploiting Blockchain and DLT to innovate and diversify their operations. Thanks to the usage of smart grids, it is possible, for instance, to exchange solar energy in a neighbourhood using applications developed on Blockchain and DLT platforms. It increases the knowledge about the provenance of the energy used and decrease the wastes, providing economic value.

Government

The number of projects, involving blockchain and DLT is growing and, with them, the number of services and possible benefits for citizens and for the public administrations themselves. The applications are related to document management and certification, identity management and the creation of cryptocurrency. The aim is to answer to the needs of specific local communities. There is the concrete commitment of local administrations and public administration institutions to develop blockchain-based ecosystems capable of enhancing and protecting the products of a specific territory.

Insurance

Blockchain and DLT can support insurance companies in accessing to secure and decentralized transactions, which provides a solid basis for fraud prevention, greater governance, better data and reporting. With Blockchain and DLT, insurers can also have

up-to-date and accurate notifications of changes, enabling them to improve risk management and maximise capital and fund opportunities, as well as the ability to adopt Big Data strategies, which are very useful for obtaining secure information about their clients, their priorities and preferences, as well as any additional information taken from third parties. From a technical point of view, insurers see the blockchain as an opportunity to integrate a third-party ecosystem to reduce the costs of their management platforms, while improving the customer experience and market share, and developing new solutions and opportunities. At the market level, insurers also have opportunities in the governance of their businesses, through improved data access, third-party controls and more sophisticated risk management systems, associated with their products and services, such as cyber insurance.

The above analyses shed light on the fact that Blockchain and DLT may impact in different ways the diverse industries.

Because of the complexity and novelty of the theme and its wide range of possible applications in the different industries, most of the articles and studies are focused on the impact that the technologies have on single sectors. Zhang and Wen (2017) focused on the IoT electric business model, whereas Holotiuk and colleagues (2017) on the Payment industry. Moreover, Nam and colleagues (2019) analysed the usage of Blockchain for the smart city. Montecchi and colleagues (2018) have analyzed the possible implications in the supply chain industry. Indeed, Blockchain can be used for traceability of products lowering the perceived risks of customers. Other fields of interest include logistic, healthcare, finance, etc. Poszler and colleagues (2019) have analysed a sample of 55 startups in the logistics industries which are using Blockchain and DLT. They examined the status quo of this ecosystem and the business models of these startups. The results stress the great potential of the growth of the technology in the logistics industry, by looking at the descriptive statistics and studying the perceived benefits brought by the technology.

As a disruptive innovation, Blockchain not only has the prospect of transforming the Financial industry, but also other sectors (Nofer et al. 2017). Another notable industry is

the “Information & Communication” sector. According to the research of Friedlmaier and colleagues (2017), the lack of standardization in the industry has brought to the development of many startups in the field.

Analyses that focus on the comprehensive set of implications that that technologies are bringing are few. Hughes and colleagues (2019) have reviewed, which are the possible implications for managers that Blockchain and DLT are bringing. Mainly, they analyzed the landscape of different sectors and explained how the technologies might be useful. The sectors are not limited to the financial one, but goes from government to energy, passing from the music industry. Blockchain and DLT are sector-agnostic solutions that can be deployed in almost all industries.

To conclude, it is a common thought that Blockchain and DLT can be deployable in different sectors. The question is to what extent they can be helpful and if there are any sectors in which they will be implemented the most.

As a result of the above considerations, a first hypothesis has been developed:

*HYPOTHESIS 1: Blockchain and Distributed Ledger Technologies are likely to develop more in some **sectors** than in others.*

3.3 Blockchain ventures’ characteristics

“How can firms utilize Blockchain features for their business processes?” (Risius and Spohrer 2017)

Much has already been said about the possible applications of Blockchain and DLT in the different sectors and which are the advantages that the technologies are bringing. However, most of the times, they are high-level considerations that do not rely on real use cases. Moreover, articles tend to focus only on industries without giving a panoramic of possible applications. Nofer and colleagues (2017), summarized in a table some applications of Blockchain and DLT, dividing the table between financial applications and non-financial applications (*figure 3.2*).

Type	Application	Description	Examples
Financial applications	Crypto-currencies	Networks and mediums of exchange using cryptography to secure transactions	Bitcoin Litecoin Ripple Monero
	Securities issuance, trading and settlement	Companies going public issue shares directly and without a bank syndicate. Private, less liquid shares can be traded in a blockchain-based secondary market. First projects try to tackle securities settlement	NASDAQ private equity Medici Blockstream Coinsetter
	Insurance	Properties (e.g., real estate, automobiles, etc.) might be registered using the blockchain technology. Insurers can check the transaction history	Everledger
Non-financial applications	Notary public	Central authorization by notary is not necessary anymore	Stampery Viacoin Ascribe
	Music industry	Determining music royalties and managing music rights ownership	Imogen heap
	Decentralized proof of existence of documents	Storing and validating the signature and timestamp of a document using blockchain	www.proofofexistence.com
	Decentralized storage	Sharing documents without the need of a third party by using a peer-to-peer distributed cloud storage platform	Storj
	Decentralized internet of things	The blockchain reliably stores the communication of smart devices within the internet of things	Filament ADEPT (developed by IBM and Samsung)
	Anti-counterfeit solutions	Authenticity of products is verified by the blockchain network consisting of all market participants in electronic commerce (producers, merchants, marketplaces)	Blockverify
	Internet applications	Instead of governments and corporations, Domain Name Servers (DNS) are controlled by every user in a decentralized way	Namecoin

Figure 3.2 - Blockchain and DLT applications (Nofer et al. 2017)

According to the industry, there are different types of utilization of the technologies and different product/service categories.

Furthermore, the potential of using Blockchain and DLT for cross-industry applications is also considered in the literature (e.g., Friedlmaier et al. 2018). However, it is not clear how the Blockchain organizations should enter this domain, operating among different industries impacting on specific processes of the clients. The researchers suggest studying the different methodologies of the use of Blockchain and DLT and new potential applications in various industries. Fenu and colleagues (2018) analysing the factors which impact on the success of an ICO, shows how companies offering products/services in the software category are more successful than others.

As previously stated, Blockchain and Distributed Ledger Technologies have the versatility to be used in different industries and for offering different product/service categories bringing benefits to various processes of the clients. For instance, Mendling and colleagues (2018) analyse the positive impact in the improvement of the efficiency in the BPM (Business Process Management) domain. Or, another example, “Blockchain technology can offer powerful solutions to enhance customers’ provenance knowledge by

providing a robust system to trace the origin, certifying authenticity, tracking custody, and verifying the integrity of products" (Montecchi et al. 2019). As Bucovetchi and colleagues (2018) stated, "most people refer to Blockchain only in terms of crypto-currencies, this technology has multiple applications." Moreover, a startup can focus on developing a new distributed ledger, on being the so-called dApp startups (developing distributed applications) or developing a new cryptocurrency or token.

The elements of this discussion led to the development of three other hypotheses:

*HYPOTHESIS 2: The Blockchain and Distributed Ledger Technologies are more likely to develop to improve some **processes** than others.*

*HYPOTHESIS 3: Some **business solutions** are more likely to be representative of the future of Blockchain and Distributed Ledger Technologies than others.*

*HYPOTHESIS 4: Blockchain and Distributed Ledger Technologies are more likely to develop for some **methodologies of use of Blockchain technology** than others.*

Besides, given the capacity to disintermediate existing services, another main use of Blockchain and DLT is the development of multi-target platforms. Therefore, the research will test another hypothesis.

*HYPOTHESIS 5: Blockchain and Distributed Ledger Technologies are likely to progress in the development and management of **platforms**.*

3.4 ICO and traditional funding methods

Since the ICO has received significant interest from researchers and practitioners, it is interesting to see whether the process of funding that allowed the startups to grow has an impact on the amount raised and, consequently, on the future of Blockchain and DLT. Moreover, as previously said, the analysis of the distribution of different types of

investments in the Blockchain startup ecosystem is a new field (Friedlmaier et al. 2018). What is of interest is also how traditional sources of funding and ICOs are bounded. For instance, associating ICO with crowdfunding, Ryu, and Kim (2016) stated that "getting funding from crowdfunding is less associated with the likelihood of follow-on venture capital investments." In the report issued by Strategy& in June 2018 (Diemers et al. 2018), it is shown how, for Blockchain startups and other technology companies, for ICOs the tendency is to raise more funds much higher than those coming from traditional investors such as venture capitals and business angels, probably due to the broader reach of the campaign.

*HYPOTHESIS 6: The **ICO** funding method is likely to have a greater impact on the future development of Blockchain, and Distributed Ledger Technologies compared to other funding sources.*

The differences between the sources of the investment, traditional and ICO, may lead to diverse results that have to be investigated. Particularly, this concern the analysis of sectors. Indeed, the sector to which the startup belongs seems to be an impacting factor in the different fundraising process. Giudici and colleagues (2018), Fisch (2019), and Ryu and Kim (2016) used dummy variables connected to the industry in a regression analysis to understand the factors impacting on the ICO and crowdfunding campaign. Prohorovs and colleagues (2019) recommend using the industry to understand the impact on the success of startup fundraising from venture capitals. The same resulted from the econometric analysis performed by Taraba and colleagues (2014). Who highlighted how "the industry appears to be essential for both investors and entrepreneurs." Finally, Yin and Luo (2018) present the market size and potential growth as a decisional criterion for investors to believe and invest in the future of a startup.

However, it is questionable if there are some sectors that are more attractive for ICO investors than for Venture Capitalists. Therefore, a last hypothesis has been identified.

*HYPOTHESIS 7: The **sector** in which the startup operates might have a significance in which **type of funding** method is received*

CHAPTER 4
RESEARCH METHODOLOGY

The comprehensive analysis of the literature sheds light on which are the main research gaps in the extant knowledge about Blockchain and DLT when considering their business applications. Mainly, it made clear that the best strategy to follow to predict the future of the technology is to make an empirical investigation of Blockchain startups and their funding.

In this section, the methodology that has been followed to make this investigation are described and, according to the main objectives of the thesis, divided into two different main sections:

1. **DATABASE: Data collection** and **categorization** of the Database of Blockchain and DLT startups.
2. **ANALYSIS:** section in which it is explained how the research questions have been answered:
    a. **Descriptive analysis** of the startup ecosystem: identification of patterns and trends.
    b. **Inferential analysis** to predict the directive of developments of Blockchain and DLT: the test of hypotheses.

4.1 Data collection and categorization of the Database of Blockchain and DLT startups

In this paragraph, the methods followed to collect the sample, relevant data, and their categorization are presented. First, it is described how rough information was collected.

Next, which were the additional information to obtain and, finally, how they were gathered.

4.1.1 Data collection of the Database of Blockchain and DLT startups

The phases of data collection and categorization have been made in collaboration with the "Osservatorio Blockchain and Distributed Ledger" of Politecnico di Milano. They provided the raw version of the database on which the census has been made.

The sample of Startups has been identified starting from Crunchbase and CoinDesk datasets by using the keywords "Blockchain," "Distributed Ledger," "Virtual currency," and "Bitcoin."

Crunchbase is an online database that collects data about the Startups ecosystem, with specific attention to entrepreneurs, financing rounds and locations. It has already been used as a principal source of data collection when dealing with startups in published scientific studies (Ghezzi et al. 2016; Zohu et al. 2016; Block and Sander 2009; Bertoni and Tykvova 2015; Croce et al. 2018; Cavallo et al. 2018). Moreover, Dalle and colleagues (2017) further suggest "that many more valuable avenues for economic and managerial research can be opened through the combination of Crunchbase with selected supplementary data sources." This consideration is explaining the usage of CoinDesk: a news web site specialized in Bitcoin and digital currencies active that has been active since 2013.

The filtering process started by considering only those startups that are born from 2014 to 2019. Precisely, the analysis is stuck at the moment of the extraction that is March 2019. Overall, 1467 startups were found. Already available data are:

- *Startup information*
  - Organization Name
  - Organization Name URL (on CrunchBase)
  - Organization's Website

- Founded Date
- Number of employees
- Company type (For-profit /Non-Profit)
- Founder
- Location

- *Financial information*
  - Last funding date
  - Last funding type
  - Total Funding amount in the national currency
  - Total Funding amount in the USD
  - ICO Funding
  - Number of funding round
  - ICO yearly funding amount
  - Traditional source of investment yearly funding amount

4.1.2 Collection and categorization of additional information

The orientation of this study is towards the business applications of Blockchain and DLT, the additional information to collect is chosen accordingly. They have been identified as key elements to disclose from the "Osservatorio Blockchain and DLT" and are here summarized:

- Sector
- Process
- Type of usage of Blockchain and DLT
- Blockchain and DLT platform
- Platform's access typology
- Type of client
- Headquarter Continent & Nation
- Brief description

Sector

The sector the startup is operating within has been considered as a key element since it may be useful to understand if there are some industries in which Blockchain and DLT are developing more than others. Main sectors were identified by "Osservatorio Blockchain and DLT" based on the most active ones in 2018 and are listed below in relation to the application of the technologies:

General purpose: startups that offer solutions that are cross-sectorial and, thus, can serve different sectors.

Finance: startups that leverage on Blockchain to increase the efficiency of the financial services offered by the principal financial institutions (bank, insurance...).

Virtual currency: startups that offer services that are deeply related with the usage of cryptocurrencies.

Media & Arts: startups whose focus is on the management of artistic and multimedia content, both physical and digital

Logistics: startups whose aim is to simplify and increase the efficiency of the exchanges among the different actors of the supply chain

Healthcare: startups offering solutions related to the healthcare sector, whose aim is to simplify the interactions between doctor and health facility with patients.

Utility: startups working in the public utility sector (energy, water...).

Telecom: startups focusing their business model on improving the existing solutions in the telecommunication sector.

Airline: startups that are trying to increase the efficiency of the booking of flight tickets and automatize the process.

Automotive: startups operating in the automotive sector to guarantee the provenance of their raw materials and to optimize the exchange in the supply chain.

Government: startups that are trying to offer solutions to governments such as self-sovereign identity or new voting systems based on Blockchain.

Insurance: startups offering solutions to improve the inefficiencies of the insurance sector.

Agri-Food: startups whose aim is to improve the trust towards to the agri-food industry and, in particular, the provenance of products.

Luxury: startups operating within the luxury sector to certify the quality of the products.

Other: all the sectors that have not shown to be enough relevant to be considered as a separate industry.

It is important to highlight that an additional category related to the sectors has been created and named "**sub-sector**." The aim was to collect more precise data about the industries startups were operating within to understand if, with the update of 2019, other emerging sectors were relevant enough to become stand-alone categories in the future analysis. In particular, the objective was to unpack the category "other" and identify its composition.

Process

The "Osservatorio Blockchain and Distributed Ledger" identified which are main business processes where Blockchain and DLT are impacting the most and are listed below:

Software development: startups that are trying to overcome the actual limitation of the Blockchain technology by proposing new and improved protocols to offer Blockchain and DLT as a service.

Data & Document Management: startups that optimize the management of data by leveraging the characteristics of transparency and immutability.

Identity: those solutions that are focusing on creating self-sovereign identities or facilitating the recognition of the traditional ones.

Capital Markets: a process that refers to the issue and negotiation of financial securities (e.g., purchase and sale of shares, issue of bonds, purchase, and sale of derivatives, etc.)

Payment: startups that are trying to offer new and improved solutions for digital payment.

Advertising Management: focusing on the management of intellectual rights and/or advertising campaigns.

Tracking & Supply chain: solutions that aim to improve the traceability of products and the optimization of the exchange in the supply chain.

Exchange & Trading: startups that are offering solutions, not related to investment, for exchanging virtual currencies in fiat.

Voting: solutions that refer to the certifiability of a correct voting process

Property Registry: solutions that refer to the optimization of the registration of property-related documents by leveraging on the characteristic of immutability and transparency, issuing certifications of properties and their traceability.

Supply Chain Finance: the set of solutions that allow a company to finance its working capital (credits, debts, stocks).

Wallet: solutions focused on the storage and management of cryptocurrencies.

Lending/Crowdfunding: solutions that are focusing on giving access to credits to people who cannot with the traditional sources and at increasing transparency in the lending and crowdfunding process.

Other: all those processes that were not relevant enough to make a stand-alone category

As it was done for the industry analysis, an additional category related to process has been created and named "**sub-process**." The aim is still to collect more precise data about which are the main processes and to provide, with the update of 2019, a more comprehensive overview.

Type of usage of Blockchain and DLT

As far as concerned, the type of usage of Blockchain and DLT, "Osservatorio Blockchain and DLT," outlined five different ways of implementing solutions leveraging on namesakes' technologies. They are categorized based on the platform they are leveraging on, resulting in two classes:

- Solutions that are developed on extant platforms:
    - *Notarization*: projects that use the distributed register of an existing platform to certify the date of a document and the fact that it has not been changed over time. The mechanism is guaranteed by the use of hashing functions that allow users to trace an entire document to a hash (alphanumeric code of fixed length). Any modification to the original document would generate a hash that, if compared with the one originally published on the Blockchain, would be different.
    - *Smart Contract / Dapp*: include solutions that use smart contracts and leverage existing networks and their features to create decentralized applications. Some of these solutions may include token creation.
    - *Cryptocurrency*: projects that exploit existing cryptocurrencies or create new ones to allow the exchange of value between actors who do not trust each other. The presence of a unique asset within the platform is fundamental.
- Solutions that need the development of a new platform:

- *DLT permissioned*: projects that concern the creation of a new platform based on a register distributed among several actors who do not trust each other but who can then modify the register independently according to the consensus mechanism used. These projects require the development of new platforms that also allow for digitizing processes and exploiting the programmability of smart contracts, but without introducing unique assets for the management of transfers and maintaining in some cases confidential transactions between network participants.
- *DLT permissionless:* Projects in which a new platform is created consisting of a network of nodes and an immutable and distributed registry for sharing information between many actors who do not trust each other. Unique assets are transferred, and it is possible to schedule transactions and create smart contracts.

The last category was represented by those startups that were related to Blockchain and DLT, but they were not leveraging on these technologies in their business model. Examples are represented by solutions that give insights and comparisons about the existing platform or are promoting investment and supporting the technologies. They were accounted for in "*no direct use of Blockchain*."

Blockchain and DLT platform

Basing on the analysis of the previous year, the most used platform identified are:

- *Bitcoin*: Bitcoin is a system for electronic transactions based not on trust but on a peer-to-peer network. It is, therefore, a permissionless distributed ledger whose transaction log is modified by the network nodes with a consent system that uses proof of work. Bitcoin also supports its solution Bitcoin script, which is a language that allows users to program some simple operations
- *Ethereum*: Ethereum is a decentralized platform born in 2014, which enables users to run a smart contract through a Turing-complete programming language, thus overcoming some limitations imposed by Bitcoin. The platform evolutionarily

manages smart contracts, allowing developers to program with Solidity language and creating decentralized applications. Money exchanges are instead managed in Ether, the platform's cryptocurrency.

- *Hyperledger*: Project started by the Linux foundation in collaboration with IBM to support the creation of Blockchain Permissioned and encourage the collaborative development of Distributed Ledger Open source.

For all those startups that were not leveraging on these platforms, three different sets were possible:

- *Other*: startups that were leveraging on existent Distributed ledger platforms that have not been considered among the principals (e.g., Iota, Ripple, Quorum, etc.)
- *Various Blockchain*: those startups that were not related to a particular Blockchain but were leveraging on different platforms. For example, when they were offering the exchange of cryptocurrencies or the possibility to implement different Blockchain platform as a service.
- *New Blockchain*: Startups that were developing new protocols to improve the actual limits of the existing platforms and proposing their innovative architectures.

Platform's access typology

Depending on how users access the registry and who can add information, the distributed ledgers are divided into permissionless and permissioned.

- *Permissionless:* Distributed ledger platforms in which anyone can take part, freely carrying out any activity, where the content of the register is public and available to all. It requires the presence of native assets to regulate consent and manage the incentive system.
- *Permissioned:* Distributed ledger platforms where to access the network, it is necessary to register and identify oneself and therefore be authorized by a central network or by the network itself.

Type of Client

According to the type of client the business solution is addressing, this category is divided in:

- *B2C*: when the business application of Blockchain and DLT are targeting the final users.
- *B2B*: when startups are offering Blockchain as a Service to businesses to make them innovate their business models.
- *Platform*: it concerns the development of new platforms that connects the demand and supply side of a particular service. Solutions that involve the development of a platform that may target both customers and business sides are also considered here.

Headquarter continent & nation and a brief description

Considering the research objectives, the geographical position of the startup was considered a key element. Indeed, it was needed to categorize the available data better and discern, which was the continent and the nation the startup was coming from. Finally, a brief description of the startup is added among the categories focusing on the usage of Blockchain and DLT in their business model.

4.1.3 Methods to collect additional information

Overall, the phase of the census of additional data and not disclosed ones on Crunchbase and CoinDesk lasted from March to September 2019. Secondary information has been used to collect these data, and they are categorized in:

- Information disclosed by the startup itself
    - *Whitepaper*: is a document that is used by the company to present in detail the solution to a problem, the benefits of a product or service offered, the analysis of a market segment or an utterly innovative technology, such as Blockchain and DLT

    - Startups' websites
    - Social Network: LinkedIn, Facebook and Twitter pages
- Information disclosed and categorized by others
    - News
    - Specialized websites in data collection of Blockchain startups: ICObench.com and Cryptototem.com

After the filtering process, 180 startups were discarded because of different reasons: failure, scam, not enough information where available, or they were entirely not related to Blockchain and DLT. The result is a census of 1287 startups for which most of the information was disclosed.

4.2 Analyses

The objective of the analysis is to predict the directives of the development of Blockchain and DLT through the study of a database of globally operating startups. Therefore, the analysis section is divided into two parts:

- *Descriptive analysis*: it is giving an overview of the ecosystem of startup studied with particular attention to the research questions identified. Furthermore, it aims at identifying trends and confirming the significance of the hypotheses tested.
- *Inferential analysis*: it is giving insights about the directives of development of Blockchain and DLT and, thus, showing how hypotheses are tested.

4.2.1 Descriptive analysis

The descriptive analysis is used to describe the characteristics of the ecosystem of startups. The purpose is to understand how Blockchain and DLT startups are operating to identify relevant trends about the innovation path of the technologies. Therefore, the way the analysis is conducted recall the points that were raised in the literature review. Each topic is analyzed considering both the occurrences of startups and their level of investment:

- Diffusion of innovation: rate of adoption

    - Yearly distribution
    - Geographic distribution
- Business application
    - Industries
    - Processes
    - Business Solutions: cross-analysis of Sector and its principal processes identifies which are the main solutions for which startups are leveraging Blockchain and DLT.
- Technology-focused
    - Type of usage of Blockchain
    - Platform
    - Type of client
- Comparison of ICO and Traditional source of investment
    - Industries
    - Processes

Each analysis will be divided into two main parts:

1. *Description of the results*: it is merely describing which are the result of each analysis focusing on numbers and percentages
2. *Consideration of the results*: the key takeaways and trends that each analysis exhibits are identified and will represent the basis for the inferential analysis.

It is important to highlight that in order to gather a better understanding of possible trends, further considerations on the sample have been made:

- *Financial analysis*: the startup Block.one (EOSIO) was able to raise alone more than $ 4 billion. Such a high value for its ICO is partially explained by the fact that EOSIO is expected to be one of the open-source Blockchain protocol with industry-leading transaction speed and flexible utility. Being an outlier, the startup will not be considered in the financial analysis of the next sections

- *Yearly trend analysis*: since the analysis is performed on a sample that was extracted in March 2019, the considerations about this year are not significant. Indeed, the 11 startups born in 2019 are not considered in the yearly analysis.

4.2.2 Inferential statistics

Inferential statistics implies the analysis of a sample of observations to delineate inferences on the observed population. It is a tool to define the correlation between variables. It can be used to test hypotheses, creating models for predicting and drawing future patterns, which might be useful to provide insights on the evolution of Blockchain and Distributed Ledger Technologies.

For this research, the multiple linear regression model will be used. It compares one dependent variable with a set of independent variables (continuous or categorical).

All the steps of the analysis will be performed by combining the use of Microsoft Excel and Minitab.

Multiple linear regression model

Models are a mathematical representation of reality. The study of multiple regression consists of determining a model that best expresses the link (on average) between the independent variables X1, X2, ..., Xk, and the dependent variable Y. It is necessary to begin by establishing the type of function that binds the dependent variable to the independent variables. The multiple linear regression is the obvious generalization of simple linear regression when we have more than one explanatory variable.

For this research, since the independent variables are all categorical variables, dummy coding will be used to create a regression model. (Alkharusi 2012)

$$Y_{ij} = B_0 + \sum_{j=1}^{k-1} B_j D_{ij} + \varepsilon_{ij}.$$

- Y represents the value of the dependent variable.

- D are the values of the independent variables.
- B0 is the constant, which represents the value of the coefficient associated with the reference category. Hence, it is the mean of the baseline category considering all the dummy variables.
- B represents the regression coefficients associated with each dummy variable. They are the difference between the average of the level associated with 1 on the dummy variable and the mean of the category associated to 0 on all the dummy variables.
- εi is the "unexplained residual."

Data filtering and dependent variables

From the literature review, the investments received by a startup are considered in the analysis as the dependent variable. The aim is to measure quantitively a qualitative factor, the innovativeness of the Blockchain and Distributed Ledger Technologies, as previously stated in the literature review chapter. Three databases have been extracted. The first one considering the total amount raised in dollars by each startup. The second, considering the observations where the amount raised, came exclusively by ICO. The last one considering the startups, which had been funded exclusively through funding sources different from the ICO. All of them are continuous variables.

For the scope of the analysis, the observations have been filtered. The startups which did not receive funding have not been considered in the analysis. For many of them, there was uncertainty on the data gathered. Besides, the value we are interested in is the amount of investment received and who the investors were, not whether a startup has received funding or not. Block.one has not been included as it received $ 4.2 billion in ICO, which represents 32.4% of the total amount of funding of all startups.

Furthermore, all those startups which did not explicitly use the Blockchain and Distributed Ledger Technologies have been removed. The analysis is therefore carried out on 951 observations in total. 721 received funding only from traditional sources, 173 only from ICO. The remaining startups (57) received funding from both sources.

To analyse the differences between startup funded through ICO and other sources of funding, these 57 startups have been inserted in the first two categories defining the first type of investment received. Consequently, there are three distinctive databases for each dependent variable:

- Total funding amount: 951 observations
- ICO: 186 observations
- Traditional sources: 765 observations

The distribution of the three dependent variables is highly skewed. It is an inverse logarithm distribution. Hence, a logarithmic transformation to make values more manageable is conducted. It will consider the skewness of the distribution (e.g., Fisch 2019; Block, 2018).

Independent variables

The independent variables selected to enter in the model followed the hypotheses development of the literature review. They are all categorical variables: sector, process, the methodology of use of the Blockchain, type of client, type of funding. The variables have been thoroughly described in previous paragraphs. However, some of those categorical variables are composed of many levels. To increase the comprehensibility of the results and to test the hypotheses, the variables have been dummified. Since the categorical variables are attributes, mutually exclusive, and collectively exhaustive, they can be transformed into a set of dummy variables. The dummification is a coding method, it is related to how it is showing the group membership. A categorical variable with k levels can be divided into k-1 categories, and each category becomes a dummy variable with a numerical value. This transformation is necessary to enter in a regression model. All the observations belonging to a category will be labelled with 1 if observation does not belong to a category the corresponding dummy variable will have 0 as value.

To improve the quality of the results, due to the high number of categories, they will be reduced in number via the grouping process. First, some levels of the categorical variables “Sector,” “Process,” and “Methodologies of use of the Blockchain” will be grouped to

improve the quality of the predictive models. The reason for grouping levels is that the performance level of the model may be pulled down by a categorical variable with too many levels. Moreover, if a categorical variable presents levels that rarely occur, this level has a low chance of making a meaningful impact on the model. Besides, one level of a categorical variable may occur very often; this would lead to a very low variation, which has not a positive impact on the model. To group levels, there are some alternative ways:

- Business logic: The grouping is performed based on the knowledge of the field and on experience.
- Frequency: By looking at the frequency distribution of each level, grouping together the levels having occurrence below 5% of the total.
- Regression coefficients: To group the levels looking at the impact on the response variable. However, since some levels may have low occurrences, they do not represent a significative set. Hence, at first, the business logic and the frequencies will be used.

Once grouped, the categorical variables have been dummified. They will be presented in detail in the inferential statistics section. The reference level for each categorical variable has been decided according to what we are interested in comparing the most.

Reference levels

The choice of the reference level is crucial to be able to read the results of the multiple regressions while using categorical variables. Minitab will show the coefficients of the dummy variables of a categorical variable in comparison to the category picked as a baseline level. Moreover, the significance of the result (the P-Value) will depend on the reference level too. What makes sense is to choose the variable which leads to an easier interpretation of the results. There are different strategies:

- Normative group: by using business logic.
- The group size: if there is not a most logical category to use, the largest category is picked.
- The category with the mean in the middle: this is the last strategy to use.

Thanks to the grouping of the variables and the hypotheses developed through the literature review, it has been possible to use the "Normative group" strategy, which is the most effective.

Control variables

A control variable enters a regression in the same way as an independent variable. However, the interpretation is different. Control variables can be variables that you are not particularly interested in, but that are related to the dependent variable. In this case, you want to remove their effects from the equation. Alternatively, they can be variables for which it is assumed to exist a cause-effect relationship with the dependent variable, but that are introduced because of other analyses performed in this research.

The potential problems of multiple linear regression are:

- ENDOGENEITY: it occurs when a variable, observed or unobserved that is not included in our models is related to a variable we incorporated in our model. The independent variables have been chosen from a thorough analysis of the literature. There is no reason to suspect the existence of a factor impacting on both the dependent and the independent variables.
- REVERSE CAUSALITY: Simultaneous causal distortion occurs in a regression when, in addition to the causal link of interest from an independent variable to the dependent variable, there is a causal link between the two. This inverse causality makes the independent variables correlated with the statistical error in the regression of interest. To test the reverse causality panel data will be necessary. The limit of the research is the novelty of the field. There is not a significant sample of past observations that would adequately test the presence of a simultaneous casual distortion.
- OMITTED VARIABLE: Distortion from omitted variable arises when a variable from regression is omitted, which is a determinant of the dependent variable and is related to one or more of the regressors. From the literature analysis, some variables impact at the macroeconomic level. They will be considered while

deciding the control variables. If the omitted variables are not considered, there is the risk of having false estimators of the effectiveness of the model. The method of the least squares OLS (Ordinary Least Square) would produce inconsistent estimates, it serves to give validity to the model.

- HETEROSCEDASTICITY: The distribution of residuals must be normal. This characteristic can arise, especially when the range of observed values is broad. It is tested through the test of equal variances. It is an assumption of the model, if not respected the quality of estimators such as the OLS is compromised. It will be tested once the best predictive model is selected.
- OVERFITTING: The model adapts to not significant variables. Leading to incorrect coefficients and predictions. It will be solved by filtering the variables which show to be significant with respect to the dependent variable.
- MULTICOLLINEARITY: Multicollinearity arises when there is a high correlation between two or more explanatory variables. In a regression model Y= X1, X2, X3, if X2 is a linear transformation of X1, and therefore there is a relation of the type X2 = a + bX1, the two variables are perfectly correlated.
- ESTIMATED REGRESSORS: Some independent variables cannot be observed, and they are required to be estimated to have a high -quality model. In this case, all the observations have been empirically performed.

As previously mentioned, some omitted variables may exist, especially because the purpose of the model is to predict the innovativeness of the technology through startups and their funding. Therefore, some macroeconomic factors are considered, and potential control variables included: the location and the number of funding rounds undertaken by the startups.

Multiple linear regression: dependent variable total funding

The lines below will show the steps of the multiple linear regression. It is essential to know that they will be performed for the three dependent variables. The total funding amount raised will be used to test all the hypotheses (next paragraph), except one and, the

other two, ICO and traditional funding, will be compared to check the diversity in the results concerning the sectors (*hypothesis 7*).

First, the descriptive statistic of the set of variables participating in the model will be performed. It will show whether there is a balance among the different variables. Moreover, the number of observations is reminded. An example of how the descriptive statistics will be showed is provided in the table below (*Table 4.1*). Here a continuous variable and a dummy variable are showed.

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
Funding_rounds	951	0	1,7171	0,0393	1,2117	1	1	1	2	10
Sector_Finance	951	0	0,1767	0,0124	0,3816	0	0	0	0	1

Table 4.1 - example of descriptive statistics

Second, the correlation matrix will be presented. To check the absence of strong multicollinearity between the various dummy variables. The multicollinearity will be tested using a correlation matrix among the independent variables. *Table 4.2* shows an example of a correlation matrix among three independent variables. A correlation greater than 0.7 in absolute values will be considered as strong, hence as confounding. It would require the removal of one of the variables from the model. Because the presence of multicollinearity would spoil the results. If the correlation is lower than 0.7 but greater than 0.3, a moderate correlation is identified. Therefore, it is necessary to test the multicollinearity through other methods. By analyzing the variability of the coefficients testing the different combinations of variables to build the best-fitting predicting model, and by observing the value of the VIF (variance inflation factor), the quality of the model is preserved. The VIF should be smaller than 10. Otherwise, the multicollinearity exists in the model.

Seeing *Table 4.*3, the VIF is showed among the results of the multiple regression in the last column. In the example, all the VIFs are smaller than 5. Hence, we cannot assert the presence of multicollinearity.

	1	2	3
Sector_Finance (1)	1		
Funding_rounds (2)	0,015	1	
Sector_General Purpose (3)	-0,274	0,073	1

Table 4.2 - example of a correlation matrix

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	14,043	0,138	101,9	0	
Sector_Finance					
1	0,706	0,224	3,15	0,002	1,81
Sector_General Purpose					
1	0,724	0,186	3,9	0	1,64
Sector_Media & Arts					
1	0,567	0,241	2,35	0,019	1,33
Sector_Virtual Currency					
1	0,241	0,188	1,28	0,201	1,63

Table 4.3 - example of regression results (focus VIF)

Third, the best fitting model must be selected. Hence, the multiple regressions will be performed for each categorical variable, and the most performing combination will be left in the model. The control variables will be left in the model due to their purpose of reducing the negative impact of the omitted variable problem. This will be an additional step used to monitor the presence of multicollinearity in the model by analysing the variability of the coefficients testing the different combinations and the value of the VIF (variance inflation factor). The table below shows an example of how the comparison between the different models will be performed (*Table 4.4*).

	MODEL 1				MODEL 2			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
			...					
R2	0,115				0,1038			
R2-adj	0,1066				0,0933			
R2-pred	0,0954				0,0802			

Table 4.4 - example of comparison between regression models

Fourth, heteroscedasticity is tested analysing the distribution of the residuals. Therefore, if the distribution is highly normal (p-value < 0.005), the variability of errors is assumed constant for each value of the dependent variables. Finally, the coefficients and the significance of each dummy variable will be presented through the best fitting multiple linear regression model.

Interpretation of the parameters in the model:

In the multiple regression model, it is assumed that each observed value of the dependent variable can be expressed as a linear function of the corresponding values of the explanatory variables, plus a residual term that translates the model's inability to reproduce precisely the observed reality. Since the partial regression coefficients are expressed in the same metric (they are pure numbers), we can determine their relative ability to explain the dependent variable. Consequently, the independent variable with the highest value of the Beta coefficient has the highest impact on the dependent variable Y.

To understand which combination of explanatory variables provides the best fitting model, the R2 (multiple determination index) is used. It indicates the amount of deviation (variance) of the dependent variable Y explained by the linear relationship with the explanatory variables. In a regression model with dummy variables, "it can be interpreted in terms of the proportion of variance in the dependent variable that is accounted for by the categorical independent variable" (Alkharusi 2012). R2 can be considered as a measure of the closeness of fit of the regression to the observed points. The closer to 1 is the value of R2, the smaller is the dispersion of the points around the regression, and the better will be the adaptation. However, R2 has some limitations. Every time a variable is added to the model it will increase, excluding the opportunity to compare different models.

Furthermore, the overfitting in the model is not considered by this parameter. Hence, R2-adj (R2 adjusted) is used to understand the quality of the model. It considers the numerosity of the independent variables. If an explanatory variable is added to the model, R2-adj will increase if the prediction capability of the model increases more than how much would have increased by chance and vice versa. Besides, Minitab provides another parameter, R2-pred (predictive R2). It is similar to R2-adj, however, it considers also the

multicollinearity in the model. It compares the quality of the models by removing one by one the observations and comparing the results. When the difference between R2-adj and R2-pred is high, the multicollinearity is negatively impacting the results of the multiple regression.

The best-fitting model will be decided to look at the R2-adj and R2-pred, as stated previously. The most desired result is to have in the model all the explanatory variables listed in the hypotheses developed in the literature review chapter. Once it is defined, the results are reliable and can be used to draw inferences to negate or confirm the hypotheses developed.

Hypotheses testing

The testing of the hypotheses will be performed first by looking at the P-Values:

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	14,043	0,138	101,9	0	
Sector_Finance					
1	0,706	0,224	3,15	0,002	1,81
Sector_General Purpose					
1	0,724	0,186	3,9	0	1,64
Sector_Media & Arts					
1	0,567	0,241	2,35	0,019	1,33
Sector_Virtual Currency					
1	0,241	0,188	1,28	0,201	1,63

Table 4.5 - example of regression results (focus on p-value)

To understand the significance of the results:

- P-value < 0.01: highly significant
- P-value < 0.05: significant

- P-value < 0.1: lowly significant

The results obtained from this analysis will be used to understand which categories is possible to test the hypotheses. The significance means that the null hypothesis (the relationship between the variances is null) is rejected. Therefore, it is possible to argue that the single category is related to the reference level.

To wrap up, if the P-Value is lower than 0.1, the category can be labelled as significant; hence, the hypotheses can be tested according to the relative value of the coefficient.

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	14,043	0,138	101,9	0	
Sector_Finance					
1	0,706	0,224	3,15	0,002	1,81
Sector_General Purpose					
1	0,724	0,186	3,9	0	1,64
Sector_Media & Arts					
1	0,567	0,241	2,35	0,019	1,33
Sector_Virtual Currency					
1	0,241	0,188	1,28	0,201	1,63

Table 4.6 - example of regression results (focus on coefficients)

Hypotheses 1,2,4,5 and 7: Once all the hypotheses will be tested, sum up the results, a graphic framework showing which the directives of innovation of the Blockchain and Distributed Ledger Technologies are, will be presented.

Hypothesis 7: The categorical variable "Sector" will be used to compare the results of a multiple linear regression model developed with the dependent variables "ICO funding" and "Traditional funding." To guarantee the completeness of the analysis, the regression will be performed changing the reference level in turn.

Hypothesis 3: An additional categorical variable, "Business solution," will be introduced. It will be tested singularly in a multiple linear regression model.

CHAPTER 5 DESCRIPTIVE ANALYSIS: The ecosystem of Blockchain and Distributed Ledger Technologies Startup

In this section, a descriptive analysis of the database is performed. The objective is to understand how Blockchain and DLT startups are operating in order to identify relevant trends about the innovation path of the technologies. Therefore, according to the main points raised in the literature review, it can be divided into four principal parts:

1. Diffusion of innovation: Blockchain and DLT
2. Business applications: Industries, Processes and Business Solutions
3. Technology-focused: Type of usage of Blockchain and DLT, Platform and Type of Client
4. Comparison of results of ICO and Traditional source of investment

N.B: A detailed description of the framework used for the analysis and the explanation of the different categories is provided in the methodology section.

It is important to highlight that in order to gather a better understanding of possible trends two filters are applied on the sample:

- *Financial analysis*: the startup Block.one (EOSIO) was able to raise alone more than $ 4 billion. Such a high value for its ICO is partially explained by the fact that EOSIO is expected to be one of the open-source Blockchain protocol with industry-leading transaction speed and flexible utility. Being an outlier, the startup will not be considered in the financial analysis of the next sections

- *Yearly trend analysis*: since the analysis is performed on a sample that was extracted in March 2019, the considerations about this year are not significant. Indeed, the 11 startups born in 2019 are not considered in the yearly analysis.

5.1 Diffusion of Innovation: Blockchain and DLT

In this paragraph, the current rate of adoption of Blockchain and DLT are analyzed. First, a comprehensive overview of the database and the distribution of the investments is provided. Yearly distribution of the birth of the startup follows. Finally, the geographical distribution of Blockchain and DLT startups is presented.

5.1.1 An overview of startup operating with Blockchain and DLT and the amount of investments

This census includes all the startups born after 2014 that are somehow related to the Blockchain technology. Overall, due to the limitations mentioned in the methodology section, 1467 startups were analyzed. From this sample, 180 startups are discarded because of different reasons: failure, spam, not enough information was available, or they were not related to the Blockchain.

The result is an analysis of **1287** startups that have raised in total $ **12,96 billion**. As shown in *figure 5.1*, the total amount of funds raised varies a lot depending on different factors, such as the source of investment. Indeed, the 174 startups that relied on Initial Coin Offering (ICO) as a source of financing raised $ 43,1 million on average compared to $ 5,1 million for the 744 startups that went for a traditional source of investment (Venture Capital, Business Angel, Equity crowdfunding...). Furthermore, 55 startups relied on both sources of financing and raised $ 1,63 billion. Finally, 314 did not gain access to any particular fund, or information about them was not disclosed.

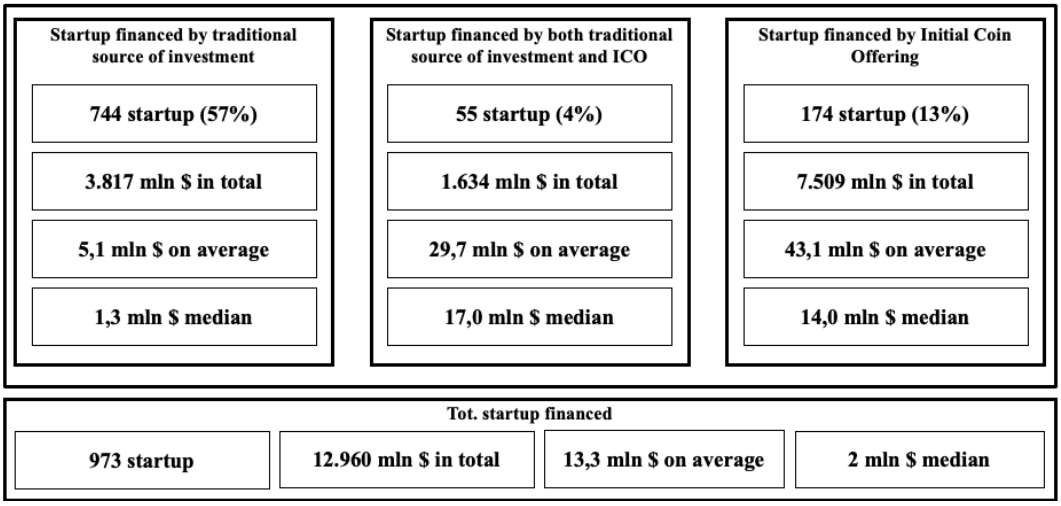


Figure 5.1 - The total distribution of investment in Blockchain and DLT startups

As stated in the methodology, from now on, the startup Block.one (EOSIO), which was able to raise alone more than $ 4 billion, will not be considered in the financial analysis of the next sections. The distribution of investment is, clearly, impacted by this decision and updated data are summarized in *figure 5.2*.

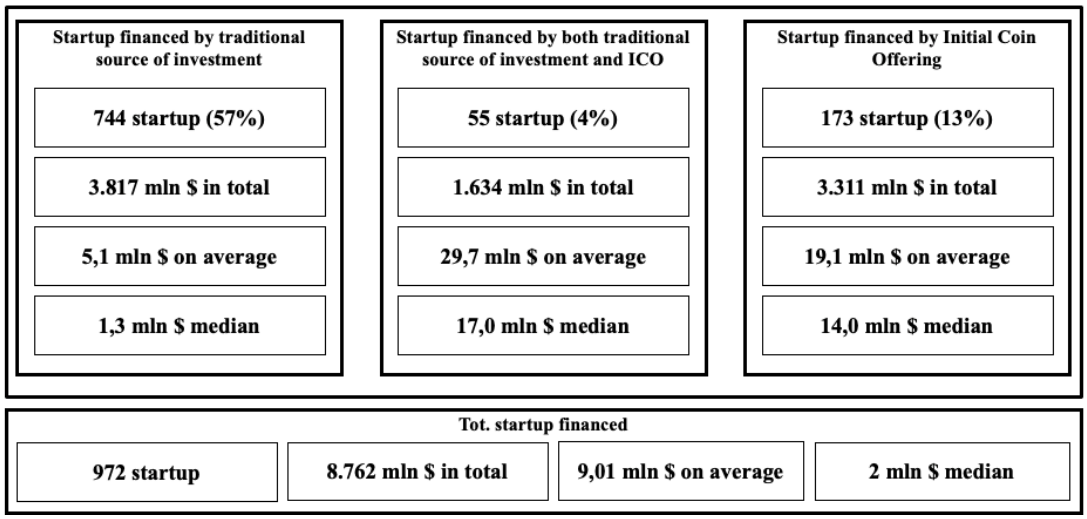


Figure 5.2 - The total distribution of investment when excluding the outlier Block.one (EOSIO)

The total amount of funds raised seems to be impacted by the source of investment to which the startup gains access. Indeed, those relying on ICO has an average value that is almost four times higher than those relying on traditional funding. However, when looking at the numbers of startup funded, traditional investments are still more widespread than ICO representing more than half of the sample.

5.1.2 The distribution of startups over the years

First, the distribution of the birth of startups over the years from 2014 to 2018 is considered (*chart 5.1*). It is important to remember that, as stated in the methodology, the number of startups born in 2019 is not considered because the sample has been collected until March 2019, resulting in a low value of 11 startups.

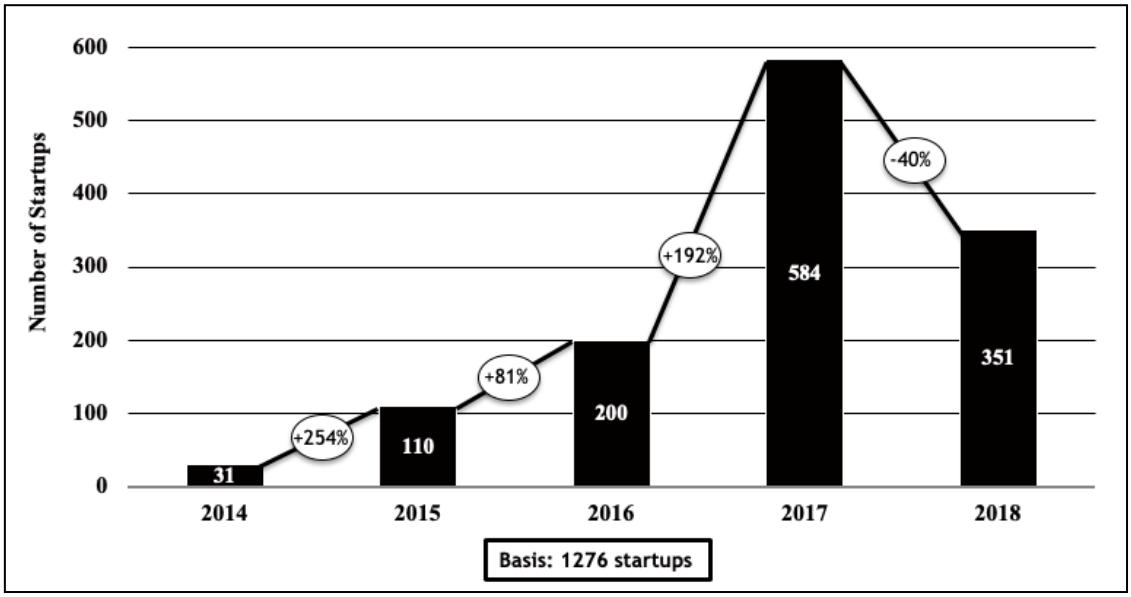


Chart 5.1 - The distribution of the birth of Blockchain and DLT startups over the years from 2014 to 2019

Overall, from 2014 to 2017, a sharp increase in the number of Blockchain and DLT startups born has been registered. Indeed, the number of births increased from 31 to 110 in 2015. A year later, the number of startups born has almost doubled reaching a value of 200. The peak has been reached in 2017, where the number of births represents almost half of the total sample, with a value of 584 startups. Finally, a lower, but still very high, value has been registered in 2018 when 351 startups are born. Indeed, from 2017 to 2018, the number registered a decrease of 40%. Secondly, the cumulative number of startups operating with Blockchain and DLT are outlined (*chart 5.2*). As emerged in the previous analysis, the cumulative curve of startups adopting Blockchain and DLT has experienced intense growth.

In the next years, further growth in the number of startups operating with Blockchain technology may be expected.

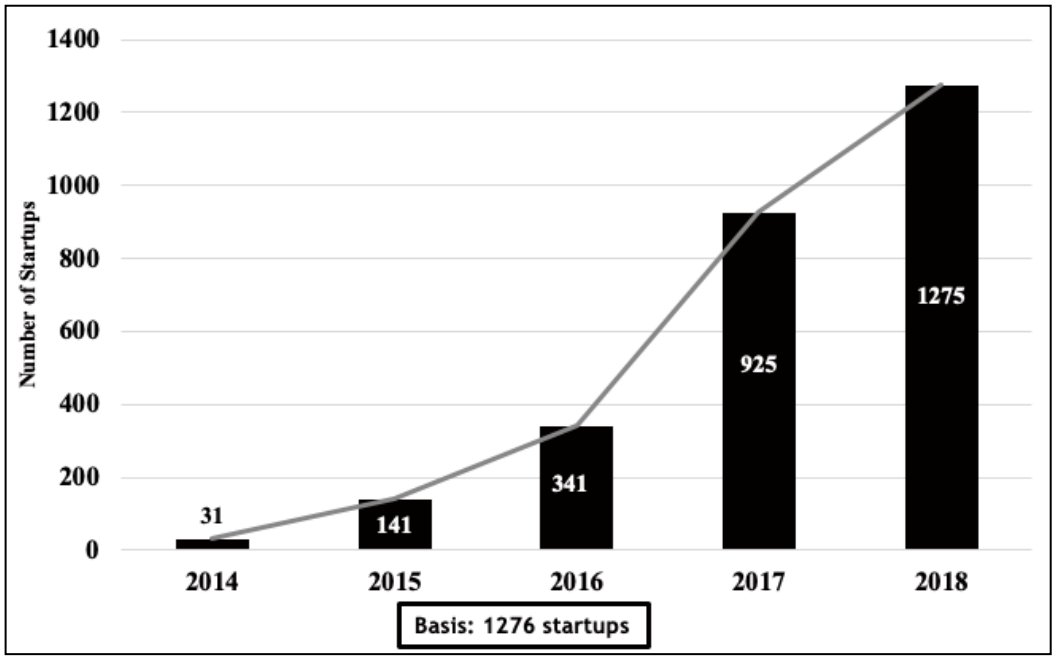


Chart 5.2 - The cumulative amount of Blockchain and DLT startups operating from 2014 to 2018

5.1.3 The geographical distribution of startup

The geographical distribution of the startups by *continent* and by *nation* are here analyzed in order to understand where the technology is developing the most. Precisely, for each continent and nation, it is considered the percentage of the total startup, the total funding amount raised, and the average amount of funding raised for each startup.

The geographical distribution by continent

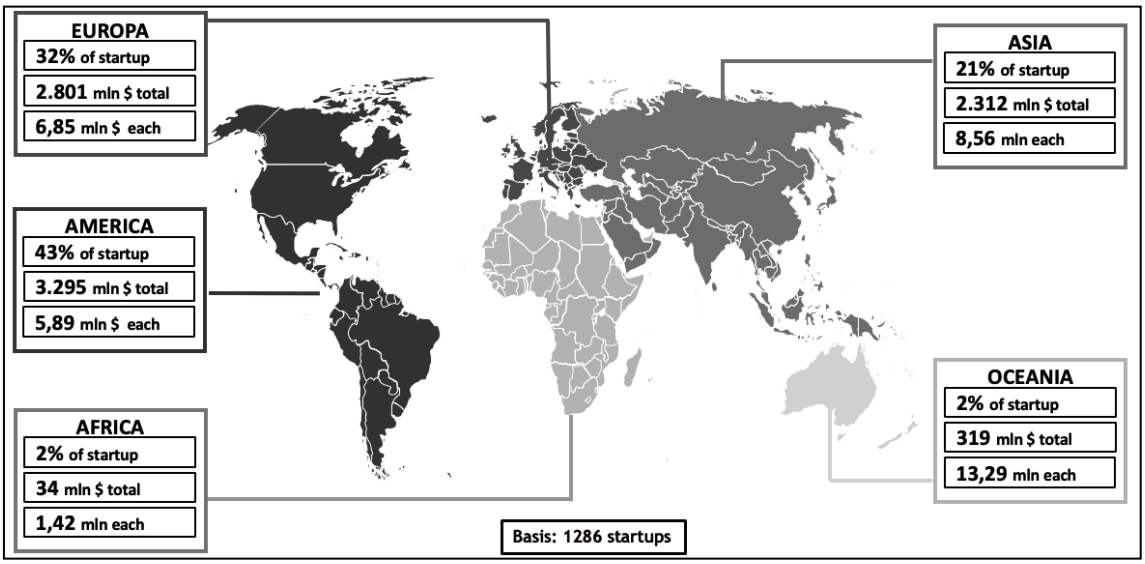


Figure 5.3 - The geographical distribution of startups and investments by continent

The results of the geographical distribution by continent are shown in *figure 5.4*. Overall, the geographical distribution of startups by continent shows that **America** is the most active, with 43 % of the total startups born in the last five years located there. It is followed by **Europe** and **Asia**, that account respectively for 32% and 21% of the total amount. The remaining 4% is equally divided between **Oceania** and **Africa**. The situation is similar when considering the total amount of funds raised, with America in the leading position with $ 3,29 billion, followed by Europe and Asia that raised respectively $ 2,80 and $ 2,32 billion. Finally, Oceania and Africa are still in the lowest place with amounts that do not even reach $ 1 billion.

When considering the average amount of funds raised for each startup, if, on the one hand, **Africa** remains in the lowest position, on the other hand, **Oceania** is the continent with the highest value with $ 13,29 million. **Asia** and **Europe** are still ranked in a good location, with $ 8,56 and $ 6,85 million, respectively. Finally, **America** is only in the fourth position, with a value of $ 5,89 million raised for each startup.

The geographical distribution by the nation

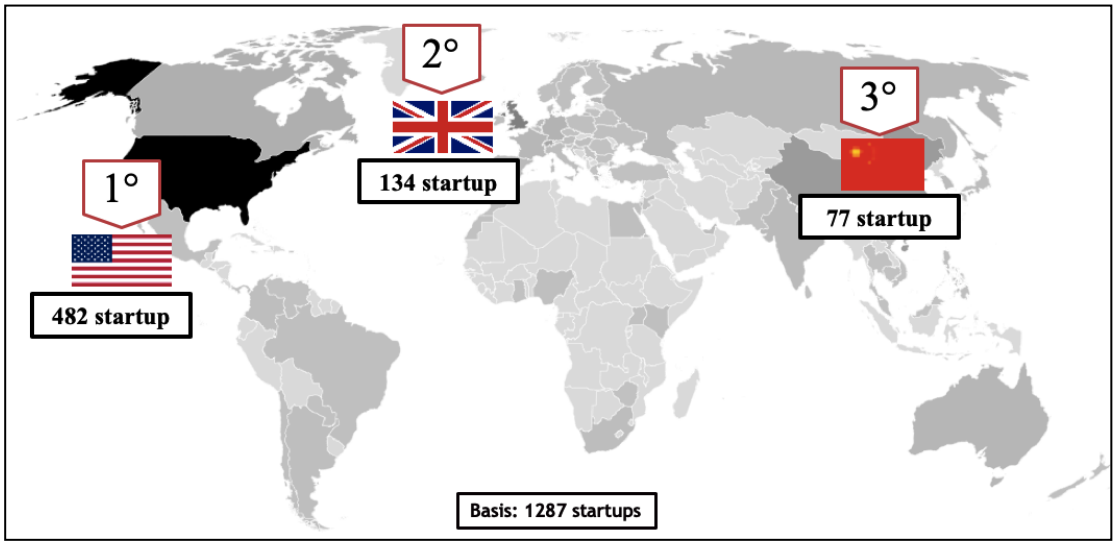


Figure 5.4 - The geographical distribution of startups and investments by the nation

NATION	TOT STARTUP ↓	% STARTUP	TOTAL FUNDINGS	AVERAGE FUNDING FOR STARTUP
US	*482*	37,48%	$2.665.485.395,00	$5.530.052,69
UK	*134*	10,42%	$553.180.366,00	$4.128.211,69
China	*77*	5,99%	$712.462.682,00	$9.252.762,10
Singapore	*68*	5,29%	$720.340.519,00	$10.593.242,93
Switzerland	*55*	4,28%	$1.103.877.962,00	$20.070.508,40
Canada	*36*	2,80%	$237.063.061,00	$6.585.085,03
Germany	*30*	2,33%	$132.587.099,00	$4.419.569,97
Hong Kong	*29*	2,26%	$168.339.402,00	$5.804.806,97
Estonia	*25*	1,94%	$174.635.855,00	$6.985.434,20
Australia	*23*	1,79%	$223.287.725,00	$9.708.161,96

Table 5.1 - The geographical distribution of startups and investments by nation sorted by the number

F*igure 5.5* and *table 5.1* show the nations where the most significant number of Blockchain startups are located. Overall, startups operating with Blockchain technology are present within 91 different nations. The **United States** is the nation where most of the startups are born, with 482 startups located there, representing almost 38% of the total sample of startups. Furthermore, **Canada** is well-positioned, with 36 startups, showing that it is North America to make America the first nation for the presence of Blockchain startups. The **United Kingdom** and **China** follow with 134 and 77 startups that accounts for another 15% of the sample.

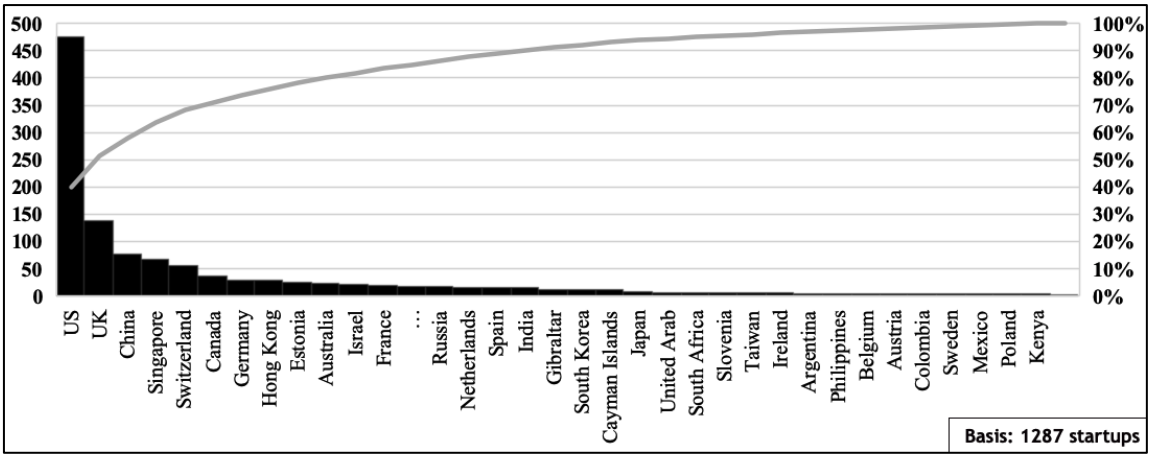


Chart 5.3 - Pareto Analysis on the geographical distribution considering the total number of startups

The Pareto Analysis shown in *chart 5.3*, highlights how 816 startups out of 1286, more than 70% of the total sample, are concentrated in only eight nations: US, UK, China, Singapore, Switzerland, Canada, Germany, and Hong Kong.

NATION	TOT STARTUP	TOTAL FUNDINGS ↓	AVERAGE FUNDING FOR STARTUP
US	476	*$2.665.485.395,00*	$5.599.759,23
Switzerland	55	*$1.103.877.962,00*	$20.070.508,40
Singapore	68	*$720.340.519,00*	$10.593.242,93
China	77	*$712.462.682,00*	$9.252.762,10
UK	139	*$553.180.366,00*	$3.979.714,86
Russia	17	*$298.849.000,00*	$17.579.352,94
Israel	21	*$277.834.679,00*	$13.230.222,81
Cayman Islands	12	*$240.811.000,00*	$20.067.583,33
Canada	36	*$237.063.061,00*	$6.585.085,03
Australia	23	*$223.287.725,00*	$9.708.161,96

Table 5.2 - The geographical distribution of startups and investments sorted by total funding

As shown in *Table 5.2*, a second perspective is given when considering the total level of investments as the focus by which to order the table. As far as concerned the total funding raised, the **United States** is still in the first position with $ 2.665,48 million raised. On the contrary, China is overtaken by **Switzerland** and **Singapore** that, respectively, account for $ 1.103,87 and $ 720,34 million.

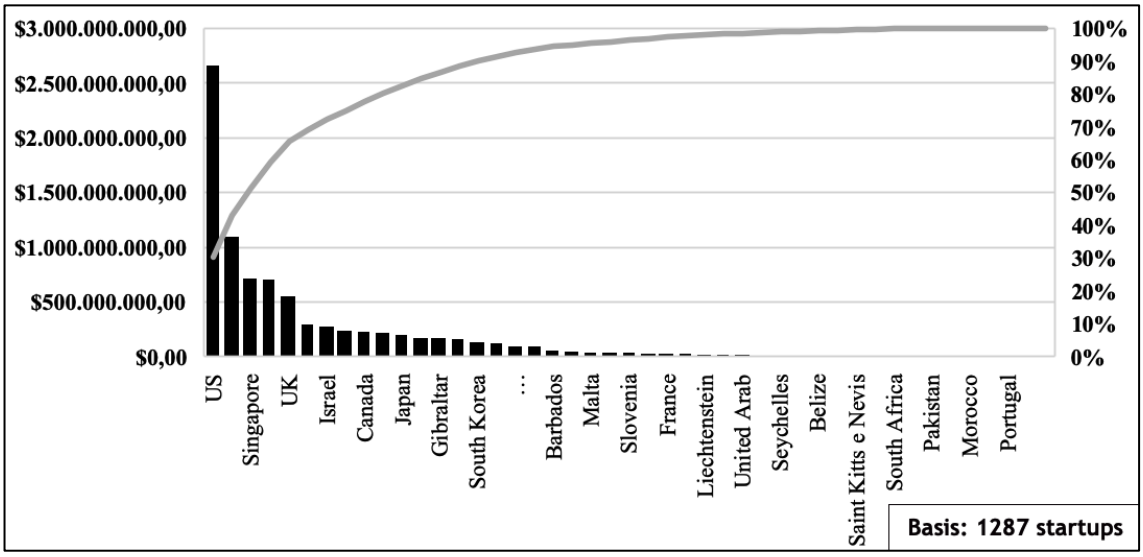


Table 5.3 - Pareto Analysis on the geographical distribution considering the total amount of investment

When performing the Pareto analysis considering the total amount of investment raised (*Table 5.3*), the same situation presented when considering the total number of startup is verified: only 10 nations (US, Switzerland, Singapore, China, and UK) raised $ 7.033,19 million, that is more than 70% of the total funding raised.

Finally, the last perspective is analyzed by considering the average funding for a startup as the centre by which to order the table (*table 5.4*).

NATION	TOT STARTUP	TOTAL FUNDINGS	AVERAGE FUNDING FOR STARTUP ↓
Switzerland	55	$1.103.877.962,00	*$20.070.508,40*
Cayman Islands	12	$240.811.000,00	*$20.067.583,33*
Russia	17	$298.849.000,00	*$17.579.352,94*
Gibraltar	12	$172.622.182,00	*$14.385.181,83*
Israel	21	$277.834.679,00	*$13.230.222,81*
South Korea	12	$133.364.000,00	*$11.113.666,67*
Singapore	68	$720.340.519,00	*$10.593.242,93*
Australia	23	$223.287.725,00	*$9.708.161,96*
China	77	$712.462.682,00	*$9.252.762,10*
Estonia	25	$174.635.855,00	*$6.985.434,20*

*only nations with more than 10 startups are considered

Table 5.4 - The geographical distribution of startups and investments sorted by the average funding

It is important to highlight that, in order to give robust values to the average funding for a startup, in this ranking, only those nations that have at least 10 startups were considered. Nations with few occurrences would have made this ranking different and bring to potential biases. What came up from the analysis is that, if compared with the Top 10 nations sorted based on the number of startups, the situation turns upside down. Indeed, the US and UK are not even ranked in the top 10, while China is only in the 9th position. On the contrary, **Switzerland** is the nation with the highest value, $ 20,07 million for each startup, followed by **Cayman Islands** and **Russia** that respectively, raised on average for startup $ 20,06 and $ 17,58 million.

America is the continent where Blockchain and DLT have attracted most of the attention, and this is true when considering both the amount of startup and funding. This consideration is especially true for **North America**, where the *United States*, with 482 startups, and *Canada*, with 36 startups, account for 40% of the total number of startups of the sample. Surprisingly, when considering the average funding for a startup, the US is not accounted for in the top 10. However, this can be explained by the great number of startups that are increasing the variance of the funding received, resulting in a lower value of the average funding for a startup.

Switzerland, the *United Kingdom*, *Germany*, and *Estonia*, among other nations, are making **Europe** the second continent in which there is great consideration for Blockchain and DLT. *China*, *Singapore*, and *Hong Kong* are affecting, in the same way, the results for Asia.

When focusing on nations, it is notable that there are some nations in which the Blockchain is evolving with a remarkably higher rate than others. Even if there are blending in the three rankings, there are nations that are always present. It can be argued that the development of Blockchain and DLT are concentrating in some locations, opening questions on whether some factors influence the development of the technologies in different nations.

Among other issues, such as the innovativeness of the country or its entrepreneurship attitude, two main factors are considered as deeply related to Blockchain and DLT:

> *1. **Regulation**: literature review shed light on one of the main limits impacting Blockchain and DLT: Regulations. Indeed, there is still much fragmentation in the regulations, especially when considering the usage of smart contracts and cryptocurrency. Mainly, not all states have already regulated this field. The presence of regulations is representing a key factor in order to make the market less risky and more attractive.*
>
> *2. **Attitude towards Blockchain and DLT**: The approach of the country towards Blockchain technology: it can be either supportive because it admits the potential of the technologies or discouraging because of the fear of social and economic instability brought by Bitcoin and other virtual currencies.*

As a result, the different regulations and approaches towards Blockchain proved to affect the presence of Blockchain startup and the average level of investment. Finally, from the analysis, what came out is that there are nations that were particularly relevant both in terms of the presence of startups and the amount of investment raised. For them, a brief description of the regulation and the approach towards Blockchain is carried out.

- *Switzerland*: Very positive attitude with the Swiss Financial Market Supervisory Authority and the Swiss government that admits the potential of the Blockchain and DLT. They already have a proper regulation for them with a comprehensive report published in 2018, followed by the "DLT-Draft Law" in March 2019.
- *Cayman Island:* The site has always been considered particularly suitable for innovative businesses. This is due to the stability of society and convenient taxation. There are no precise regulations yet, but it is thought that the approach towards Blockchain and DLT will be positive.
- *Russia:* the nation has a favorable position towards Blockchain and DLT in general, but it is against cryptocurrencies that are associated with the black market and illegal activities. However, the attitude is favorable, and it has to be considered that it is also the homeland of Ethereum.
- *Gibraltar:* The state has recognized the need to regulate this market and has developed its DLT framework. Several associations have been created related to Blockchain and DLT to increase the level of knowledge and encourage their diffusion.
- *Singapore*: The attitude towards Blockchain and DLT are singularly positive. In particular, this is also valid for cryptocurrencies as the Monetary Authority of Singapore (MAS) is creating a digital token for the Singapore dollar on the Ethereum Blockchain.
- *Australia*: the government has taken a largely non-interventionist approach to the regulation of cryptocurrency while it is widely supportive of the technology; this is proved by the large investment to investigate possible Blockchain and DLT solutions within government services.
- *Malta*: The Government of Malta has established through three different acts an already stable regulation towards Blockchain and DLT: Malta Digital Innovation Authority Act (MDIA), The Innovative Technology Arrangements and Services Act ("ITAS) and the Virtual Financial Asset Act (VFAA).
- *Estonia*: one of the nations that moved first against Blockchain and DLT adoptions. It has also always been considered a pioneering nation for innovative, high-tech themes. This is explaining why it is among the cities in which the Blockchain is being tested the most.

- *United Kingdom*: the UK crypto assets Taskforce made a "taskforce report" where they define three kinds of tokens (exchange, security, and utility). Financial regulators have warned the usage of cryptocurrencies in investment, but there is not any prohibition.
- *China:* Similar to Russia, China favors the development of Blockchain and DLT but is unfavorable to the spread of the various cryptocurrencies in circulation. Instead, it is testing the use of a national cryptocurrency.
- *US:* Several state governments affecting cryptocurrencies have already been proposed. However, there is still no general rule that is shared by all the states nor a proper definition of virtual currencies. On the contrary, the USA has always been a proper field for a startup to evolve, and this is no exception.

Overall, for all the nations analyzed, it is clear that the adoption of the Blockchain and DLT are widely incentivized and, for some of them, already well-regulated or close to being so. The presence of regulation is an important driver in their diffusion since market participants can operate with a higher degree of certainty, increasing the level of trust in the company and consumer adoption.

Nonetheless, the attitude towards cryptocurrencies seems less favorable, and there is a widespread discourage towards the usage of cryptocurrencies as a mean for trading due to its volatility and risks. They are considered as potential causes of economical and, at a large, social instability.

These considerations left several research questions open on the impacts that the different regulations and attitudes of the different nations are having on Blockchain and DLT diffusion.

5.2 Business applications: Industries, Processes & Solutions

In this section, the focus is on the Industries and business processes in which Blockchain and DLT are involved the most. A cross-analysis between Sectors and processes will then

help to find which are the leading business solutions and how Blockchain and DLT bring value. Finally, a brief analysis of the type of client solutions are addressed is outlined.

As a reminder, the outlier Block.one is not considered in the financial analysis whereas the 11 startups of 2019 are not considered in the yearly ones.

5.2.1 Industries

In order to have a comprehensive overview of the possible insights, three different analysis is performed:

- Distribution of startup and funding by *sector*
- The average distribution of funding by *sector* for each startup
- The distribution of the birth of startups over the years by *sector*

In "**other,**" the industries that, with this year update, showed to be not relevant enough are included and are insurance, government, luxury, airline, and other sectors. Whereas a sector that proved to be relevant and, thus, it should be considered in the future analysis is **Real Estate**.

The distribution of startup and funding by sector

Here**,** an analysis of the industries where startups of the sample are operating within is performed (*chart 5.4*). Furthermore, the distribution of the funding raised in the different sectors is depicted.

As far as concerned the distribution of startup by sector, **General Purpose** is the sector where most of the startups are operating within, representing a quarter of the sample. That means that more than 300 startups have a value proposition that can serve different sectors. Furthermore, almost another quarter of the startups is offering services that are related to the usage of **Virtual Currency**. Moreover, **Finance** and **Media & Arts**, together, account for another 27% with respectively 204 and 135 startups.

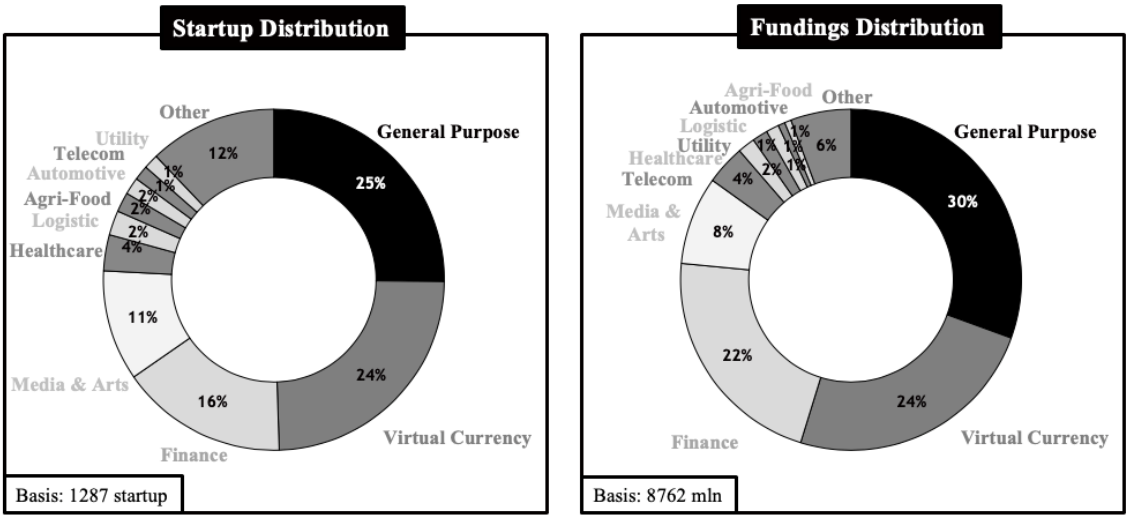


Chart 5.4 - Distribution of Blockchain and DLT startups and funding by sector

Those clustered in **Other** are 156, accounting for another 12%, whereas **Healthcare** represents 4%. Finally, the remaining part is almost equally divided by the rest of the sectors: **Logistic**, **Agri-food**, **Automotive** for the 2% and **Telecom,** and **Utility** for 1%.

When focusing on the distribution of funding, the situation is similar, and first positions do not change. Indeed, **General Purpose**, with $ 2.677,70 million, still represents the sector with the highest value. **Virtual Currency** and **Finance** follow accounting respectively for 24% and 22%. The three sectors, together, represent more than three-quarters of the total amount of investments. When comparing the percentage of startups and funding, there is a slight increase in those startups that are serving different sectors or offering financial services.

Additionally, **Media & Arts** has a significant value with $ 733,14 million, which represents 8% of the total investment. Those clustered in **Other** and **Telecom** 156, respectively, represent 6 and 4%. Finally, besides **Utility** that accounts for 2%, the remaining sectors only represent the 1%.

The average distribution of funding by sector for startup

For each industry, an analysis of the average value of the financing for a startup is also performed (*chart 5.5*). On average, each startup has raised $ 6,81 million.

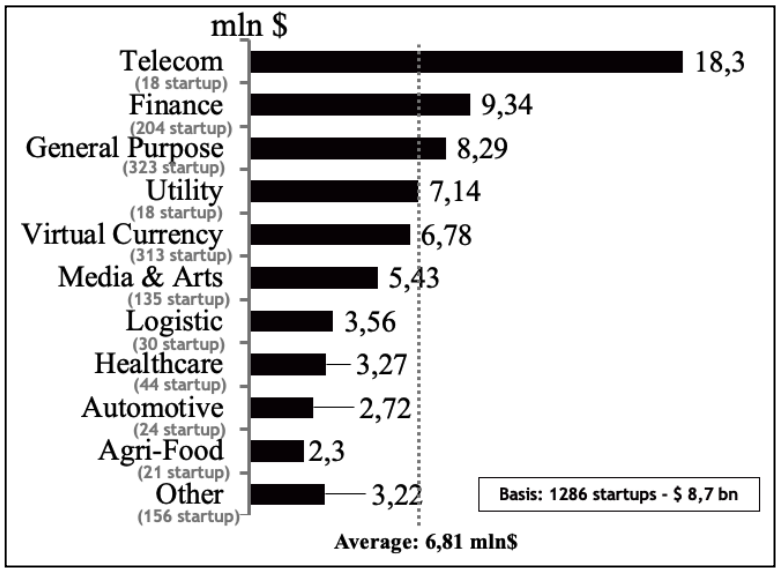


Chart 5.5 - the average distribution of funding for Blockchain and DLT startups by sector

Surprisingly, **Telecom**, which is among those sectors that account only for 1% of the total startups, is the one with the highest average value for a startup with $ 18,3 million. This result is explaining why it has a good amount of 4% when looking at the funding distribution. The same is true for **Utility**, whose startup raises on average $ 7,14 million that is higher than the average value.

Furthermore, coherently with the previous analysis, **Finance** and **General Purpose** are on the podium, respectively, with values of $ 9,34 and $ 8,29 million each, that is higher than the average. On the contrary, **Virtual Currency** and **Media & Arts**, which were in a good position in both the previous analysis, have now values that are even lower than the average, with $ 6,78 and $ 5,43 million for a startup.

Moreover, startups working in the **Logistic** and **Healthcare** industries raises on average $ 3,56 and $ 3,27 million. Finally, the lowest values are represented by **Automotive** and **Agri-food** that, respectively, reach $ 2,72 and $ 2,3 million.

The distribution of the birth of startups over the years by sector

An analysis of the distribution of the birth of the startups, from 2014 to 2018, and, considering the most dynamic industries, is here performed (*chart 5.6*).

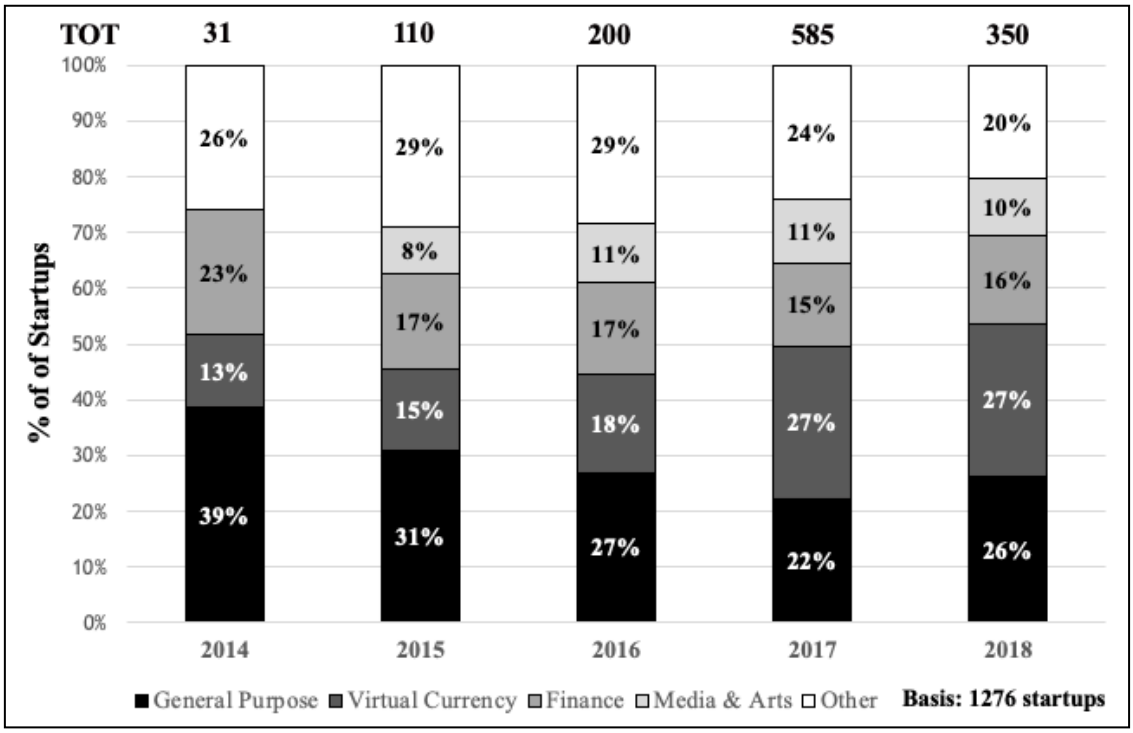


Chart 5.6 - the distribution of the birth of Blockchain and DLT startups over the years by sector

In the previous analysis, **General Purpose**, **Virtual Currency**, **Finance,** and **Media & Arts** proved to be particularly relevant, making them the focus of this analysis.

Overall, in 2014 and 2015, startups offering **cross-sectoral** solutions and focusing on the development of Blockchain and DLT are those representing the largest size when considering the percentage of birth of the startup each year, with values of 39% and 31%. In the following years, they experienced a sound decrease that reached its lowest point in 2017 with a low value of 22%. In 2018, 91 startups were born in this category.

On the contrary, the percentage of startups operating in **Virtual Currency** has been growing steadily from a value of 13% in 2014 to 27% in 2018. The highest growth has been registered between 2016 and 2017. Moreover, the percentage of **Finance** has been almost steady during the years, and the same trend is registered for startups operating in **Media & Arts**, even if they started to be present a year later, in 2015.

Finally, the percentage of births of startups operating in "other" sectors has been decreasing during the years, reaching its lowest value in 2018 representing only one-fifth of the total births.

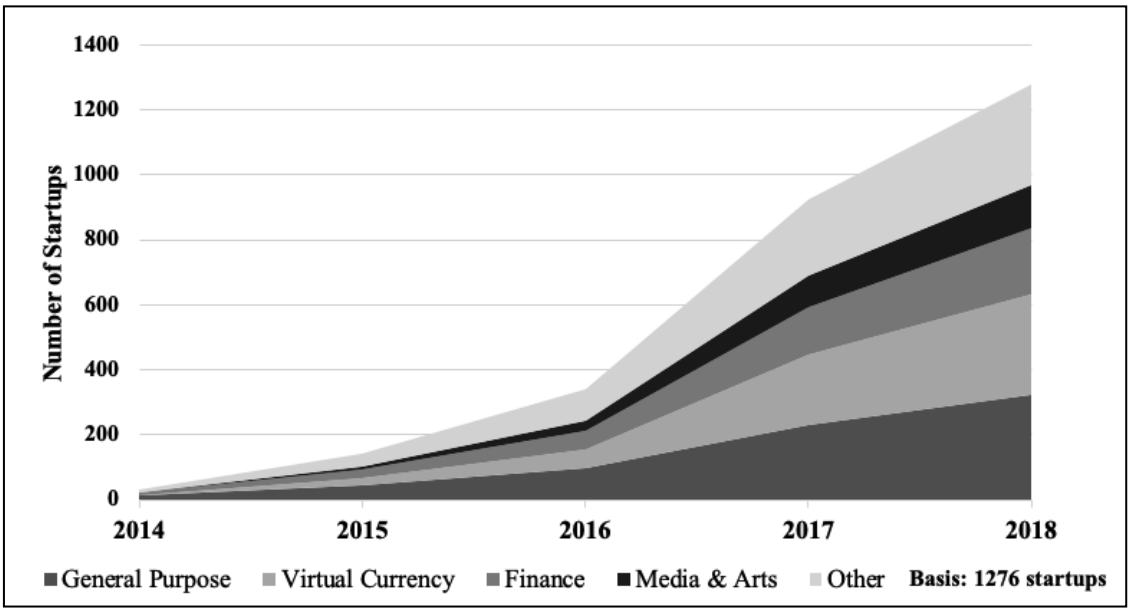


Chart 5.7 - the cumulative distribution of the births of Blockchain and DLT startups by sector

A similar perspective is given when considering the cumulative distribution of startups by years (*chart 5.7*). Overall, when comparing the growths, **General Purpose** is among those that are growing at a slower pace, whereas **Virtual Currency** experienced a considerable increase in the last years. This is resulting in having almost the same number of startups for the two sectors at the end of 2018. **Finance, Media & Arts,** and other sectors have also grown at almost a constant pace. Whereas **other** sectors experienced a slowdown in 2018.

The recognized trends in this analysis are thus confirming and giving insights on the following research questions identified:

1. *Are there any industries in which Blockchain and DLT are expected to grow more? If yes, which are them?*
2. *Is Finance the industry that will be more affected by Blockchain and DLT? or is it Media & Arts?*

5.2.2 Processes

Here, a similar analysis is performed, moving the focus on processes, and it will be divided in three steps.

- Distribution of startup and funding by *process*
- The average distribution of funding by the *process* for each startup
- The distribution of the birth of startups over the years by the *process*

The category "**Other**" considers supply chain finance, property registry, voting, and other processes that were not relevant enough to create a category are included. Whereas the creation of a new and decentralized **Marketplace** has been identified as one of the main processes that should be considered in future analysis.

The distribution of startup and funding by process

Here**,** an analysis of the processes where startups are focusing on the implementation of Blockchain and DLT are performed (*chart 5.8*). Furthermore, the distribution of the funding raised in the different processes is depicted.

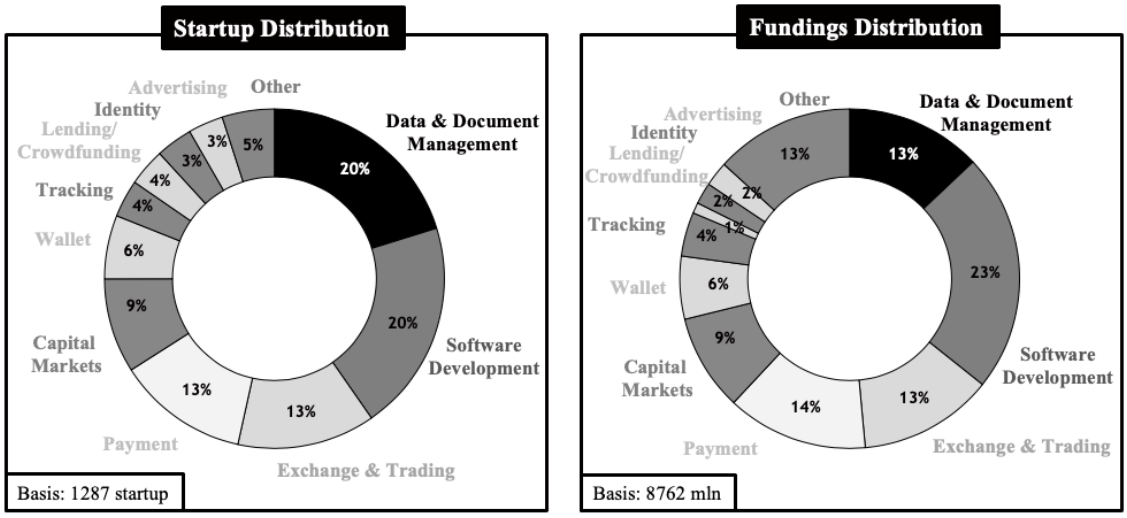


Chart 5.8 - Distribution of Blockchain and DLT startups and funding by process

For what concerns the distribution of startup by the process, Blockchain and DLT are involved the most in those processes that include storage and management of **Data and Documents,** leveraging on the characteristics of immutability and transparency, and **Software Development**, focused on overcoming the actual limitations of most Blockchain protocols. Indeed, together, they account for 40% of the total startups.

Exchange & Trading and **Payment** both account for another 13%, whereas **Capital Markets** and **Wallet**, respectively, for 9% and 6%. Finally, the lowest portions are occupied by **Tracking** and **Lending & Crowdfunding** (4%) and **Identity** and **Advertising** (3%), with other processes that account for the last 5%.

Looking at how funding is distributed, the situation is similar. Indeed, the largest portion of the investments is on **Software Development** with almost a quarter of the total investment. Moreover, those working on **Payment**, **Capital markets** and **Exchange & Trading** have similar shares also in the financial perspective.

On the contrary, **Data & Document Management** that has a lower value of 13%, showing that the startups focusing on this process, on average, are not the principal focus of investors.

The average distribution of funding by the process for startup

The analysis of the average value of funding for a startup is described in the following chart (*chart 5.9*).

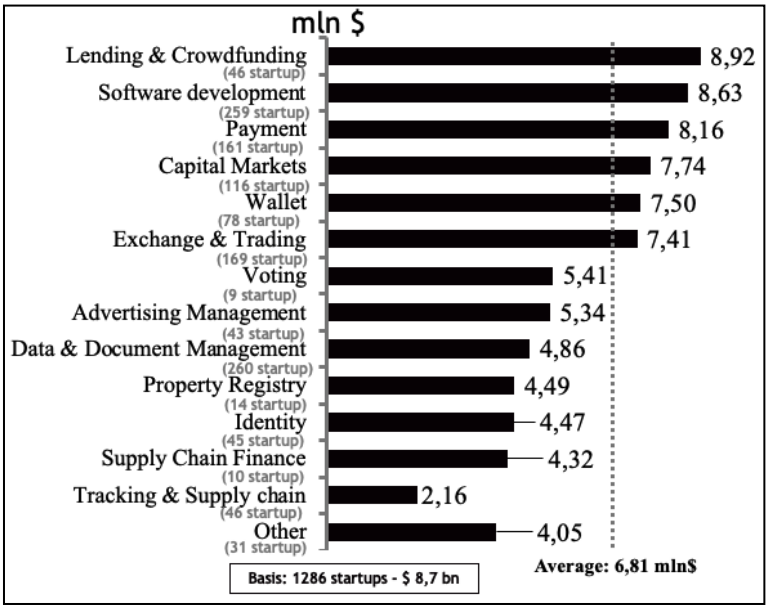


Chart 5.9 - the average distribution of funding for Blockchain and DLT startups by process

Overall, some categories with low numbers appear to have a value of funding that is higher than the average value of $ 6,81 million, such as **Lending & Crowdfunding**, **Wallet,** and

Capital markets. Moreover, among the most numerous, **Software development** with $ 8,92 million, **Payment** with $ 8,63 million, and **Exchange & Trading** with $ 7,41 million, have still very high values confirming what stated above. **Voting** and **Advertising Management** have also important values that are close to the average with, respectively, $ 5,41 and $ 5,34 million. Finally, the process that received the least investment is the **Tracking & Supply chain** with an amount of 2,16 million dollars.

The distribution of the birth of startups over the years by the process

An analysis of the distribution of the birth of the startups by the years considering the most active processes is here performed (*chart 5.10)*.

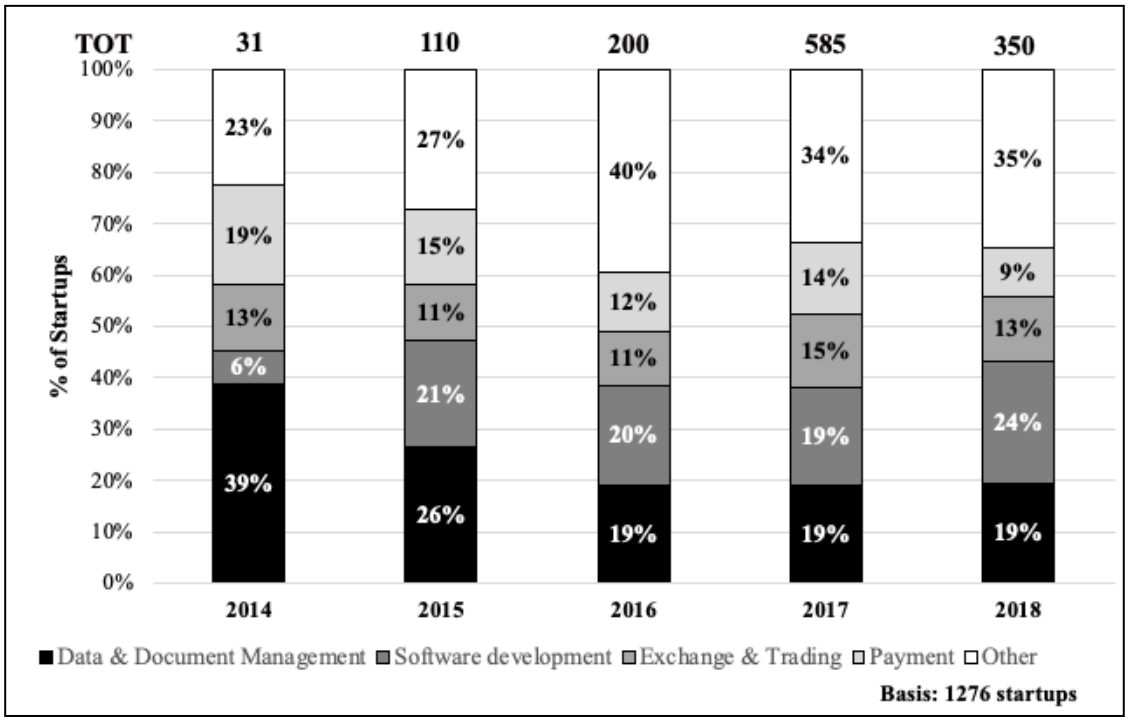


Chart 5.10 - the distribution of the birth of Blockchain and DLT startups over the years by the process

Overall, the percentage of birth of startups that are using Blockchain to enhance the **Management of Data** has experienced a constant decrease from 2014 to 2016 passing from a value of 39% to 19%. This percentage has been constant in the following years. However, this consideration is valid only when looking at percentages. If considering the absolute numbers, their amount is still very high and, in most the cases, still represent the most numerous portions of the sample.

This decrease is countered by a consistent increase in the fraction of those startups focusing on **Software Development** to improve the technology itself and offer it, in most of the cases, as a service. Indeed, their value surged from 6% in 2014 to 24% in 2018.

Furthermore, the portions of those using Blockchain for **Exchange & Trading** have been almost steady from 2014 to 2018. Finally, a deep decrease has been registered for the percentage of a startup offering new solutions of **Payment** with cryptocurrencies from 19% to a low value of 9%. This decrease is reflected by a consistent increase in the fraction of startup using Blockchain to enhance **Other** processes that reached its peak in 2016 with 40% and has stabilized in the following years on a value that is around 35%.

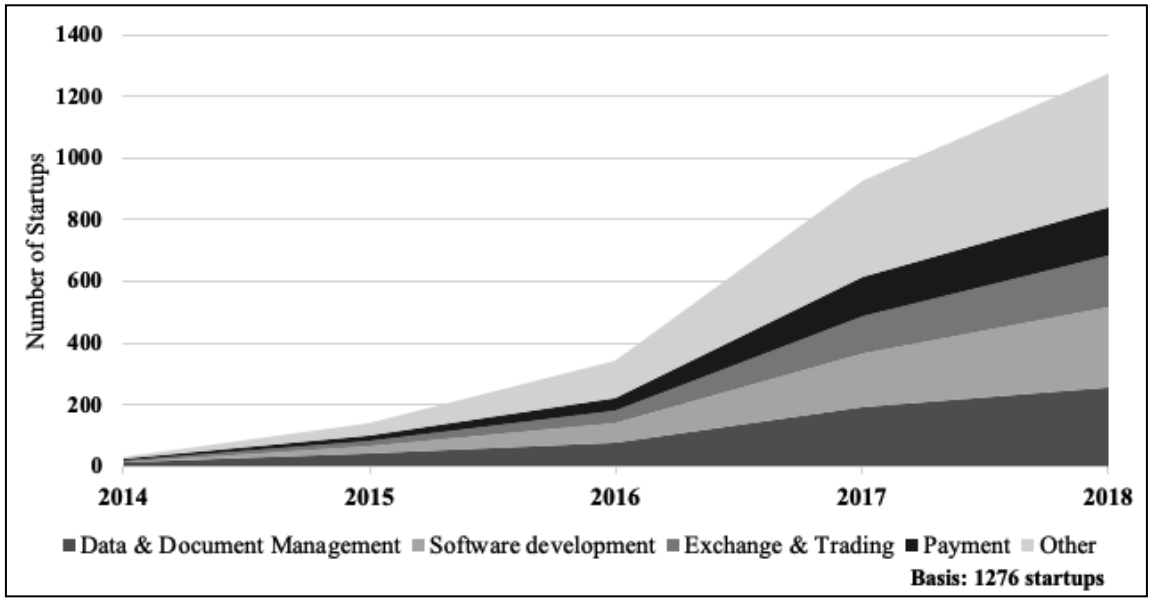


Chart 5.11 - the cumulative distribution of the births of Blockchain and DLT startups by process

By considering the cumulative distribution of the births of the startups (*chart 5.11*), what emerges is that the opposite trends of **Data & Document Management** and **Software Development** are resulting in an equal value at the end of 2018. Furthermore, those focusing on exchanging of cryptocurrencies both in terms of **paying** or in **converting** them in Fiat currencies are growing at a steady pace. Finally, other processes are increasingly finding new opportunities for adoption.

Overall, the identified trends in these analyses are thus confirming and giving insights on the following research questions:

1. *Are there any processes for which Blockchain and DLT are expected to be more implemented? If yes, which are them?*
2. *Are Blockchain and DLT expected to be still so related to the usage of cryptocurrencies and management of data?*
3. *Are Blockchain and DLT still in an initial phase? Or a dominant design is emerging?*

5.2.3 Business Solutions

This paragraph aims to provide a cross-analysis of which are the main processes for each sector. Moreover, it is showing in a more precise fashion how the different processes are deployable in the diverse industries giving insights on how Blockchain and DLT may impact and innovate business models. A similar analysis has already been presented by "Osservatorio Blockchain and DLT" (2018), and this will represent an update. A first and comprehensive overview of the distribution of startups considering Industries against processes is given (*chart 5.12*).

Basis:1287 startups	Data & Document Management	Software Development	Exchange & Trading	Payment	Capital Markets	Wallet	Tracking & Supply Chain	Lending & Crowdfunding	Identity	Advertising Management	Other
General Purpose	63	181	6	10	11	1	7	1	17	8	19
Virtual Currency	14	23	99	67	23	69	1	11	1	1	4
Finance	19	10	22	33	71	4		30	8		7
Media & Arts	50	13	6	16	1	2		2	2	22	21
Healthcare	37	3		1		1	1				1
Logistic	8	2		2			16				2
Agri Food	5		3	4			12				
Automotive	7	3	2	5	2		2				
Telecom	3	5	5	3			2				
Utility	8	5	1	1					1		2
Other	46	14	25	19	8	1	5	2	16	12	8

Chart 5.12 - the distribution of Blockchain and DLT startups considering Industries against Processes

Crossing the application processes with the sectors, it is possible to notice how some of them are focusing mainly on some processes, but for most of them, even if not as numerous, very different applications are found. Indeed, startups belonging to **General Purpose**, **Virtual Currency**, **Finance,** and **Media & Arts** found application for Blockchain and DLT in almost all the identified processes even if they focus their attention on some peculiar ones.

Whereas, other industries are more focused on the application of Blockchain and DLT for some particular processes. This consideration concerns **Healthcare**, which is highly related to *Data & Document Management*, and **Agri-Food** and **Logistic** with *Tracking & Supply Chain*.

A further and more detailed analysis of each sector is provided in the following sections to identify, based on the crossings that were found to be more numerous, which are the main business applications for each industry and how Blockchain and DLT bring value. The condition to be more numerous has been considered to have more chance of repeatability of the solution.

For each sector, the number of startups, the total funding raised, and the percentage of the investment raised compared to the total amount of investment are reported.

General Purpose

In General Purpose, there are those startups that offer solutions that are cross-sectorial and, thus, can serve different sectors. Overall, 323 startups are operating within this sector and raised a total amount of funding equal to $ 2.677.705.547,00. The most significant crossings are reported in *table 5.5*.

General Purpose	Number of startups	Tot funding raised	% of Tot funding
Software development	180	$1.837.384.783,00	20,97%
Data & Document Management	63	$365.929.694,00	4,18%
Identity	17	$101.108.201,00	1,15%
Advertising Management	8	$29.449.599,00	0,34%

Table 5.5 - most significant crossings within the General Purpose sector

- *Software development*: startups that are focusing on developing new platforms or proposing an improvement on the extant ones in order to overcome the limits mentioned above of Blockchain and DLT. They are all proposing innovative architectures by combining in different ways the main pillars of Blockchain and DLT: Network, Consensus Algorithm, Structure of the database, Transactions and Assets. These solutions are the principal focus of investors since they were able to raise $1.837,38 million, that represents more than one-fifth of the total amount of investment.
- *Data & Document Management:* startups that offer solutions to optimize the management of any data by leveraging on characteristics of transparency and immutability of Blockchain and DLT. In this sector, startups are creating platforms to let any user collect, certify and exchange personal data. Indeed, they let users prove, with absolute certainty, when data was created and if it has been modified from its original state. Moreover, startups creating improved protocols with a particular focus on the limits that concern data privacy and safety are considered. Most of the time, their solution is proposed as synergic for Cloud-based and AI solutions. These kinds of solutions also represent an outstanding value of 4,18% with regards to the total investment raised by startups.
- *Identity*: solutions whose aim is to create a self-sovereign identity that will decentralize the management of identity documents and login credentials to different websites. On the business side, it helps firms to build a better KYC process respecting data privacy. Whereas, on the customer side, it gives back to people the decision about with whom to share information about their identity.
- *Advertising Management*: startups offering platform solutions to connect advertisers, publishers, and users in token-based digital marketing.

The crossing between **General Purpose** and *Software development* represents the one with most occurrences and with the highest level of investment. It is represented by those startups who are proposing new and improved architectures compared to the extant Blockchain and DLT platforms to overcome the present limitations.

The high number of startups that are trying to propose their solution is a further confirmation that Blockchain and DLT are still in an initial phase, and a dominant design in its architecture has not emerged yet.

Furthermore, it is noticeable how most of the startups offering solutions for *Data & Document management* are focused on the development of a platform that is sector-agnostic and then deployable in the diverse industries.

Virtual Currency

In Virtual currency, there are those startups that offer services that are deeply related to the usage of cryptocurrencies. Overall, 313 startups are operating within this sector and raised a total amount of funding equal to $ 2.122.097.356,00. The most significant crossings are reported in *table 5.6*.

Virtual Currency	Number of startups	Tot funding raised	% of Tot funding
Exchange & Trading	99	$600.553.556,00	6,85%
Wallet	69	$509.437.528,00	5,81%
Payment	67	$545.518.531,00	6,23%
Software Development	23	$193.524.941,00	2,21%
Lending/Crowdfunding	11	$74.420.000,00	0,85%

Table 5.6 - most significant crossings within the Virtual Currency sector

- *Exchange & Trading*: startups that offer solutions for the conversion of Cryptocurrencies in Fiat currencies and trading platforms. They also consider the creation of marketplaces that are based on the usage of virtual currencies.
- *Wallet*: startups that allow users to manage and store their cryptocurrencies. They are focused on offering an always easier and intuitive way for these activities in order to let anyone deal with cryptocurrencies.
- *Payment*: Startups that offer solutions to let users pay for services and goods with their cryptocurrencies. Indeed, they enable merchants to accept multiple cryptocurrencies from buyers as payment methods while receiving in fiat currency.
- *Software Development:* solutions whose aim is to improve the actual performance of virtual currencies dealing in particular with their volatility issue. Indeed, most of these

startups are trying to offer “stable coin” solutions creating cryptocurrencies that are backed by real assets and fiat currencies.

- *Lending & Crowdfunding:* startups that are offering solutions for borrowing and lending cryptocurrencies.

As aforementioned, solutions of *Exchange & Trading*, *Wallet*, and *Payment* are highly related to the **Virtual Currency** sector. Indeed, more than 75% of the sector is formed by these processes. They also gathered great attention from investors being able to raise together $ 1.655, 509 million that is almost 20% of the total amount of investment. This consideration is even reinforced by those startups that are trying to improve the performances of cryptocurrencies in particular for their volatility, which accounts for another 2,21%.

This result is proving how, when dealing with Blockchain and DLT, one of the focus is still on offering solutions related to the new virtual currencies. However, as aforementioned, with the hype surrounding the virtual currencies that are stabilizing, these values are expected to slowdown in the next years.

Finance

In Finance there are those startups that leverage on Blockchain to increase the efficiency of the financial services offered by the principal financial institutions (bank, insurance...). Overall, 204 startups are operating within this sector and raised a total amount of funding equal to $ 1.906.240.585,00. The most significant crossings are reported in *table 5.7*.

Finance	Number of startups	Tot funding raised	% of Tot funding
Capital Markets	71	$669.919.329,00	7,65%
Payment	33	$380.498.611,00	4,34%
Lending/Crowdfunding	30	$332.947.745,00	3,80%
Data & Document Management	19	$111.451.137,00	1,27%

Table 5.7 - most significant crossings within the Finance sector

- *Capital Markets*: solutions that concern the tokenization of real assets and investment funds and allow users to invest with their fiat money or cryptocurrencies.

- *Payment*: startups that are offering cross-border transactions or off-chain solutions to improve the scalability of payment technology. Moreover, they are including solutions that allow marketplace transactions where trust between the buyer and seller may be limited.
- *Lending & Crowdfunding*: startups, which bring enhanced transparency and reliability in credit and lending. They enable connections between lenders and borrowers located anywhere in the world, regardless of currency. By reducing the traditional banking brokerage costs and management fees, they give a more efficient service. Moreover, they include solutions that allow open access to microcredit credit to users who cannot obtain this service through traditional channels.
- *Data & Document Management*: startups that are offering solutions to reduce the operational bureaucracy for financial institutions and increase the trust in documents by uploading them on-chain.

Finance has been identified as one of the sectors in which Blockchain and DLT can bring most of the advantages. Results are confirming that solutions in this sector are attractive for investors since *Capital Markets*, *Payment,* and *Lending & Crowdfunding* account for more than 15% of the total amount of investment. The adoption of Blockchain and DLT in these processes is due to efficiency and safety. Moreover, a relevant number of startups exploit the technologies to improve the efficiencies of internal processes (*Data & Document Management*) of financial institutions to confirm what stated in the literature.

However, the number (19) is lower than what expected. From the use case analysis of Osservatori Digital Innovation (2019), a significant portion of the cases is represented by financial institutions announcing or launching projects related to the reduction of inefficiencies in the processes (largely renown as an issue in the industry).

Media & Arts

In Media & Arts, there are those startups whose focus is on the management of artistic and multimedia content, both physical and digital. It includes solutions belonging to the Gaming, Music, Arts & Social Media Industries. Overall, 135 startups are operating within

this sector and raised a total amount of funding equal to $ 733.139.999,00. The most significant crossings are reported in *table 5.8*.

Media & Arts	Number of startups	Tot funding raised	% of Tot funding
Data & Document Management	50	$339.462.655,00	3,87%
Advertising Management	22	$121.260.000,00	1,38%
Payment	16	$69.342.537,00	0,79%
Software Development	13	$91.012.784,00	1,04%

Table 5.8 - most significant crossings within the Media & Arts sector

- *Data & Document Management*: Startups that propose to protect copyright and property rights with the Blockchain and DLT. For example, by offering true digital ownership in gaming platform in order to guarantee to the users the exclusive property of the digital goods.
- *Advertising Management:* solutions that are simplifying the interaction between the advertiser and the publisher and/or eliminating the intermediaries that were among them. Particularly relevant in the Social Media industry.
- *Payment*: optimization of payment in the Media Industry by proposing cash-back, frictionless, and more secure payment solutions.
- *Software Development*: startups that are creating a platform in order to let users create decentralized applications in the gaming industry.

Overall, in **Media & Arts**, solutions regarding the distribution of content and, in particular, the assurance of the protection of copyright and intellectual property raised a good amount of funding, with a value of $ 339,462 million.

Therefore, there are great opportunities for adoption for the Music, Art, and Gaming sectors. Finally, the connection between advertiser and publisher, brand and influencers without the need of an intermediary is also an interesting solution.

Healthcare

In Healthcare, there are those startups offering solutions related to the healthcare sector, whose aim is to simplify the interactions between doctor and health facility with patients.

Overall, 44 startups are operating within this sector and raised a total amount of funding equal to $ 125.416.138,00. The most significant crossings are reported in *table 5.9*.

Healthcare	Number of startups	Tot funding raised	% of Tot funding
Data & Document Management	37	$125.416.138,00	1,43%

Table 5.9 - most significant crossings within the Healthcare sector

- *Data & Document Management*: startups that save on Blockchain and DLT the data of the patient, the results of the visits, and his health history so that it is easily accessible by the doctors in case of need. Moreover, they can facilitate the payment of invoices or make it possible to monetize health data by making them accessible to third parties.

Logistic

In Logistic, there are those startups whose aim is to simplify and increase the efficiency of the exchanges among the different actors of the supply chain. Overall, 30 startups are operating within this sector and raised a total amount of funding equal to $ 106.898.670,00. The most significant crossings are reported in *table 5.10*.

Logistic	Number of startups	Tot funding raised	% of Tot funding
Tracking & Supply Chain	16	$18.575.804,00	0,21%
Data & Document Management	8	$57.372.866,00	0,65%

Table 5.10 - most significant crossings within the Logistic sector

- *Tracking & supply chain*: these are the actors who assemble the transactions along the supply chain and guarantee their traceability by generating unique IDs for each product.
- *Data & Document Management*: startups that digitize on Blockchain documents related to the movement of goods such as landing receipts to streamline the movement of goods

Agri-Food

In Agri-Food, there are those startups whose aim is to improve the trust towards the agri-food industry and, in particular, the provenance of products. Overall, 24 startups are operating within this sector and raised a total amount of funding equal to $ 55.305.980,00. The most significant crossings are reported in *table 5.11*.

Agri-Food	Number of startups	Tot funding raised	% of Tot funding
Tracking & Supply Chain	12	$18.207.263,00	0,21%

Table 5.11 - most significant crossings within the Agri-Food sector

- *Tracking & supply chain*: it can be considered a sub-sector of Logistic with a particular focus on the traceability of food products to certify their provenance and quality.

Automotive

In Automotive, startups are operating in the automotive sector to guarantee the provenance of their raw materials and to optimize the exchange in the supply chain. Overall, 21 startups are operating within this sector and raised a total amount of funding equal to $ 57.105.268,00. The most significant crossings are reported in *table 5.12*.

Automotive	Number of startups	Tot funding raised	% of Tot funding
Data & Document Management	7	$6.448.024,00	0,07%
Payment	5	$42.377.200,00	0,48%

Table 5.12 - most significant crossings within the Automotive sector

- *Data & Document Management*: solutions that allow drivers to make money out of their mobility data by sharing them to help urban planning or to give feedback for mobility-related transactions such as fuel, insurance…
- *Payment*: solutions that combine the different mobility-related payments, such as insurance and maintenance, and then make it a single payment leveraging on Blockchain and DLT.

Utility

In Utility, startups are working in the public utility sector (energy, water...). Overall, 18 startups are operating within this sector and raised a total amount of funding equal to $ 128.662.798,00. The most significant crossings are reported in *table 5.13*.

Utility	Number of startups	Tot funding raised	% of Tot funding
Tracking & Supply Chain	12	$86.226.462,00	0,98%

Table 5.13 - most significant crossings within the Utility sector

- *Tracking & Supply Chain*: These are startups linked to the tracking of energy produced from renewable sources in order to enable P2P exchanges.

Telecom

In Telecom, startups are focusing their business model on improving the existing solutions in the telecommunication sector. Overall, 18 startups are operating within this sector and raised a total amount of funding equal to $ 328.885.300,00. The most significant crossings are reported in *table 5.14*.

Telecom	Number of startups	Tot funding raised	% of Tot funding
Data & Document Management	8	$167.860.300,00	1,92%
Software Development	5	$42.195.000,00	0,48%

Table 5.14 - most significant crossings within the Telecom sector

- *Data & Document Management:* startups that ensure the protection of user data, sharing as little as possible with advertisers when using telecommunications
- *Software Development*: startups that are promoting the usage of Blockchain and DLT to democratize internet access and make it free for those who cannot use it now

Insurance

In Insurance, there are startups operating startups offering a solution to improve the inefficiencies of the sector. Overall, 19 startups are operating within this sector and raised a total amount of funding equal to $ 36.388.880,00. The most significant crossings are reported in *table 5.15*.

Insurance	Number of startups	Tot funding raised	% of Tot funding
Data & Document Management	11	$7.910.843,00	0,09%
Payment	2	$22.691.037,00	0,26%

Table 5.15 - most significant crossings within the Insurance sector

- *Data & Document Management*: startups whose aim is to reduce the inefficiencies in the sharing and management of data between the various actors in the insurance sector.
- *Payment*: Startup proposing the self-execution payment of insurance contracts through the usage of smart contracts.

BUSINESS SOLUTIONS

To wrap up, the business solutions previously detailed have been gathered in *table 5.16*.

INDUSTRY	PROCESS	BRIEF DESCRIPTION	Number of Startups	% on the tot num of startups	Funding amount raised	% on the tot funding amount
General Purpose	*Software development*	overcoming Blockchain & DLT limits and proposing innovative protocols	180	13,47%	$1.837.384.783,00	20,97%
	Data & Document Management	optimization of management of any kind of data & overcoming data privacy issues	63	4,12%	$365.929.694,00	4,18%
	Identity	creation of self-sovereign identity to decentralize the management of documents	17	1,20%	$101.108.201,00	1,15%
	Advertising Management	connecting advertiser, publishers and users without the need of intermediaries	8	0,62%	$29.449.599,00	0,34%
Virtual Currency	*Exchange & Trading*	trading solutions and conversion in fiat currencies for cryptocurrencies	99	7,88%	$600.553.556,00	6,85%
	Wallet	management and storage of cryptocurrencies	69	6,38%	$509.437.528,00	5,81%
	Payment	let users pay for services and goods with their cryptocurrencies	67	4,48%	$545.518.531,00	6,23%
	Software development	the aim is to improve the actual performance of virtual currencies	23	1,65%	$193.524.941,00	2,21%
	Lending/Crowdfunding	borrowing and lending cryptocurrencies	11	1,01%	$74.420.000,00	0,85%
Finance	*Capital Markets*	tokenization of real assets and investment funds	71	4,99%	$669.919.329,00	7,65%
	Payment	cross-border and inter-bank transactions	33	2,44%	$380.498.611,00	4,34%
	Lending/Crowdfunding	connecting lender and borrower without the need of intermediaries	30	2,05%	$332.947.745,00	3,80%
	Data & Document Management	reducing the operational bueucracy for financial institutions	19	0,92%	$111.451.137,00	1,27%
Media & Arts	*Data & Document Management*	protection of copyrights and property rights with true digital ownership	50	3,09%	$339.462.655,00	3,87%
	Advertising Management	connecting brands and influencers and/or advertiser and publisher	22	1,83%	$121.260.000,00	1,38%
	Payment	cash-back, frictionless and more secure payment option	16	1,00%	$69.342.537,00	0,79%
	Software development	creation of decentralize applications such as gaming platform	13	0,95%	$91.012.784,00	1,04%
Healthcare	*Data & Document Management*	optimize the management of health data and sharing between patient and doctors	37	3,56%	$125.416.138,00	1,43%
Logistic	*Tracking & Supply chain*	certification of provenance and traceability of products	16	1,58%	$18.575.804,00	0,21%
	Data & Document Management	digitalization of documents related to the movement of goods	8	0,62%	$57.372.866,00	0,65%
Agri-Food	*Lending/Crowdfunding*	certification of provenance, quality and traceability of food products	12	1,04%	$18.207.263,00	0,21%
Automotive	*Data & Document Management*	make mobility data valuable	7	0,83%	$6.448.024,00	0,07%
	Payment	combination of more mobility-related payment in a single one	5	0,35%	$42.377.200,00	0,48%
Telecom	*Data & Document Management*	protection of data when using telecom services	8	0,26%	$167.860.300,00	1,92%
	Software development	democratization of internet access	5	0,50%	$42.195.000,00	0,48%
Utility	*Tracking & Supply chain*	tracking of renewable energy to sell in P2P exchanges	12	0,93%	$86.226.462,00	0,98%

Table 5.16 - Blockchain and DLT main applications in the diverse industries and processes

5.2.4 Type of Client

Here**,** an analysis of the type of client to which Blockchain and DLT startups solutions are addressed is performed (*chart 5.13*). The distribution of startups and their level of investment are considered.

According to what stated in the methodology, the type of client may be:

- *B2C*: when the business application of Blockchain and DLT are targeting the final customers.
- *B2B*: when startups are offering Blockchain as a Service to businesses to make them innovate their business models.
- *Platform*: it concerns the development of new platforms that connects the demand and supply side of a service. Solutions that concern the development of a platform that may target both customers and business sides are also considered here.

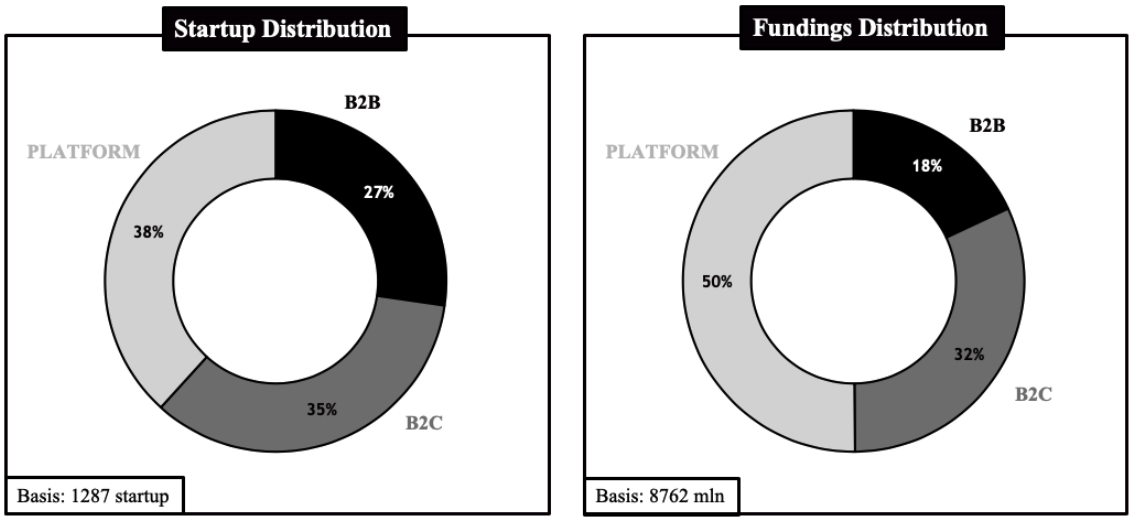


Chart 5.13 - Distribution of Blockchain and DLT startups and funding by type of client

The results show that Platform-based solutions are the most widespread, representing 38% of the total startups. An almost equal share is characterized by solutions that are targeting the final customers with 35%. Finally, startups that are limiting their offer to businesses represent 27%.

When considering the level of investment, it is notable how Platform raised half of the total amount of investment. Whereas, B2C solutions raised almost an equal share compared to the distribution of startups. Finally, B2B solutions are not only the least numerous but also the least invested.

One of the main pillars of Blockchain and DLT is decentralization, reducing the necessities of middlemen in many diverse industries and services. Therefore, it should not surprise that solutions aiming at the creation of a Platform to decentralize existing services are those who are gaining most of the attention.

The same consideration is true when comparing B2C and B2B markets. Indeed, the reduction in need of intermediaries is making many Blockchain and DLT solutions directly related to customers without the need to refer to middle business.

5.3 Focus on technologies: Platforms and their usage

In this last paragraph, the focus moves to the analysis of the different ways in which startups are leveraging on Blockchain and DLT based on the framework developed by "Osservatorio Blockchain and DLT" (2018). An analysis of the most used platforms follows.

5.3.1 How startups are leveraging on Blockchain and DLT

As aforementioned in the methodology section, where there is a more detailed description, "Osservatorio Blockchain and DLT" identified five different ways companies can leverage on Blockchain and DLT. Briefly, they are clustered in two main classes depending on the need of creating a new platform:

- Solutions that are developed on extant platforms:
    - Notarization: projects that use the distributed register of an existing platform to certify the date of a document and the fact that it has not been changed over time.

    - Smart Contract / Dapp: include solutions that use smart contracts and leverage existing networks and their features to create decentralized applications.
    - Cryptocurrency: projects that exploit existing cryptocurrencies or create new ones to allow the exchange of value between actors who do not trust each other.
- Solutions that need the development of a new platform:
    - DLT permissioned: These projects require the development of new platforms that also allow for digitizing processes and exploiting the programmability of smart contracts, but without introducing unique assets for the management of transfers and maintaining in some cases confidential transactions between network participants.
    - DLT permissionless: Projects in which a new platform is created consisting of a network of nodes and an immutable and distributed registry for sharing information between many actors who do not trust each other. Unique assets are transferred, and it is possible to schedule transactions and create smart contracts.

It is important to highlight that for not all startups, it was clear how they were leveraging on Blockchain and DLT because there was not enough information, or they were not disclosed. Indeed, 96 startups are not considered in this analysis resulting in a basis of 1191 startups that raised $ 7,53 billion.

The distribution of startup and funding by platform usage

Here**,** an analysis of the distribution of startups and their investment based on the ways they leverage on Blockchain and DLT platforms is depicted (*chart 5.14*).

Overall, solutions that include the deployment of **Smart Contracts** and Decentralized applications are those having the most success, being the most numerous, and most invested. Indeed, half of the sample is focusing on implementing new and different ways to offer these services.

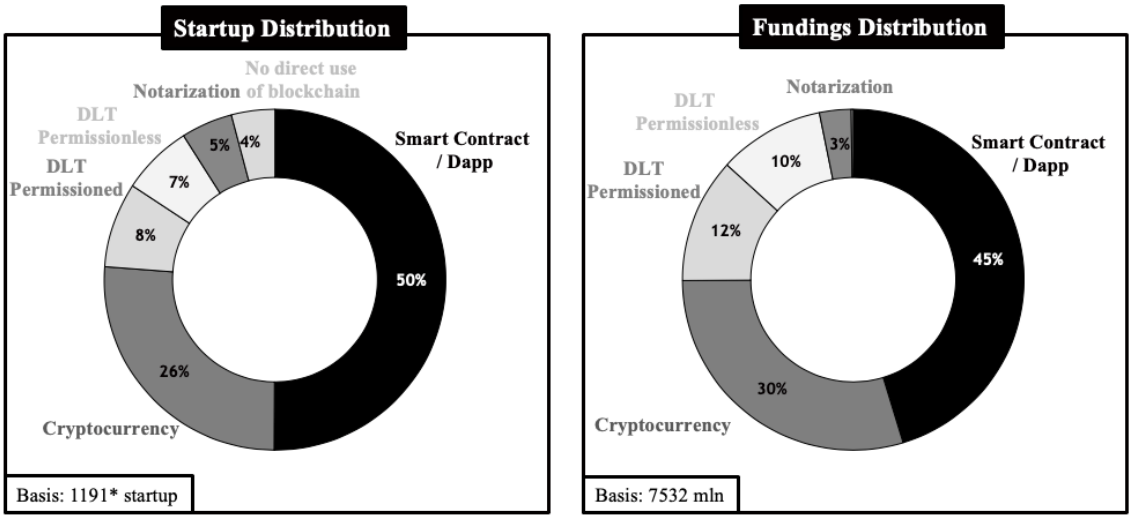


Chart 5.14 - Distribution of Blockchain and DLT startups and funding by platform usage

Moreover, another quarter of startup is focusing on creating and improving ways to use and manage **Cryptocurrencies**. These solutions are also attracting many investors, with 30% of the funding invested in this direction.

Furthermore, more one-fifth of the startups are implementing solutions of Blockchain as a service offering to companies the chance to create and use Distributed Ledgers. Among them, 8% is offering solutions with **permissioned DLT**, while 7% with **permissionless DLT**. Finally, only 5% are limiting their offers to **Notarization,** and 4% are **not directly** using Blockchain but are considered because they offer consulting services or information about Blockchain. The distribution of funding for these clusters is comparable to the distribution of startup apart from those that are not directly using Blockchain for which the amount of investment is so low that it is not even detectable.

The average distribution of funding by platform usage for startup

The analysis of the average value of the financing by the platform usage for the startup is described in the following chart (*chart 5.15*).

When looking at the average values of investment raised, the situation has reversed. **Smart Contract & Dapps** that were the most numerous by far receive only $ 5,72 million for a startup that is even lower than the average.

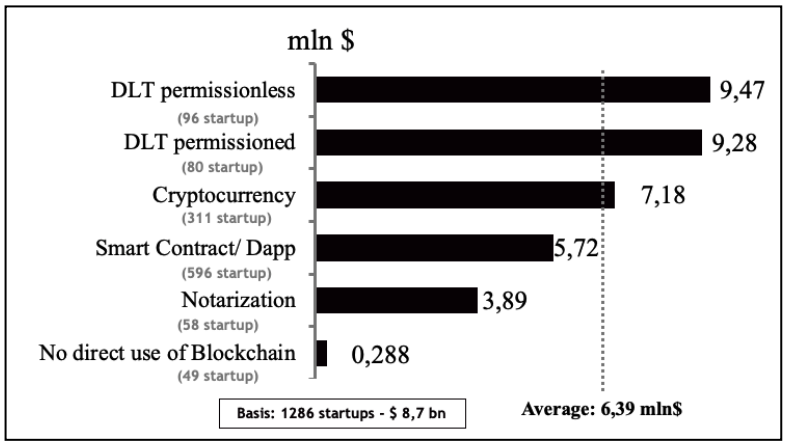


Chart 5.15 - the average distribution of funding for Blockchain and DLT startups by platform usage

However, this can be explained but the so high value of the number of startups (569) that is lowering the average. On the contrary, those startups that create both **permissioned** and **permissionless** platforms attract investors the most with, respectively, $ 9,28 and $ 9,47 million, that is higher than the average. Moreover, solutions that are focused on the usage of cryptocurrencies raise, on average, an amount of $7,18 million, which is slightly higher than the average. Finally, those offering the only **Notarization** are not only the least numerous but also the least invested.

Overall, **Smart Contracts** and Decentralized applications are the most widespread solutions due to the numerous implementations in various sectors that solutions including smart contracts, can have. Smart contracts are programmable and, thus, suitable for many diverse applications. This consideration is making them a great opportunity to create a new source of values that is what startups are looking for.

Moreover, as aforementioned, solutions concerning Blockchain and DLT are still related to the concept of **cryptocurrency** and their usage. Their diffusion and level of investment is further proof of this statement.

To conclude, startups that are creating **new platforms** and thus, exploiting the full potential of Blockchain and DLT, are those attracting a higher level of funding.

5.3.2 Blockchain and DLT Platforms

In the methodology section, it was shown how "Osservatorio Blockchain and DLT" identified, which are the main platform based on previous analyses: *Bitcoin*, *Ethereum* and *Hyperledger*. The other possibilities are:

- *Other*: startups that were leveraging on existent Distributed ledger platforms that have not been considered as the principal (e.g., Iota, Ripple, Quorum, …)
- *Various Blockchain*: those startups that were not related to a particular Blockchain but were leveraging on different platforms. For example, when they were offering the exchange of cryptocurrencies or the possibility to implement different Blockchain platform as a service.
- *New Blockchain*: Startups that were developing new protocols to improve the actual limits of the existing platforms and proposing their innovative architectures.

The distribution of startup and funding by the platform used

Here**,** an analysis of the distribution of startups and their investment based on Blockchain and DLT platforms is depicted (*chart 5.16*)

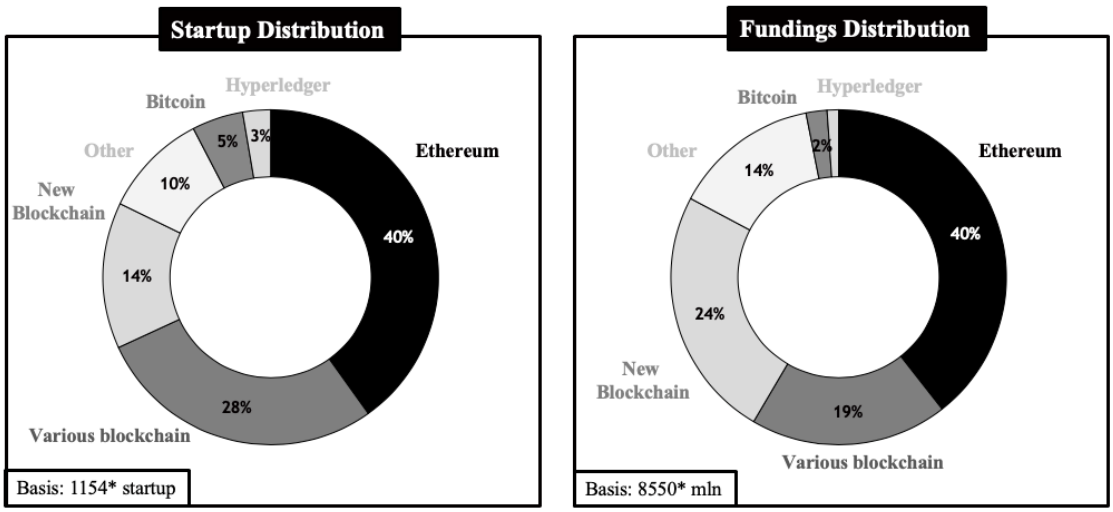


Chart 5.16 - Distribution of Blockchain and DLT startups and funding by the platform used

Among the different Blockchain platforms available, **Ethereum** appears to be the most used one with 463 startups. Moreover, solutions that are across different Blockchain and

DLT, such as wallet and exchange of cryptocurrencies, are also widespread, with more than a quarter of the startup going toward this direction. On the contrary, only 14% of the startups are developing a **new Blockchain**. **Bitcoin** and **Hyperledger** are other important Blockchain and DLT that have a relevant value, respectively, of 5% and 3%. Finally, all the other Blockchain and DLT that were not enough used to create a separate category are included in other, accounting for another 10%.

Accordingly, investors are attracted more by those startups that are using **Ethereum** as reference Blockchain with 3,37 billion dollars. On the contrary, solutions leveraging on the **various Blockchain and DLT** are not so attractive as their occurrence, with only 19% of the investment. An opposite turnover regards the startups that are creating a **new Blockchain** since almost a quarter of the total investments believe in these projects. Furthermore, startups using **Bitcoin** or **Hyperledger** raised only 3% of the total funding, but this is also due to their low numerosity. Finally, a relevant amount of 14% competes to startup using other types of Blockchain.

The average distribution of funding by the platform used for startup

The analysis of the average value of the financing by the platform used for the startup is described in the following chart (*chart 5.17*).

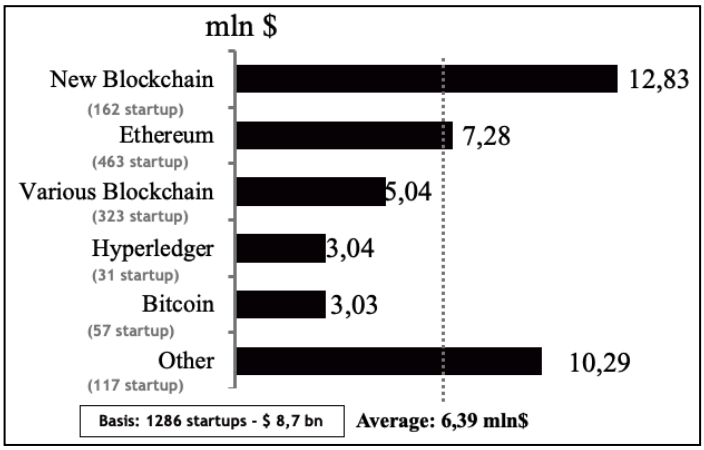


Chart 5.17 - the average distribution of funding for Blockchain and DLT startups by the platform used

Focusing on the average value that each startup has received by the platform used, it is clear how those developing a **new Blockchain** are gaining most of the attention. Indeed,

they are raising a value that is double the average. Moreover, those relying on **Ethereum** are in the second position proving that there is a confident trust in this platform. Finally, solutions that are across **various Blockchain and DLT** are not that attractive with an average value that is lower than the total average.

It is noticeable how solutions leveraging on **Other** Blockchain and DLT have an average value of $ 10,29 million, which is higher than the average.

Focus on the category "other" for the analysis based on the platform used

In Other, some startups were leveraging on existent Distributed ledger platforms that have not been considered as principal. Overall, 117 startups are operating within this cluster and raised a total amount of funding equal to $ 1.204.696.799,00. The distribution of startups and their investment is reported in *chart 5.18*.

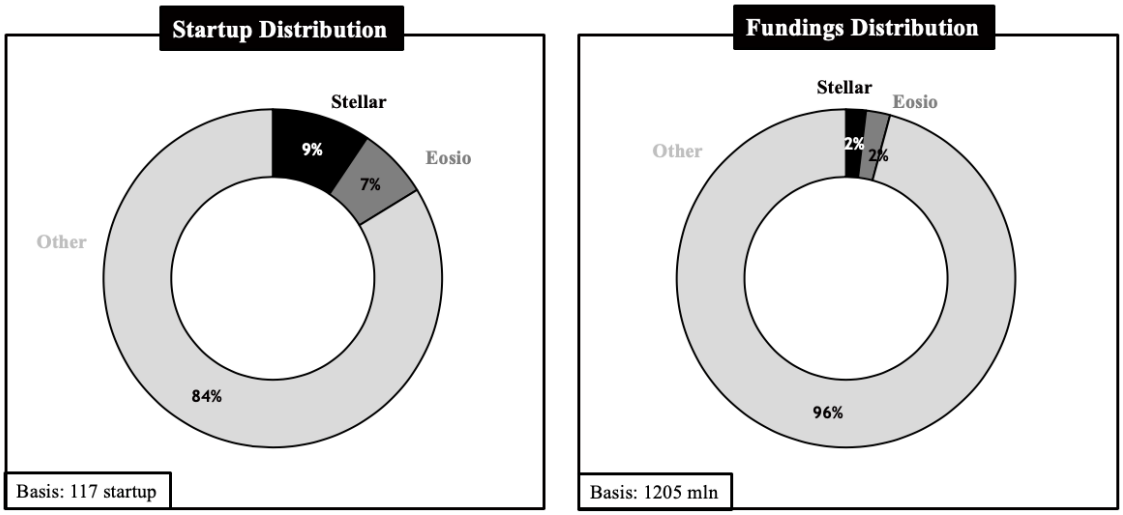


Chart 5.18 - Distribution of Blockchain and DLT platforms within the category "Other"

When unpacking the category other, only two other Blockchain platforms resulted relevantly and, thus, potentially be considered in future analyses: **Stellar** and **Eosio**.

Overall, Ethereum is the Blockchain and DLT platform that has been used the most, and that gained most of the attention by investors. This should not surprise because Ethereum is the first Blockchain that made possible the deployment of **Smart Contracts** that are, nowadays, one of the leading centers of interest of these technologies, in an easy and

decentralized way. Moreover, being the first mover, it could leverage a network effect that, in turn, is increasing the trust in the platform by users.

As far as concerned **Bitcoin**, its low programmability is what made it a solution that is almost limited to the exchange of cryptocurrencies.

Finally, startups developing **new protocols** are those that are most invested, and this is the last proof that Blockchain and DLT are in an initial phase, and limits still must be overcome.

5.4 Analysis of Funding typology: Traditional vs. ICO

In this paragraph, the aim is to understand whether there are some differences in the previously performed analyses when considering the funding typology. In particular, a first analysis of the trends of both ICO and Traditional investments during the years is outlined. Next, their distribution in the diverse industries and processes is analyzed. Finally, key trends emerged are discussed.

5.4.1 The distribution of investments over the years

The following bar charts (*chart 5.19; chart 5.20*) show the distribution of the typology of funding received by the startups over the years. The distinction is between ICO and "traditional" funding sources (funding sources different from the ICO), which are mostly venture capital investments. Since the ICO fundraising method relies on the Blockchain and DLT, it is interesting how much Blockchain startups have exploited it. Looking at the type of funding received by startups over time, it emerges that the phenomenon of **ICOs** begins in 2014 with the Ethereum Foundation, first to be funded with this new methodology and used in turn by many other projects. In 2017, the year of the highest hype, on the other hand, it reached 82% of total funding per year, collected through the ICO. In 2018, ICO represented 37%. However, it is important to consider here the Hong Kong-based startup Block.One, which alone raised more than $ 4 billion. In this case, the percentage would reach 70%.

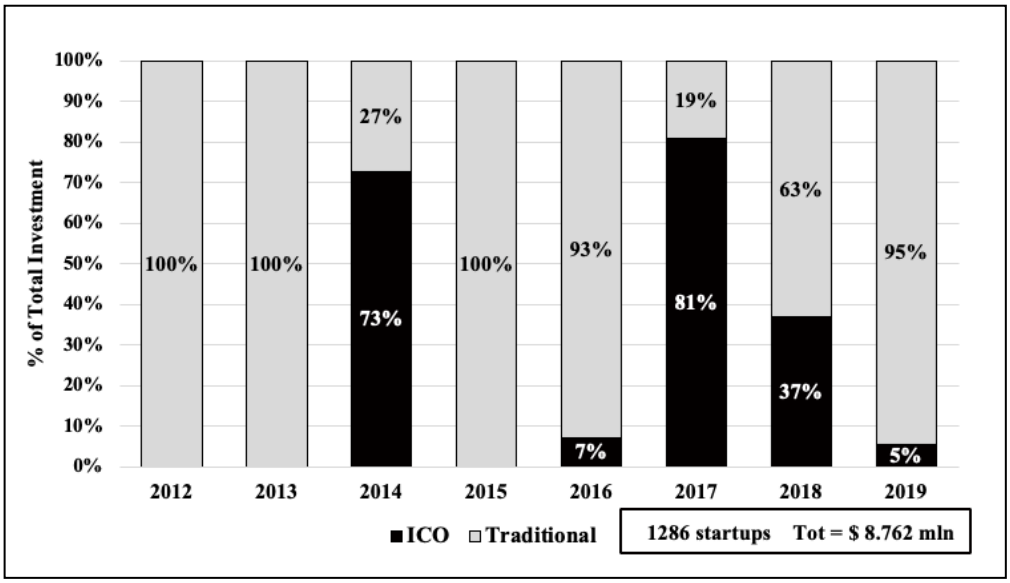


Chart 5.19 - Percentages of Investments by typology of funding over the years

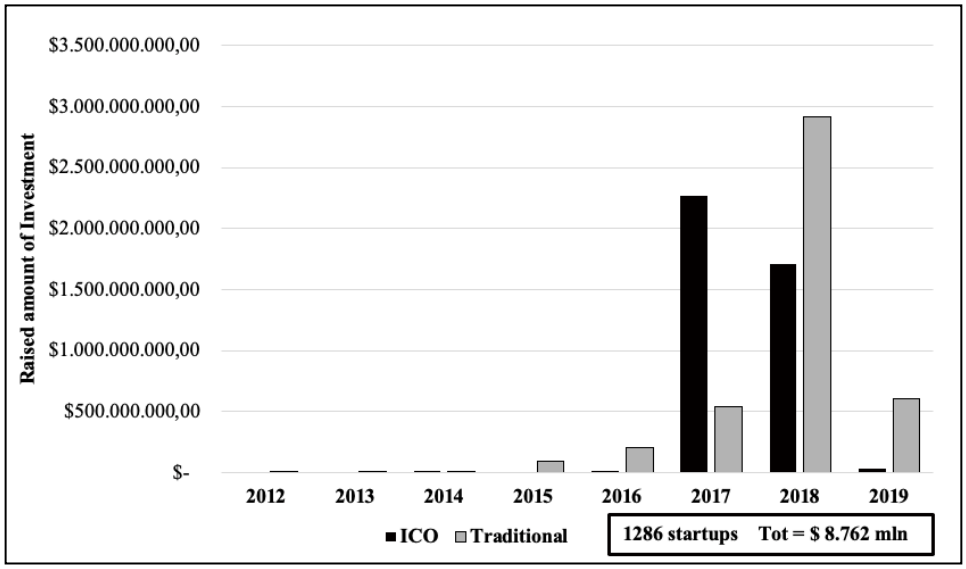


Chart 5.20 - Distribution of Investments by the typology of funding over the years

Due to these outstanding investments, the ICO method started to get the attention of investors but also of regulators. The legal status of ICOs is still under analysis. In 2019, there was a sudden drop; funding through the ICO has accounted for only 6% of the total. Looking at the investments as a whole, 2017 and 2018 accounts together for more than 88% of the funding received. The hype train hit not only the ICO domain but also the domain of venture capitals and business angels, the traditional investors. Despite the reduction in investment coming from ICO campaigns, the investments from traditional

sources increased from around half-billion dollars to almost $ 3 billion, representing 63% of the funding raised, leading 2018 to be the top year in the overall amount of investments gathered by the startups. In terms of aggregate amount, it does not make sense to draw conclusions about 2019, since the data gathered comprise only three months of the year. It is important to note that the years 2012 and 2013 are here represented due to the presence of pre-seed investments.

5.4.2 The distribution of Investments by typology across industries

Below, it is represented the distribution of the funding methods across the sectors (*chart 5.21)*

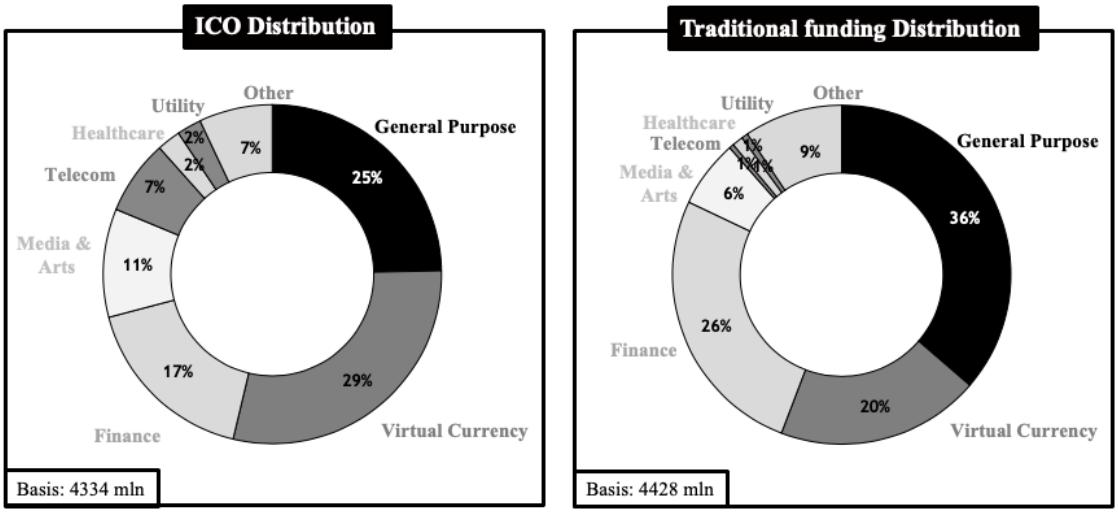


Chart 5.21 - Distribution of Investments by the typology of funding in the diverse industries

There are a few differences between the pie charts. However, it is important to notice how traditional investors tend more to invest in established industries, such as the financial sector or the **General Purpose** sector, which together represent 62% of the funding provided. Moreover, 20% of their investments are concentrated on the "**Virtual Currency**" domain. Which remains an important pillar in the Blockchain and distributed ledger field. Focusing on the ICO, the "Virtual Currency" sector obtains almost 30% of the investments. The result was expected the ICO campaign is based on the sale of tokens.

Compared to traditional investors, ICO investors tend to fund also less established sectors in the domain such as the “Media & Arts” and the “Telecom” industries.

5.4.3 The distribution of Investments by typology across processes

Below, it is represented the distribution of the funding methods across the business processes targeted by the startups (*chart 5.22*)

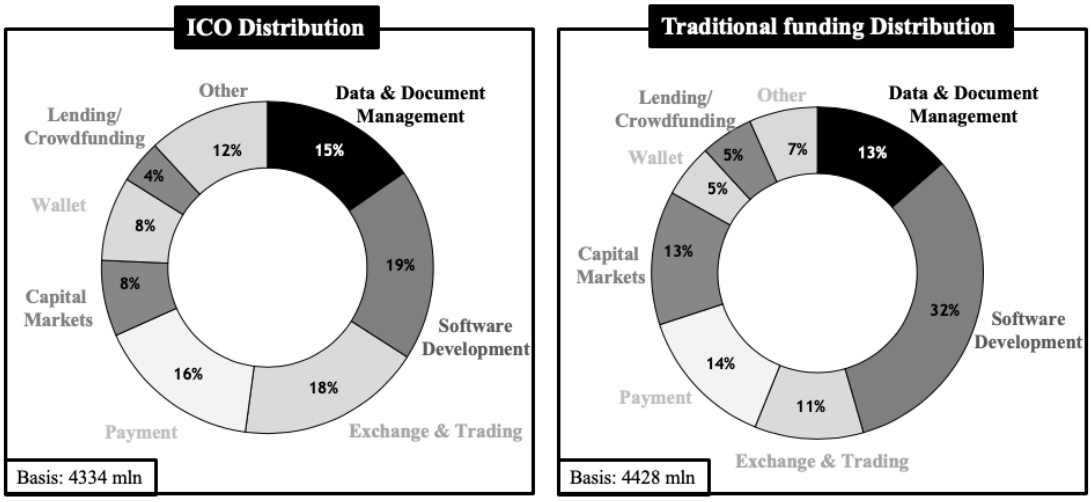


Chart 5.22 - Distribution of Investments by the typology of funding in the diverse processes

Among the startups that have only received funding from the ICO, the weight of the **Software Development** startups falls considerably, from 32% to 19%, while the category **Exchange & Trading** (from 11% to 18%) grows (almost doubling). The decrease in the first category is because recently, the most important projects related to solutions that allow Software Development tends to rely on traditional methods of financing. The large funds raised through ICO from Exchange & Trading solutions are instead an indication of the new methods of financing Exchange that, if initially were mainly traditional companies (e.g., Coinbase), today are increasingly decentralized and sometimes also have their tokens (e.g., Binance). Another difference to notice is the traditional investments in **Capital Markets** startups are 5% greater than the ones coming from ICO campaigns. The business model of these startups is strictly related to the ones of the investors themselves and, therefore, easily understandable by them.

CHAPTER 6
INFERENTIAL ANALYSIS

In the literature review, the relevance of some potential directives of innovation and development of the Blockchain and Distributed Ledger Technologies have been presented. The sector, the methodology of use of Blockchain technology, the typology of client-targeted, and the typology of investor has shown to have a direct impact on the amount of capital attracted by the Blockchain startups analysed. Therefore, they might be representative of the future development of the technologies and can be used to understand whether a new venture is following the right path or is going in an unexplored or previously less successful domain. In the following lines, the process and results of the inferential analysis will be presented. The final purpose is to find results, which will support the testing of the hypotheses which will be discussed in the next chapter.

The objectives of this analysis are summarized here:

- To understand which the directives of development and innovation of Blockchain and distributed ledger technology are.
- To understand whether differences between ICO and other sources of funding exist in highlighting the sectors as directives of innovation and development.
- To understand which business solutions will be more representative of the future of the domain. Showing which type of business models, leveraging on Blockchain and distributed ledgers technologies, might be more frequent in the next years.

The means through which the objective is reached are:

- Performing a multiple linear regression. Analysing the significance and the coefficients of each independent variables impacting on the dependent variable "Total funding amount."

- Performing a multiple linear regression. Analysing the significance and the coefficients of the levels of the categorical variable "Sector." Considering as response variables "ICO funding" and "Traditional funding."
- Performing a multiple linear regression. Analysing the significance and the coefficients of the level of a new categorical variable "Business solution." Created ad hoc, by crossing the variables "Sector" and "Process," from the descriptive analysis of the database.

6.1 Data filtering

The startups which did not receive funding have not been considered in the analysis. For many of them, there was uncertainty on the data gathered. Besides, the value we are interested in is the amount of investment received and who the investors were, not whether a startup has received funding or not. Block.One has not been included as it received more than 4 billion in ICO, which represents 1/3 of the total amount of funding of all startups. Furthermore, all those startups which did not explicitly use the Blockchain and Distributed Ledger Technologies have been removed. The analysis is therefore carried out on 951 observations in total. 721 received funding only from traditional sources, 173 only from ICO. The remaining startups (57) received funding from both sources.

To analyse the differences between startup funded through ICO and other sources of funding, these 57 startups have been inserted in the first two categories defining the first type of investment received. Consequently, there are three distinctive databases for each dependent variable:

- Total funding amount: 951 observations
- ICO: 186 observations
- Traditional sources: 765 observations

6.2 Dependent variables

The dependent variables are analyzed in the following sections.

6.2.1 Total funding amount

The distribution of the total funding amount received is highly skewed. It is an inverse logarithm distribution (*chart 6.1*).

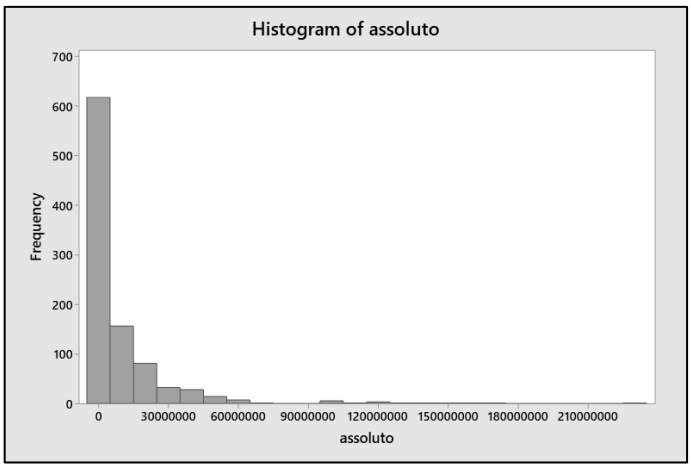


Chart 6.1 - Distribution of total funding amount in absolute values

Hence, a logarithmic transformation to make values more manageable is conducted (*chart 6.2*). It will consider the skewness of the distribution (Fisch 2019; Block 2018).

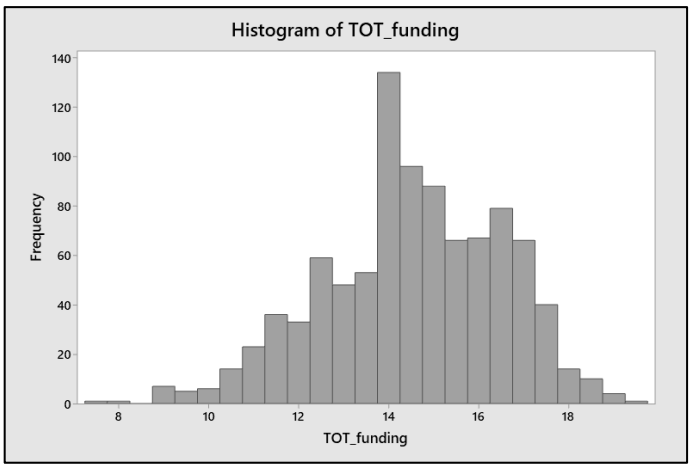


Chart 6.2 - Distribution of logged total funding amount

6.2.2 ICO

The distribution of the ICO funding amount received is highly skewed (*chart 6.3*). It is an inverse logarithm distribution.

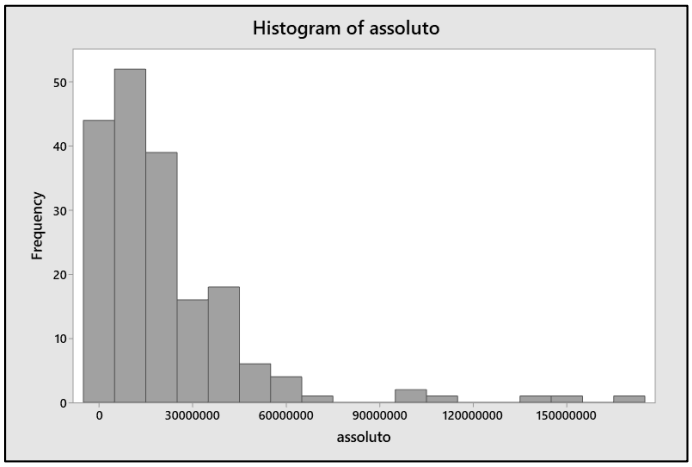


Chart 6.3 - Distribution of ICO funding amount in absolute values

Hence, a logarithmic transformation to make values more manageable is conducted (*chart 6.4*). It will consider the skewness of th distribution (Fisch 2019; Block 2018).

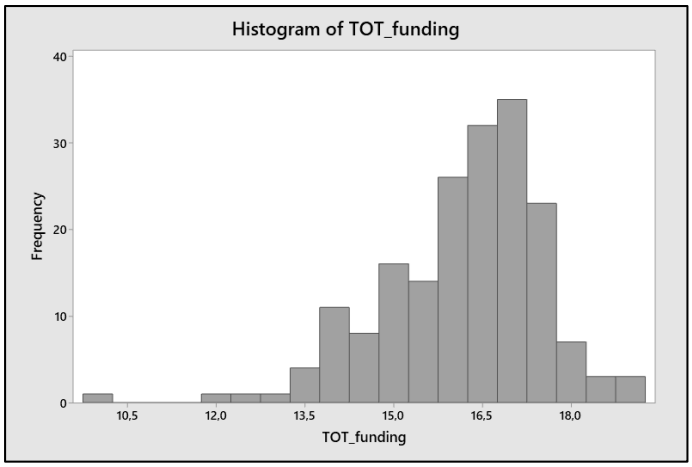


Chart 6.4 - Distribution of logged ICO funding amount

6.2.3 Traditional sources

The distribution of the traditional funding amount received is highly skewed (*chart 6.5*). It is an inverse logarithm distribution.

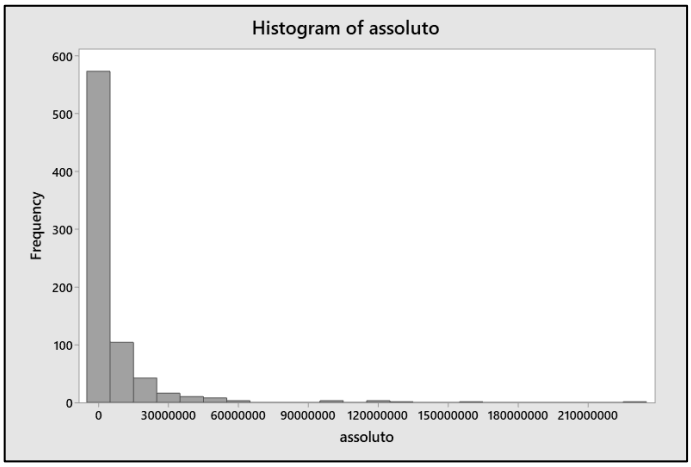


Chart 6.5 - Distribution of traditional funding amount in absolute values

Hence, a logarithmic transformation to make values more manageable is conducted (*chart 6.6*). It will consider the skewness of the distribution (Fisch 2019; Block 2018).

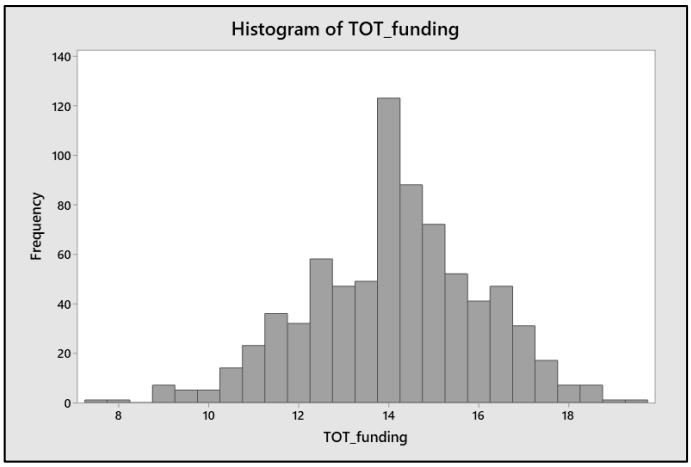


Chart 6.6 - Distribution of logged traditional funding amount

6.2.4 Independent variables

The independent variables have been selected following the hypotheses developed analysing the literature. They are categorical variables, which in the descriptive analysis of the database have been used to give a vision of the current international status quo of the Blockchain and Distributed Ledger Technologies. Below (*Table 6.1*), the table sums up the independent variables, the outcome of the literature analysis.

Variable	Description	Hypotheses
Sector	The industry to which the startup belongs.	1. "Blockchain & Distributed Ledger technologies are likely to develop more in some sectors than in others." 7. "The sector in which the startup operates might have a significance in which type of funding method is received."
Process	The main business processes where Blockchain & DLT are impacting the most.	2. The Blockchain & Distributed Ledger technologies are more likely to develop to improve some processes than others."
Methodology of use	Ways of implementing solutions leveraging on Blockchain & DLT.	4. "Blockchain & Distributed Ledger technologies are more likely to develop for some methodologies of use of the blockchain technology than others."
Type of client	Type of client the business solution is addressing.	5. "Blockchain & Distributed Ledger technologies are likely to progress in the development and management of platforms."
Type of funding	Typology of funding received by the startup.	6. "The ICO funding method is likely to have a greater impact on the future development of Blockchain & Distributed Ledger technologies compared to other funding sources." 7. "The sector in which the startup operates might have a significance in which type of funding method is received."
Business solution	Main crossings between Sector and Process	3. "Some business solutions are more likely to be representative of the future of Blockchain and Distributed Ledger Technologies than others"

Table 6.1 - Hypotheses and related independent variables

The hypotheses from 1 to 5 and 7 will be tested through the regression analysis with the dependent variable "Total funding amount." *Hypothesis 6* will consider the dependent variables "ICO funding" and "Traditional funding," using the single categorical variable "Sector."

6.2.5 Grouping

First, some levels of the categorical variables "Sector," "Process", "Methodologies_bc" and "Business solutions" will be grouped to improve the quality of the predictive models. The reason for grouping levels is that the performance level of the model may be pulled down by a categorical variable with too many levels. Moreover, if a categorical variable presents levels that rarely occur, this level has a low chance of making a meaningful impact on the model. Besides, one level of a categorical variable may occur very often; this would lead to a very low variation which has not a positive impact on the model. To group levels, there are some alternative ways:

- To use business logic: The grouping is performed based on the knowledge of the field and experience.
- Frequency: By looking at the frequency distribution of each level, grouping the levels having occurrence below 5% of the total.
- Regression coefficients: To group the levels looking at the impact on the response variable. However, since some levels may have low occurrences, they do not represent a significative set. Hence, at first, the frequencies will be used.

For each categorical variable, descriptive data are presented. They are extraction of the data presented in the previous chapter; however, the number of observations has been changed due to the technical requirement of the inferential analysis.

Sector: the levels will be grouped according to the occurrences because of the broad differences among the various levels (*table 6.2*).

Sector	Frequency
General Purpose	26,85%
Virtual Currency	24,28%
Finance	17,70%
Media & Arts	10,19%
Other	7,30%
Healthcare	2,88%
Logistic	2,16%
Utility	1,85%
Agri-Food	1,65%
Telecom	1,34%
Insurance	1,23%
Automotive	1,03%
Luxury	0,72%
Government	0,62%
Airline	0,21%

Table 6.2 - Occurrences of sectors

Owing to that the relative frequency of some levels is mainly below 5%, they will be incorporated with the level "Other." Hence, the new categorical variable "Sector" is composed by: "General Purpose," "Virtual Currency," "Finance," "Media & Arts," "Other."

Process: the levels will be grouped according to the occurrences because of the broad differences among the various levels, and according to business logic. Some processes listed below are highly correlated.

Process	Frequency	Occurrences
Software development	21,45%	204
Data & Document Management	20,82%	198
Payment	14,41%	137
Exchange & Trading	12,93%	123
Capital Markets	8,62%	82
Wallet	4,73%	45
Lending/Crowdfunding	3,58%	34
Identity	3,36%	32
Tracking & Supply chain	3,26%	31
Advertising Management	2,84%	27
Other	1,37%	13
Supply Chain Finance	0,95%	9
Voting	0,95%	9
Property Registry	0,74%	7

Table 6.3 - Occurrences of processes in percentage and absolute values

First, according to the business logic and the frequencies, "Software Development," "Data & Document Management," and "Payment" will be left as single levels. "Exchange & Trading" and "Wallet" will be grouped in a single category, due to their similarities. The two levels are characteristic of business models focused on the storage or conversion of virtual currencies. The new category will be called "Wallet & Exchange." Moreover, the level "Lending/Crowdfunding" will be incorporated in the category "Capital Markets," since it can be seen as a subset of the second. Owing to that the relative frequency of some levels is largely below 5%, they will be incorporated with the level "Other." However, the level "Tracking & Supply chain" resulted in a variable of interest from the literature analysis. Therefore, it will be left as a sole category. The new categorical variable "Process" is composed by: "Software Development," "Data & Document Management," "Payment," "Wallet & Exchange," "Capital Markets," "Tracking & Supply chain," "Other."

Methodologies_bc: below, the frequencies) are shown (*Table 6.4*). Here, the business logic must be combined with the other factors to improve the quality of the decision.

Methodology	Frequency
Smart Contract/ Dapp	48,82%
Cryptocurrency	22,14%
DLT permissioned	14,79%
DLT permissionless	6,24%
Notarization	3,73%

Table 6.4 - Occurrences of methodologies of use

"Notarization" can be seen as a sub-set of "Smart Contract/ Dapp," hence, it can be incorporated with that level. "DLT permissioned" and "DLT permissionless" can be grouped, since in both the case the startup has developed a new protocol.

Therefore, the new categorical variable "Methodologies_bc" is composed of three categories: "Solutions on bc," "DLT" and "Cryptocurrency."

Business solution: the levels will be grouped according to the occurrences because of the broad differences among the various levels, and according to business logic.

Sector	Process	Frequency	Occurrences
General purpose	Software development	14,62%	139
	Data & Document Management	5,26%	50
	Identity	1,47%	14
	Advertising Management	0,63%	6
Virtual Currency	Echange & Trading	8,62%	82
	Payment	5,89%	56
	Wallet	3,72%	36
	Software development	2,10%	20
	Data & Document Management	1,26%	12
	Lending/Crowdfunding	0,84%	8
Finance	Capital Markets	5,57%	53
	Payment	3,05%	29
	Lending/Crowdfunding	2,42%	23
	Data & Document Management	1,79%	17
Media & Arts	Data & Document Management	4,84%	46
	Payment	1,47%	14
	Advertising Management	1,37%	13
	Software development	1,05%	10
Healthcare	Data & Document Management	2,31%	22
Logistic	Tracking & Supply chain	1,05%	10
	Data & Document Management	0,74%	7
Agri-Food	Tracking & Supply chain	0,84%	8
Automotive	Payment	0,42%	4
	Data & Document Management	0,11%	1
Telecom	Data & Document Management	0,74%	7
	Software development	0,32%	3
Utility	Tracking & Supply chain	0,21%	2

Table 6.5 - Occurrences of processes in percentage and absolute values

Since, it is interesting to test which business solutions will be more representative of the future of Blockchain and Distributed Ledger Technologies, the grouping will be performed based on the occurrences, but with a more flexible approach. The categories considered will be the ones with at least 10 occurrences in the database. Hence:

Sector	Process
General purpose	Software development
	Data & Document Management
	Identity
Virtual Currency	Echange & Trading
	Payment
	Wallet
	Software development
	Data & Document Management
Finance	Capital Markets
	Payment
	Lending/Crowdfunding
	Data & Document Management
Media & Arts	Data & Document Management
	Payment
	Advertising Management
	Software development
Healthcare	Data & Document Management

Table 6.6 - business solutions

6.2.6 Independent variables description

Sector: categorical variable divided into 5 levels: "General Purpose," "Finance," "Virtual Currency," "Media & Arts," and "Other." It is representative of the most frequent industries in which the startup operates. To improve the quality of the results, the 5 levels will be transformed into dummy variables.

- *Sector_General Purpose:* dummy variable. It comprises startups that provide a generalized service across multiple domains. Due to the novelty of the field, it is expected to have a significant positive correlation with the dependent variable.
- *Sector_Finance:* dummy variable. In this category, all the startups exploit the Blockchain to make the services offered by the main financial institutions (banks, insurance companies, markets,...) more efficient. Since it is one of the pioneer

sectors, it is expected to have a significant positive correlation with the dependent variable.

- *Sector_Virtual Currency:* dummy variable. In this category, there are those startups that provide services or products closely related to digital currencies. The Blockchain technology presented itself to the world through the Bitcoin, the first notorious cryptocurrency. However, recently, the disruptive potential of technology has been seen in other typologies of use.
- *Sector_Media & Arts:* dummy variable. Startups that are dealing with the management of multimedia and artistic content, both physical and digital.
- *Sector_Other:* dummy variable. In this category, there are all the startups in areas not sufficiently widespread to be considered as individual dummy variables. This cluster will be removed from the model and considered as the reference level.

Process: categorical variable divided into 8 levels: "Software Development," "Data & Document Management," "Payment," "Wallet & Exchange," "Capital Markets," "Tracking & Supply chain," "Other." It is representative of the most frequent business models of the startups. To improve the quality of the results, the seven levels will be transformed into dummy variables.

- *Process_Software Development:* dummy variable. Startups that are trying to overcome the actual limitation of the Blockchain technology by proposing new and improved protocols to offer Blockchain and DLT as a service. It is expected to remain a significant service category in the next years. Since the technologies have not reached a dominant design.
- *Process_Data & Document Management:* dummy variable. Startups that optimize the management of data by leveraging the characteristics of transparency and immutability. Since the technologies are leveraged to increase the efficiencies in these kinds of processes, it is expected a positive correlation with the dependent variable.
- *Process_Payment:* dummy variable. Startups that are trying to offer new and improved solutions for digital payment.

- *Process_Wallet & Exchange:* dummy variable. Startups that are offering solutions, not related to investment, for exchanging virtual currencies in fiat and solutions focused on the storage and management of cryptocurrencies.
- *Process_Capital Markets:* dummy variable. The process that refers to the issue and negotiation of financial securities (e.g., purchase and sale of shares, issue of bonds, purchase, and sale of derivatives,..).
- *Process_Tracking & Supply Chain:* dummy variable. Solutions that aim to improve the traceability of products and the optimization of the exchange in the supply chain. As seen in the descriptive analysis chapter, it is not a widely spread process among startups. However, it is a domain primarily analysed in the literature, and use cases already exist. What is expected is that traceability will be one of the most significant factors in the next years.
- *Process_Other:* dummy variable. In this category, you will find all the startups in areas not sufficiently widespread to be considered as individual dummy variables. This will be removed from the model and considered as the reference level.

Methodologies_bc: categorical variable divided into 3 levels: "Solutions on Blockchain," "DLT," and "Cryptocurrency." It is representative of the different typologies of use of Blockchain technology. To improve the quality of the results, the three levels will be transformed into dummy variables.

- *Methodologies_bc_Solutions on bc:* dummy variable. Projects that develop solutions on existing Blockchain and DLT or distributed ledgers. It considers cases of exclusive notarization. Furthermore, all the projects in which smart contracts are developed and deployed, exploiting existing networks, and their programmability characteristics to create decentralized applications Dapps. Since the use cases of the Blockchain technology are growing in number, it is expected that the market of business applications is increasing. Hence, a significant positive correlation is envisaged.
- *Methodologies_bc_DLT:* dummy variable. Projects that involve the creation of a network of nodes and an immutable and distributed ledger where information is shared among numerous actors who do not trust each other. This mechanism also

allows for digitizing processes and exploiting the programmability of smart contracts,

- *Methodologies_bc_Cryptocurrency:* dummy variable. Projects that exploit the already existing cryptocurrencies to allow the exchange of value between actors who do not know each other and do not trust each other. In these projects, the presence of a unique asset within the platform becomes fundamental. This will be removed from the model and considered as the reference level. Therefore, the analysis will be performed comparing the results to the trend of the exclusive usage of cryptocurrency. It has been the first mainstream use of the technologies; however, in the last years, the business applications are taking hold. What is expected is to experience an increase in business applications in the future compared to the use of cryptocurrencies.

Type_client: categorical variable divided in 3 levels: "B2C", "B2B" and "PLATFORM". It is representative of the different clients target of Blockchain startups. To improve the quality of the results, the three levels will be transformed into dummy variables.

- *Type_client_B2C:* dummy variable. It includes all those startups of which the client is the consumers.
- *Type_client_B2B:* dummy variable. It includes all those startups of which the client is businesses.
- *Type_client_PLATFORM:* dummy variable. When the startup is developing a multi-sided platform. The purpose of its operations is the development and/or the management of the platform. This will be removed from the model and considered as the reference level. Starting from this, it would be possible to see how exclusively B2C or B2B startups are performing compared to startups which develop and/or manage platforms. The results of the analysis will support to draw inferences on the future of the technologies.

Type_funding: categorical variable divided into 3 levels: "ICO," "TRADITIONAL," and "BOTH". It is representative of the difference between the ICO fundraising process and

other sources of funding. To improve the quality of the results, the three levels will be transformed into dummy variables.

- *Type_funding_ICO:* dummy variable. It comprises the startups which received funding exclusively from ICO.
- *Type_funding_BOTH:* dummy variable. Here, the startups which have received investments from ICO and other sources are considered.
- *Type_funding_TRADITIONAL:* dummy variable. In this category, all the startups which did not received funding through ICO but through other sources are considered. This will be removed from the model and considered as the reference level. In this way, the results will show the comparison between ICO funding and the startups, which received exclusively funding from traditional sources (different from ICO).

Business solution: categorical variable. It is representative of the most frequent business solutions in the startup ecosystem. To improve the quality of the results, the levels will be transformed into dummy variables. For a comprehensive description of the categories, refer to the descriptive analysis chapter. The group "Other" will be removed from the model and considered as the reference level.

6.3 Control variables

6.3.1 Control variables introduced for ruling confounding effects and interest

- *Regulations*: Since different countries have a different view on the technology, the national regulations are strongly impacting on the business development of related applications. To limit this effect, the control variable **"Location"** is a prospective candidate to enter the model, to mitigate the effect of regulations on the investment received. Furthermore, the location seems to be a significant factor, as shown in the literature. Giudici and colleagues (2018), Shian and Han Wu (2019), and Fenu and colleagues (2018) had shown or had expressed an opinion on the correlation

between the location of the company issuing the ICO and the success of the ICO campaign. Mollick (2014) had demonstrated the correlation between crowdfunding and the location of the organization. While Prohorovs and colleagues (2018) and Friedlmaier and colleagues (2017) urge for further researches in the analysis of the correlation between the location and the funding amount raised by a new venture. To conclude, the descriptive analysis of the database performed in the previous chapter showed how the Blockchain startups are geographically distributed. The discussion brought up some elements, including regulations, that made the variable of interest. However, since there are many DAOs (Decentralized Autonomous Organizations), the variable has not been introduced as an independent variable. It is expected that the correlation will be unbalanced due to the presence of tax havens.

- The number of "**Funding_rounds**" is also considered. It should increase the quality of the predictive model. Since the number of funding rounds undertaken by the startups varies from 1 to 10 in the database, logically a startup which has received more funding rounds should have given evidence of prospective growth. However, the number of funding rounds may be influenced by the policy of investors. Therefore, it will be exclusively inserted as a control variable. These considerations will be considered while analysing the results.

6.3.2 Control variables description

Location: categorical variable, which will be divided into five dummy variables:

- *Location_Regulated countries:* dummy variable. It comprises all those countries which developed clear regulations for ICO and, in general, for the utilization of tokens for the fundraising process. Among them, the US is not considered because of the great portion of startups which are located there. The countries belonging to the category are Switzerland, Cayman Islands, Russia, Gibraltar, Singapore, Australia, Malta, Estonia, UK, and China.
- *Location_Rest of Europe:* dummy variable. It comprises all the European countries which do not have special regulations for the ICO.

- *Location_Rest of Asia:* dummy variable. It comprises all the Asian countries which do not have special regulations for the ICO.
- *Location_North America:* dummy variable. It comprises the US and Canada.
- *Location_Other:* dummy variable. All the other geographical areas with relatively small occurrences of observations are included (Africa, South and Central America, the rest of Oceania). This will be removed from the model and considered as the reference level.

Funding rounds: It is a categorical variable. The values range from 1 to 10 funding rounds. The variable will be considered as a continuous variable in the multiple linear regression.

6.4 Multiple linear regression

In this paragraph, the steps and results of the multiple linear regression are showed. First, the results considering the dependent variable "Total funding amount" are represented. They will be used in the discussion chapter to test the hypotheses. Afterward the comparisons between the sector's categories resulting using "ICO funding" and "Traditional sources funding" as dependent variables will be implemented. Finally, a new categorical variable will be introduced as an independent variable, "Business solution," and tested in a regression model in respect of the dependent variable "Total funding amount." This analysis will be presented in the discussion chapter.

6.4.1 Dependent variable: Total funding amount

Descriptive statistics

The table below shows the descriptive statistics of the 951 observations in the analysis. A deep analysis of the database is provided in the related section. However, this table gives a quick overview of the data used in inferential analysis *(table 6.7*).

Variable	N	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
TOT_funding	951	14,52	0,0643	1,983	7,601	13,305	14,509	16,118	19,271
Funding_rounds	951	1,7171	0,0393	1,2117	1	1	1	2	10
Sector_Finance	951	0,1767	0,0124	0,3816	0	0	0	0	1
Sector_General Purpose	951	0,2597	0,0142	0,4387	0	0	0	1	1
Sector_Media & Arts	951	0,10305	0,00986	0,30418	0	0	0	0	1
Sector_Virtual Currency	951	0,2471	0,014	0,4316	0	0	0	0	1
Process_Capital Markets	951	0,122	0,0106	0,3274	0	0	0	0	1
cess_Data & Document Managemen	951	0,2082	0,0132	0,4062	0	0	0	0	1
Process_Payment	951	0,1441	0,0114	0,3513	0	0	0	0	1
Process_Software development	951	0,2145	0,0133	0,4107	0	0	0	0	1
Process_Tracking & Supply chain	951	0,0326	0,00576	0,17767	0	0	0	0	1
Process_Wallet & Exchange	951	0,1767	0,0124	0,3816	0	0	0	0	1
Methodologies_bc_DLT	951	0,2198	0,0134	0,4143	0	0	0	0	1
ologies_bc_Smart Contract/ Dapp	951	0,5489	0,0161	0,4979	0	0	1	1	1
Type_Client_B2B	951	0,2923	0,0148	0,4551	0	0	0	1	1
Type_Client_B2C	951	0,3249	0,0152	0,4686	0	0	0	1	1
Type_funding_BOTH	951	0,05994	0,0077	0,23749	0	0	0	0	1
Type_funding_ICO	951	0,1819	0,0125	0,386	0	0	0	0	1
Location_North America	951	0,3964	0,0159	0,4894	0	0	0	1	1
Location_Regulated countries	951	0,3523	0,0155	0,4779	0	0	0	1	1
Location_Rest of Asia	951	0,08202	0,0089	0,27454	0	0	0	0	1
Location_Rest of Europe	951	0,1167	0,0104	0,3213	0	0	0	0	1

Table 6.7 - Descriptive statistics of the variables in the model

Logged total funding amount raised (dependent variable): the mean values are 14,52 (therefore, around $ 2 million), the median is 14,51. The logarithmic transformation had the purpose to distribute the dependent variable normally. The largest amount of funding received is 19,271 ($ 234 million) and the minimum is 7,601 ($ 2000)

Correlation matrix

The correlation matrix of the explanatory variables is presented (*Table 6.9)*. It is used to check the presence of multicollinearity in the model. The correlation index, in absolute values, greater than 0.3, are highlighted in grey. The pairwise correlation of these potential problems are shown below (*table 6.8).*

Variable 1	Variable 2	Correlation Index
Sector_General Purpose	Process_Software Development	0.503
Sector_Virtual Currency	Process_Wallet & Exchange	0.489
Sector_Finance	Process_Capital Markets	0.468
Sector_Virtual Currency	Type_client_B2C	0.394
Process_Software Developmen	Type_client_B2B	0.368
Sector_General Purpose	Type_client_B2B	0.363
Process_Wallet & Exchange	Type_client_B2C	0.350
Sector_General Purpose	Methodologies_bc_DLT	0.317

Table 6.8 - Pairwise correlation table

Therefore, to mitigate the effect of multicollinearity, it is supposed that, in the final model, one of the variables "Sector" or "Process" will not be included. However, since the interest of this analysis is to test the hypotheses, this discussion will be postponed when performing the multiple linear regression; analysing the VIFs and the changes in the coefficients while finding the best fitting model.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Sector_Finance (1)	1																				
Funding_rounds (2)	0,015	1																			
Sector_General Purpose (3)	-0,274	0,073	1																		
Sector_Media & Arts (4)	-0,157	-0,064	-0,201	1																	
Sector_Virtual Currency (5)	-0,265	-0,076	-0,339	-0,194	1																
Process_Capital Markets (6)	0,468	-0,046	-0,177	-0,116	-0,027	1															
cess_Data & Document Management	-0,122	-0,047	-0,008	0,218	-0,222	-0,191	1														
Process_Payment (8)	0,038	0,024	-0,175	-0,001	0,154	-0,153	-0,21	1													
Process_Software development (9)	-0,182	0,025	0,503	-0,093	-0,181	-0,195	-0,268	-0,214	1												
Process_Tracking & Supply chain (10)	-0,085	0,014	-0,028	-0,062	-0,105	-0,068	-0,094	-0,075	-0,096	1											
Process_Wallet & Exchange (11)	-0,041	-0,01	-0,249	-0,121	0,489	-0,173	-0,238	-0,19	-0,242	-0,085	1										
Methodologies_bc_DLT (12)	-0,073	0,105	0,317	-0,038	-0,204	-0,089	-0,028	-0,08	0,248	0,103	-0,186	1									
ologies_bc_Smart Contract/ Dapp (13	0,06	-0,07	-0,017	0,127	-0,304	-0,024	0,205	-0,104	0,016	0	-0,178	-0,585	1								
Type_Client_B2B (14)	-0,025	-0,005	0,363	-0,127	-0,181	-0,07	-0,028	-0,125	0,368	0,09	-0,243	0,133	0,109	1							
Type_Client_B2C (15)	0,014	-0,029	-0,293	-0,021	0,394	-0,025	-0,052	0,144	-0,27	-0,115	0,35	-0,189	-0,134	-0,446	1						
Type_funding_BOTH (16)	0,046	0,253	0,012	-0,013	-0,032	0,001	0,023	0,035	-0,056	0,004	0,034	0,026	-0,029	-0,075	0,014	1					
Type_funding_ICO (17)	0,017	-0,128	-0,006	0,055	-0,03	0,082	-0,034	0,001	-0,06	-0,01	-0,033	0,033	-0,044	-0,123	-0,007	-0,119	1				
Location_North America (18)	-0,043	0,049	0,02	0,029	0,019	-0,052	-0,045	-0,014	0,069	0,021	-0,043	-0,004	0,026	0,06	-0,034	-0,033	-0,204	1			
Location_Regulated countries (19)	0,016	-0,048	-0,045	0,011	0,016	0,061	0,028	-0,014	-0,058	-0,024	0,028	0,023	-0,066	-0,092	0,09	0,046	0,166	-0,598	1		
Location_Rest of Asia (20)	-0,008	-0,031	0,015	-0,013	-0,002	-0,006	-0,002	-0,003	0,031	0,01	0,012	0,036	-0,014	0,019	-0,036	-0,011	0,038	-0,242	-0,22	1	
Location_Rest of Europe (21)	0,038	-0,007	0,054	-0,037	-0,087	0,005	0,088	-0,028	-0,03	0,025	-0,031	0,005	0,047	0,033	-0,035	-0,009	0,032	-0,295	-0,268	-0,109	1

Table 6.9 - Correlation matrix

Best fitting model

Each categorical variable (with the categories as dummy variables) have been tested in combination with the control variables. The results are summarized in *Table 6.25*, on the next page. Furthermore, Model 6 considers all the independent and control variables. However, since the categories of the variable "Process" are generally not significant, and the multicollinearity represented a potential issue, Model 7 has been developed. The R-pred is 31,93% in this case, hence greater than in Model 6. Model 7 will be used for hypotheses testing. Consequently, in this research, the second hypothesis developed through the literature review will not be tested. The VIFs, for what concerns the independent variables are largely below the threshold value 10; therefore, the multicollinearity can be excluded to have an impact in this model. The only high values are those linked to the categories "North America" and "Regulated Countries" of the variable "Location." They present a VIF close to 5 but not greater than 10. A possible justification of these values is linked to the high number of startups belonging to the two clusters. *Chart 6.7* shows the heteroscedasticity test of the residuals for Model 7. The P-Value is smaller than 0,005; therefore, the model is homoscedastic, and the results are reliable. It indicates that the variance of the random variables remains constant as the observations vary.

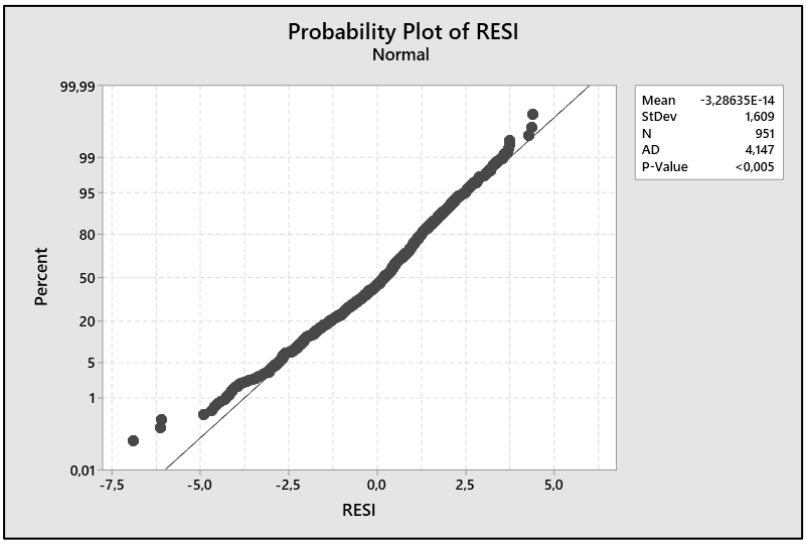


Chart 6.7 - Heteroscedasticity test for the final model

	MODEL 1				MODEL 2				MODEL 3				MODEL 4				MODEL 5				MODEL 6				MODEL 7			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
Independent Variables																												
Sector																												
Sector_Finance	0,891	0,196	0	1,51																	0,66	0,197	0,001	2,05	0,818	0,172	0	1,56
Sector_General Purpose	0,71	0,178	0	1,64																	0,758	0,176	0	2,14	0,713	0,163	0	1,86
Sector_Media & Arts	0,629	0,231	0,007	1,34																	0,444	0,206	0,031	1,41	0,41	0,201	0,042	1,35
Sector_Virtual Currency	0,341	0,181	0,06	1,64																	0,179	0,2	0,373	2,7	0,345	0,185	0,062	2,3
Process																												
Process_Capital Markets					0,313	0,261	0,232	1,95													0,297	0,254	0,242	2,5				
cess_Data & Document Management					-0,416	0,236	0,078	2,45													-0,04	0,205	0,844	2,51				
Process_Payment					-0,09	0,252	0,721	2,09													0,225	0,233	0,335	2,43				
Process_Software development					-0,313	0,233	0,181	2,45													-0,084	0,211	0,69	2,72				
Process_Tracking & Supply chain					-0,542	0,39	0,165	1,28													-0,047	0,348	0,893	1,38				
Process_Wallet & Exchange					-0,059	0,242	0,807	2,28													0,43	0,245	0,08	3,17				
Methodologies_bc																												
Methodologies_bc_DLT									0,292	0,183	0,112	1,55									0,311	0,198	0,115	2,42	0,186	0,19	0,33	2,25
ologies_bc_Smart Contract/ Dapp									-0,31	0,152	0,042	1,53									-0,134	0,165	0,417	2,43	-0,234	0,159	0,143	2,27
Type_Client																												
Type_Client_B2B													-0,764	0,149	0	1,25					-0,489	0,143	0,001	1,52	-0,556	0,139	0	1,44
Type_Client_B2C													-0,469	0,145	0,001	1,25					-0,319	0,139	0,022	1,52	-0,293	0,136	0,032	1,48
Type_funding																												
Type_funding_BOTH																	1,971	0,236	0	1,08	1,805	0,233	0	1,11	1,833	0,232	0	1,1
Type_funding_ICO																	2,256	0,145	0	1,07	2,114	0,144	0	1,12	2,121	0,143	0	1,11
Control variables																												
Location																												
Location_North America	1,019	0,283	0	5,18	1,11	0,287	0	5,27	0,972	0,285	0,001	5,2	1,084	0,282	0	5,16	1,269	0,251	0	5,18	1,286	0,248	0	5,34	1,228	0,246	0	5,24
Location_Regulated countries	1,556	0,285	0	6,01	1,619	0,289	0	5,09	1,478	0,287	0	5,05	1,583	0,285	0	5,01	1,337	0,253	0	5,02	1,327	0,251	0	5,2	1,282	0,249	0	5,1
Location_Rest of Asia	1,069	0,341	0	2,36	1,168	0,345	0,001	2,39	0,989	0,343	0,004	2,38	1,11	0,34	0,001	2,36	0,984	0,302	0,001	2,36	0,96	0,297	0,001	2,41	0,923	0,296	0,002	2,38
Location_Rest of Europe	0,509	0,321	0,113	2,88	0,65	0,326	0,046	2,92	0,5	0,323	0,121	2,87	0,594	0,319	0,063	2,85	0,482	0,283	0,089	2,85	0,475	0,281	0,091	2,95	0,432	0,279	0,122	2,89
Funding rounds																												
Funding_rounds	0,36	0,051	0	1,02	0,365	0,051	0	1,01	0,343	0,051	0	1,02	0,357	0,05	0	1,01	0,348	0,046	0	1,08	0,323	0,046	0	1,12	0,324	0,046	0	1,11
R2	0,115				0,1038				0,1047				0,1153				0,3028				0,3464				0,3417			
R2-adj	0,1066				0,0933				0,0981				0,1087				0,2977				0,3316				0,3312			
R2-pred	0,0954				0,0802				0,0884				0,0996				0,2911				0,3155				0,3193			

Table 6.10 - Comparison between different regression model combinations

Hypotheses testing

Here, the final model is wrapped up (*Table 6.11)*. The coefficients are shown in the first column. It is necessary to remember that this is a log-linear multiple regression; because the dependent variable has been subjected to a logarithmic transformation. Therefore, the coefficients are not linked in absolute values to the amount raised in dollars. However, since the dependent variable approximates a qualitative measure, the interest is in the relative values of the coefficients. Compared to the reference levels and the other categories.

	FINAL MODEL			
Variable	Coeff.	SE	P-Value	VIF
Independent Variables				
Sector				
Sector_Finance	**0,818**	0,172	0***	1,56
Sector_General Purpose	**0,713**	0,163	0***	1,86
Sector_Media & Arts	**0,41**	0,201	0,042**	1,35
Sector_Virtual Currency	**0,345**	0,185	0,062*	2,3
Methodologies_bc				
Methodologies_bc_DLT	0,186	0,19	0,33	2,25
ologies_bc_Smart Contract/ Dapp	-0,234	0,159	0,143	2,27
Type_Client				
Type_Client_B2B	**-0,556**	0,139	0***	1,44
Type_Client_B2C	**-0,293**	0,136	0,032**	1,48
Type_funding				
Type_funding_BOTH	**1,833**	0,232	0***	1,1
Type_funding_ICO	**2,121**	0,143	0***	1,11
Control variables				
Location				
Location_North America	**1,228**	0,246	0***	5,24
Location_Regulated countries	**1,282**	0,249	0***	5,1
Location_Rest of Asia	**0,923**	0,296	0,002***	2,38
Location_Rest of Europe	0,432	0,279	0,122	2,89
Funding rounds				
Funding_rounds	**0,324**	0,046	0***	1,11
R2	**0,3417**			
R2-adj	**0,3312**			
R2-pred	**0,3193**			

Table 6.11 - Regression results of the final regression model

In the following lines, the hypotheses developed in the literature review chapter will be tested. From this multiple linear regression, it will be possible to answer the first six hypotheses. The hypotheses are summarized in the table below (*Table 6.12)*.

Variable	Hypotheses
Sector	*1. "Blockchain & Distributed Ledger technologies are likely to develop more in some sectors than in others."*
Process	*2. The Blockchain & Distributed Ledger technologies are more likely to develop to improve some processes than others."*
Methodology of use	*4. "Blockchain & Distributed Ledger technologies are more likely to develop for some methodologies of use of the blockchain technology than others."*
Type of client	*5. "Blockchain & Distributed Ledger technologies are likely to progress in the development and management of platforms."*
Type of funding	*6. "The ICO funding method is likely to have a greater impact on the future development of Blockchain & Distributed Ledger technologies compared to other funding sources."*

Table 6.12 - Hypotheses and related independent variables

As stated previously, the independent variable process has been removed by the model. Due to the lack of significance and to avoid the overfitting of variables in the model. Consequently, *hypothesis 2* cannot be tested in this research. Room is left for future researches.

Looking at the P-Values in the final model, it is not possible to argue about the methodologies of use of the Blockchain and Distributed Ledger Technologies. Being for both the dummy variables greater than 0,1. Statements about their effect on the future development of the technologies in comparison to the reference level cannot be developed. Thus, *hypothesis 4* cannot be answered.

For what concerns hypotheses 1, 5, and 6 instead, the significance level supports the discussion.

Variable	Coeff.	SE	P-Value
Sector			
Sector_Finance	**0,818**	0,172	0***
Sector_General Purpose	**0,713**	0,163	0***
Sector_Media & Arts	**0,41**	0,201	0,042**
Sector_Virtual Currency	**0,345**	0,185	0,062*

Table 6.13- Regression results: sector

Starting from *hypothesis 1*, the reference level is represented by the category "Other." Hence, all those sectors grouped because of low occurrences in the set of observations. The P-Value proves the significance of the different levels. All the sectors are significant

and show a positive correlation with the dependent variable. The financial sector is highly significant; moreover, the coefficient shows a positive correlation with the dependent variable, and it is the highest among all the sectors. The last sentence confirms *hypothesis 1*.

Variable	Coeff.	SE	P-Value
Type_Client			
Type_Client_B2B	**-0,556**	0,139	0***
Type_Client_B2C	**-0,293**	0,136	0,032**

Table 6.14 - Regression results: type of client

For what concerns *hypothesis 5*, the reference level is represented by the category "Platform." In this way, the direct comparison between purely B2B and B2C startups could have been presented. As we can see in the table above, both are significant; hence, it is possible to draw inferences about the domain. Both B2B and B2C startups show a negative correlation with the dependent variable. This means that the multi-target startups, developing and/or managing platforms, will more probably represent the future of the Blockchain and Distributed Ledger Technologies. Confirming the *hypothesis 5*.

Variable	Coeff.	SE	P-Value	VIF
Type_funding				
Type_funding_BOTH	**1,833**	0,232	0***	1,1
Type_funding_ICO	**2,121**	0,143	0***	1,11

Table 6.15 - Regression results: type of funding

Finally, for *hypothesis 6*, the reference level is represented by traditional funding sources. In this way, the comparison between ICO and different funding methods would have been straightforward. In the analysis, also the category "BOTH" has been considered. When a startup has received investments both from an ICO campaign and other funding sources. Both the dummy variables are highly significant. They present a very highly positive coefficient, showing a strong correlation with the dependent variable. The variable of greatest interest is "Type_funding_ICO," which shows a coefficient of 2,121. It confirms the hypothesis. From this research, the ICO funding appears to be much more

representative of the future of entrepreneurial finance in the domain of the Blockchain and Distributed Ledger Technologies than other fundraising methods.

Control variables

In this paragraph, the control variables are analysed, regarding the location of the startups and the number of funding rounds in which they participated.

Variable	Coeff.	SE	P-Value
Control variables			
Location			
Location_North America	**1,228**	0,246	0***
Location_Regulated countries	**1,282**	0,249	0***
Location_Rest of Asia	**0,923**	0,296	0,002***
Location_Rest of Europe	0,432	0,279	0,122

Table 6.16 - Regression results: location

The categorical variable "Location" has been introduced to mitigate potential problems coming from omitted variables. The aim has been to control the presence of different regulations across the countries. This situation is also related to a limitation of this variable, and many startups are DAOs. Therefore, they freely decided where to locate the headquarters, preferring "tax havens" when possible. Having these considerations in mind, it is possible to analyse in detail the results. The reference level has been chosen as "Other." Hence, considering countries in which the number of startups is much lower than the categories showed in the table. The dummy variable "Rest of Europe" is not significant, thus, not analysed. For what concerns the other categories, all of them show a strong positive correlation with the dependent variable. In particular, North America and the so-called "Regulated countries" (the composition has been described previously).

Variable	Coeff.	SE	P-Value
Funding rounds			
Funding_rounds	**0,324**	0,046	0***

Table 6.17 - Regression results: number of funding rounds

The continuous variable "Funding_rounds" appears to have a highly significant moderate positive correlation with the dependent variable.

The framework of the model

The final model is graphically summarized in the framework below.

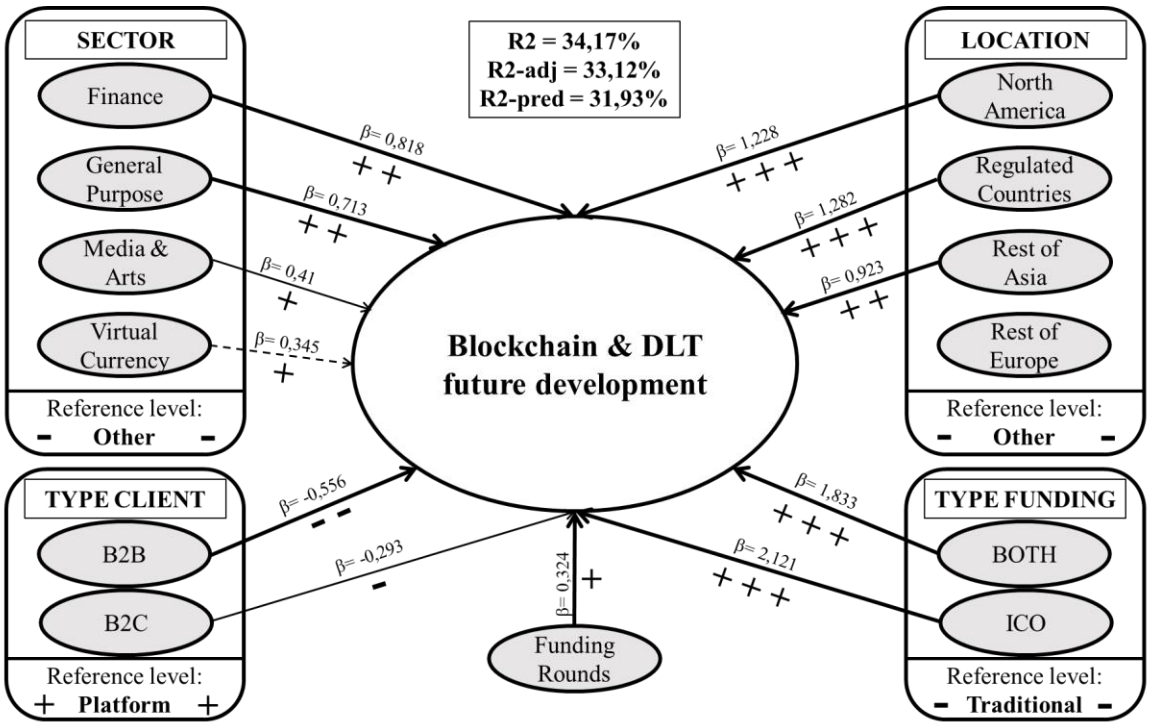


Figure 6.1 - Framework of the multiple linear regression model

6.4.2 Sectors: ICO funding vs. Traditional funding

Descriptive statistics

The tables below show the descriptive statistics of the 186 observations in the analysis of the ICO and the 765 observations in the analysis of the traditional funding database. A deep analysis of the database is provided in the related section. However, this table gives a quick overview of the data used in inferential analysis.

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
TOT_funding_ICO	186	0	16,156	0,0992	1,352	10,127	15,425	16,476	17,039	18,933
Sector_Finance	186	0	0,1828	0,0284	0,3875	0	0	0	0	1
Sector_Media & Arts	186	0	0,1344	0,0251	0,342	0	0	0	0	1
Sector_Other	186	0	0,1882	0,0287	0,3919	0	0	0	0	1
Sector_Virtual Currency	186	0	0,2151	0,0302	0,412	0	0	0	0	1

Table 6.18 - Descriptive statistics: ICO

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
TOT_funding_Traditional	765	0	14,123	0,069	1,907	7,601	12,834	14,219	15,425	19,271
Sector_Finance	765	0	0,1752	0,0138	0,3804	0	0	0	0	1
Sector_Media & Arts	765	0	0,0954	0,0106	0,294	0	0	0	0	1
Sector_Other	765	0	0,2196	0,015	0,4143	0	0	0	0	1
Sector_Virtual Currency	765	0	0,2549	0,0158	0,4361	0	0	0	1	1

Table 6.19 - Descriptive statistics: traditional funding

Regression findings

To compare how the different types of funding methods have an impact on the development of the technologies. The multiple linear regression is performed between the independent variable "Sector" and the two dependent variables "ICO funding" and "Traditional funding." To have a complete view of the model, different reference levels will be tested.

Reference level: Sector_Other

	ICO				Traditional			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
Sector								
Sector_Finance	-0,154	0,325	0,637	1,61	1,032	0,217	0	1,48
Sector_General Purpose	0,029	0,295	0,922	1,79	0,785	0,197	0	1,61
Sector_Media & Arts	0,075	0,354	0,832	1,48	0,451	0,263	0,086	1,3
Sector_Virtual Currency	0,471	0,313	0,133	1,68	0,231	0,197	0,241	1,61
R2	0,0246				0,0395			
R2-adj	0,003				0,0344			
R2-pred	0				0,0267			

Table 6.20 Regression results comparison in sectors: ICO vs. Traditional (Reference level: Other)

The results show the absence of correlation between the categorical variable sector and the dependent variable ICO. All the P-Values are greater than 0.1. Therefore, it is not possible to draw inferences on the domain. *Hypothesis 7* cannot be confirmed or denied in this step.

Reference level: Sector_General Purpose

	ICO				Traditional			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
Sector								
Sector_Finance	-0,183	0,298	0,54	1,35	0,247	0,21	0,24	1,39
Sector_Media & Arts	0,046	0,329	0,888	1,28	-0,333	0,257	0,195	1,24
Sector_Other	-0,029	0,295	0,922	1,36	-0,785	0,197	0	1,45
Sector_Virtual Currency	0,442	0,284	0,121	1,39	-0,553	0,19	0,004	1,49
R2	0,0246				0,0395			
R2-adj	0,003				0,0344			
R2-pred	0				0,0267			

Table 6.21 - Regression results comparison in sectors: ICO vs. Traditional (RL: General Purpose)

The results show the absence of correlation between the categorical variable sector and the dependent variable ICO. All the P-Values are greater than 0.1. Therefore, it is not possible to draw inferences on the domain. *Hypothesis 7* cannot be confirmed or denied in this step.

Reference level: Sector_Finance

	ICO				Traditional			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
Sector								
Sector_General Purpose	0,183	0,298	0,54	1,82	-0,247	0,21	0,24	1,83
Sector_Media & Arts	0,229	0,356	0,521	1,5	-0,581	0,273	0,034	1,4
Sector_Other	0,154	0,325	0,637	1,65	-1,032	0,217	0	1,76
Sector_Virtual Currency	0,625	0,315	0,049	1,71	-0,801	0,21	0	1,83
R2	0,0246				0,0395			
R2-adj	0,003				0,0344			
R2-pred	0				0,0267			

Table 6.22 - Regression results comparison in sectors: ICO vs. Traditional (RL: Finance)

Comparing the sectors with the reference level Finance, the only significant category is Virtual Currency, P-Value 0,049. The regression coefficient shows a positive correlation with the dependent variable (0,625), whereas, for "Traditional funding" the coefficient is negative (-0,801). The result confirms *hypothesis 7*.

Reference level: Sector_Media & Arts

	ICO				Traditional			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
Sector								
Sector_Finance	-0,229	0,356	0,521	1,93	0,581	0,273	0,034	2,34
Sector_General Purpose	-0,046	0,329	0,888	2,22	0,333	0,257	0,195	2,74
Sector_Other	-0,075	0,354	0,832	1,95	-0,451	0,263	0,086	2,58
Sector_Virtual Currency	0,396	0,344	0,252	2,04	-0,22	0,257	0,393	2,74
R2	0,0246				0,0395			
R2-adj	0,003				0,0344			
R2-pred	0				0,0267			

Table 6.23 - Regression results comparison in sectors: ICO vs. Traditional (RL: Media & Arts)

The results show the absence of correlation between the categorical variable sector and the dependent variable ICO. All the P-Values are greater than 0.1. Therefore, it is not possible to draw inferences on the domain. *Hypothesis 7* cannot be confirmed or denied in this step.

6.4.3 Business solutions

Descriptive statistics

The tables below show the descriptive statistics of the 951 observations in the analysis. A deep analysis of the database is provided in the related section. However, this table gives a quick overview of the data used in inferential analysis.

Variable	N	N*	Mean	SE Mean	StDev	Minimum	Q1	Median	Q3	Maximum
TOT_funding	951	0	14,52	0,0643	1,983	7,601	13,305	14,509	16,118	19,271
Business solution_FIN_Capital	951	0	0,05573	0,00744	0,22952	0	0	0	0	1
Business solution_FIN_Data	951	0	0,01788	0,0043	0,13257	0	0	0	0	1
Business solution_FIN_Lending	951	0	0,02419	0,00498	0,1537	0	0	0	0	1
Business solution_FIN_Payment	951	0	0,03049	0,00558	0,17203	0	0	0	0	1
Business solution_GP_Data	951	0	0,05258	0,00724	0,2233	0	0	0	0	1
Business solution_GP_Identity	951	0	0,01472	0,00391	0,1205	0	0	0	0	1
Business solution_GP_Software	951	0	0,1462	0,0115	0,3535	0	0	0	0	1
Business solution_H_Data	951	0	0,02313	0,00488	0,15041	0	0	0	0	1
siness solution_M&A_Advertising	951	0	0,01367	0,00377	0,11618	0	0	0	0	1
Business solution_M&A_Data	951	0	0,04837	0,00696	0,21466	0	0	0	0	1
Business solution_M&A_Payment	951	0	0,01472	0,00391	0,1205	0	0	0	0	1
Business solution_M&A_Software	951	0	0,01052	0,00331	0,10206	0	0	0	0	1
Business solution_Other	951	0	0,3817	0,0158	0,4861	0	0	0	1	1
Business solution_VC_Data	951	0	0,01262	0,00362	0,11168	0	0	0	0	1
Business solution_VC_Exchange	951	0	0,08623	0,00911	0,28084	0	0	0	0	1
Business solution_VC_Lending	951	0	0,00841	0,00296	0,09138	0	0	0	0	1
Business solution_VC_Payment	951	0	0,05889	0,00764	0,23553	0	0	0	0	1

Table 6.24 - descriptive statistics of business solutions

Regression findings

The table below displays the parameters of the regression model. The first column shows the regression coefficients, in bold the ones corresponding to significant values of the P-Value (smaller than 0,1), and the underlined coefficients are the ones with a P-Value smaller than 0,2 but greater than 0,1. The latter must be analysed cautiously, however, coefficients far from 0 can be considered in the analysis.

	MODEL			
Variable	Coeff.	SE	P-Value	VIF
Sector				
Business solution_FIN_Capital	**0,797**	0,29	0,006	1,08
Business solution_FIN_Data	0,558	0,489	0,254	1,03
Business solution_FIN_Lending	**0,846**	0,424	0,046	1,04
Business solution_FIN_Payment	0,081	0,38	0,832	1,05
Business solution_GP_Data	0,391	0,297	0,189	1,08
Business solution_GP_Identity	0,196	0,537	0,715	1,02
Business solution_GP_Software	**0,682**	0,197	0,052	1,18
Business solution_H_Data	-0,408	0,433	0,346	1,04
siness solution_M&A_Advertising	0,806	0,556	0,148	1,02
Business solution_M&A_Data	0,02	0,308	0,949	1,07
Business solution_M&A_Payment	0,246	0,537	0,647	1,02
Business solution_M&A_Software	0,29	0,632	0,647	1,02
Business solution_VC_Data	-0,916	0,578	0,113	1,02
Business solution_VC_Exchange	**-0,493**	0,241	0,041	1,12
Business solution_VC_Lending	-0,058	0,704	0,934	1,01
Business solution_VC_Payment	0,18	0,283	0,525	1,09
R2	0,0293			
R2-adj	0,0127			
R2-pred	0			

Table 6.25 - Regression results business solutions

Looking at the results, considering that the reference level is the category "Other," thus all the less frequent business solutions, it is possible to confirm *hypothesis 3*. Four business solutions present a high level of significance, and three of them (General Purpose – Software development, Finance – Capital Markets, Finance – Lending/Crowdfunding) display a strong positive correlation with the positive variable. Therefore, they are business solutions that might drive the future development of the Blockchain and DLT. On the other hand, Virtual Currency – Exchange & Trading will be less likely to develop as a type of business applications in the next years.

CHAPTER 7
DISCUSSION AND CONCLUSION

7.1 Discussion

An empirical investigation of globally operating Blockchain startups and their raised amount of investment has been made to make inferences about the directives of development of Blockchain and Distributed Ledger Technologies and their future use in diverse industries. The advantage of analysing a database of startups is that they are the innovators able to provide an overview of the business applications of the technologies. Therefore, the basis of the analysis was a database of 1287 startups that raised in total $ 12,96 billion from different funding sources. From the literature review arisen that only two papers discussed a comprehensive analysis of a Blockchain organization database (Friedlmaier et al. 2018; Momo et al. 2019), and only one was focused on startups (Friedlmaier et al. 2018). The empirical analysis grants the uniqueness of this work, figure an inferential analysis that predicts the innovation path of Blockchain and DLT.

Startup financed by traditional source of investment	Startup financed by both traditional source of investment and ICO	Startup financed by Initial Coin Offering
744 startup (57%)	55 startup (4%)	173 startup (13%)
3.817 mln $ in total	1.634 mln $ in total	3.311 mln $ in total
5,1 mln $ on average	29,7 mln $ on average	19,1 mln $ on average
1,3 mln $ median	17,0 mln $ median	14,0 mln $ median

Tot. startup financed			
972 startup	8.762 mln $ in total	9,01 mln $ on average	2 mln $ median

Table 7.1 - The total distribution of investment when excluding the outlier Block.one (EOSIO)

7.1.1 Diffusion of Innovation

First, the diffusion of innovation of the technologies is discussed. When considering the **rate of acceptance** of Blockchain and DLT for startups, and, the cumulative curve, it is arguable that it resembles an S-shaped curve (Nieto et al. 1998) and that the technologies have surpassed the point of inflection. This conclusion is in contrast with the conclusions of different studies that identify Blockchain and DLT as still in their early phase of adoption (Woodside et al. 2017; Friedlmaier et al. 2018).

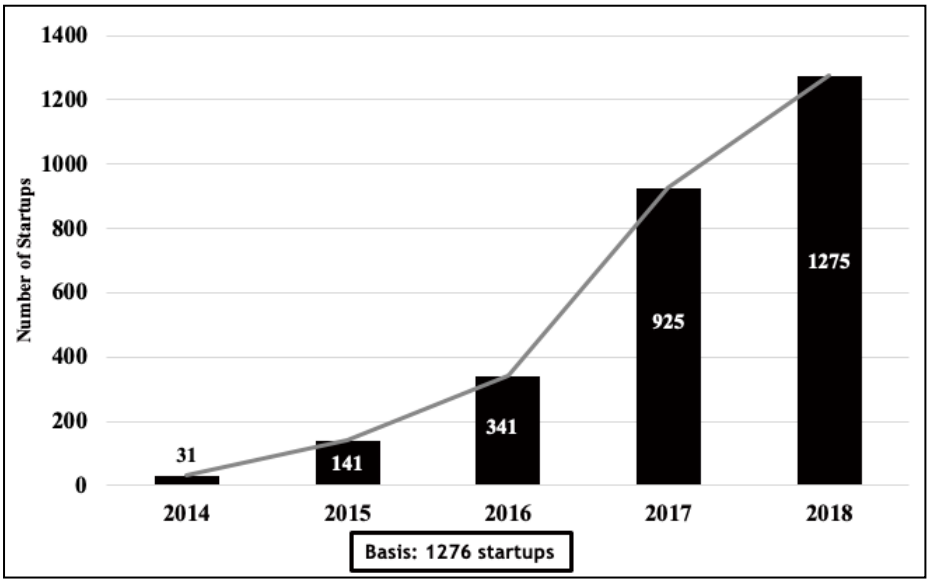


Chart 7.1 - The cumulative amount of Blockchain and DLT startups operating from 2014 to 2018

However, this would mean that a decrease in the number of startups should be expected in the following years. As previously done by Luu (2018), the focus has been moved on the distribution of funding during the years, and a different trend was identified. Moreover, the exceptional growth registered in the number of startups 2017 may be explained by the hype towards Blockchain and DLT coming from the market value of Bitcoin that surged from less than $ 20 billion to more than $ 200 billion. Indeed, this trend had an impact also on the underpinning technologies that became the focus of the attention of researchers, developers, businesses and, especially, media.

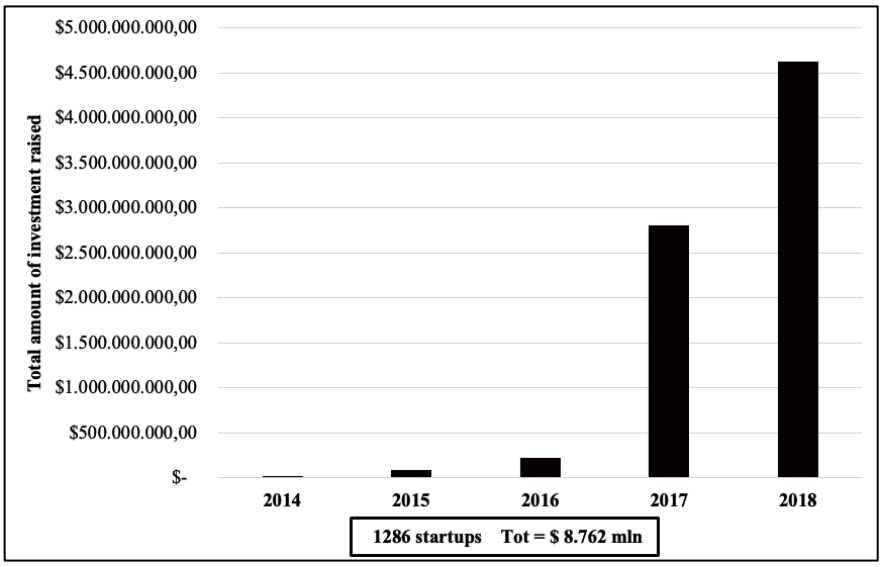


Chart 7.2 - The distribution of total amount of investment across the years

Combining these considerations, the rate of adoption of Blockchain and DLT are better represented by the Gartner's Hype Cycle in *figure 7.1* (Panetta 2018). Indeed, the researchers stated that the Blockchain and DLT had passed the trough of disillusionment, the point reached after having inflated expectations, and they are approaching the slope of enlightenment. To conclude, in the next years, further growth in the number of startups operating with Blockchain technology may be expected.

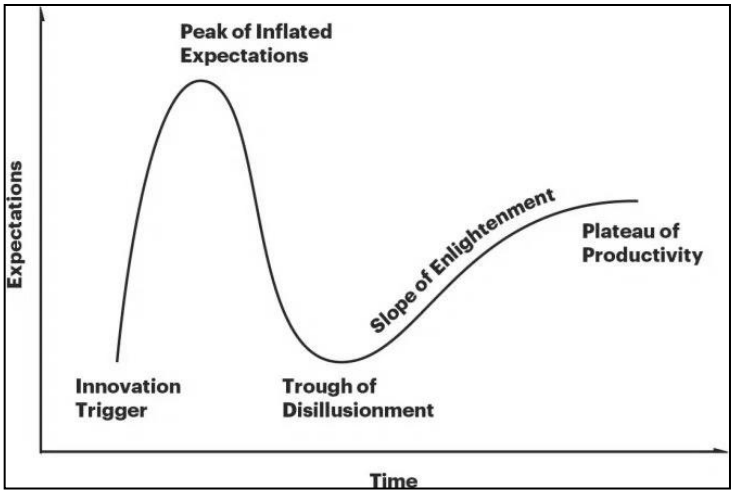


Figure 7.1 - Gartner hype cycle for the emergence of a new technology

As far as concerned the **geographical distribution** (*figure 7.2*), America is the continent where Blockchain and DLT are implemented the most, both in terms of the number of

startups and the amount of funding raised. The United States alone, with 482 startups, account for almost 40% of the total number of startups of the sample. Switzerland, United Kingdom, Germany, and Estonia, among other nations, are making Europe the second continent in which there is great consideration for Blockchain and DLT; China, Singapore, and Hong Kong are affecting, in the same way, the results for Asia.

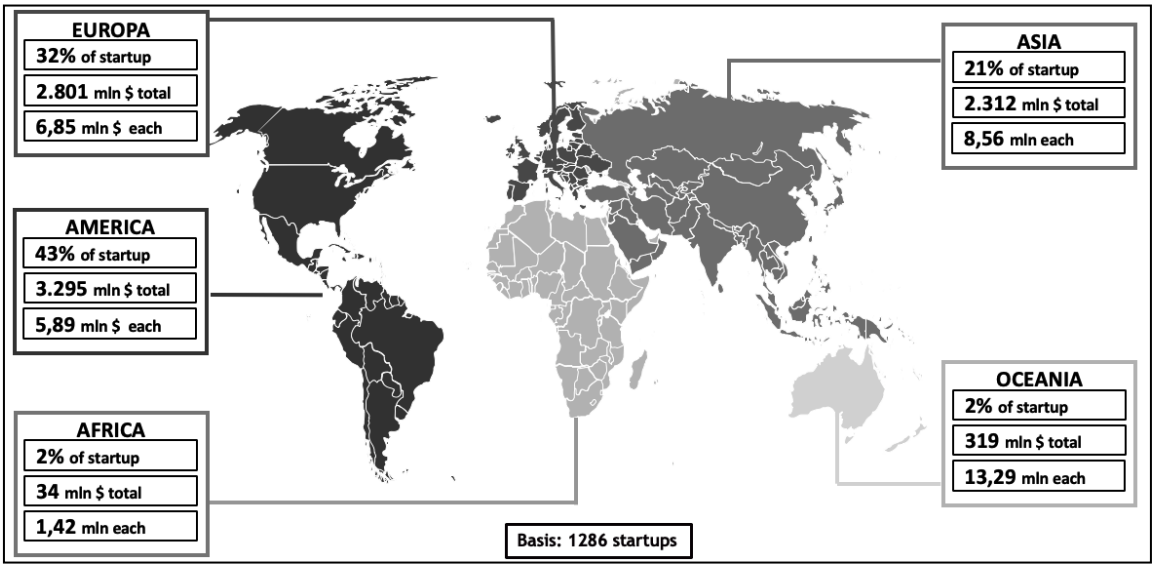


Figure 7.2 - The geographical distribution of startups and investments by continent

From the analyses, the location appeared as a significant potential directive of innovation of the technologies. Moreover, some countries are particularly relevant both in terms of presence of startups and the amount of investment raised. These results are explained by the different regulations and approaches towards Blockchain and DLT of the different nations. Switzerland, Cayman Islands, Australia, Russia, China, USA, Gibraltar, Singapore, Malta, UK showed a positive attitude and, many of them have already properly regulated the field.

Variable	Coeff.	SE	P-Value
Control variables			
Location			
Location_North America	**1,228**	0,246	0***
Location_Regulated countries	**1,282**	0,249	0***
Location_Rest of Asia	**0,923**	0,296	0,002***
Location_Rest of Europe	0,432	0,279	0,122

Table 7.2 - Regression results: location

The research (*Table 7.2*) demonstrated that these countries, which presented special regulations for ICO and business applications of the Blockchain and distributed ledgers technologies, displayed a positive regression coefficient (1,282). This result was expected, as Niforos (2018) stated, to provide stability and space to innovate to organizations, the presence of appropriate regulations and governance for business applications of Blockchain and DLT are essential.

The regression model showed how North America would be likely to be in the frontline for the development and innovation of Blockchain and DLT. United States has also been leading the number of ICO campaigns (Giudici et al. 2018; Fisch 2019). The countries in "Rest of Asia" also presented a significant positive regression coefficient, which is driven by the presence of Japan and South Korea. The two neighbour countries are considered two Blockchain hubs in Asia and are quickly developing regulations and patents, and their ICO and cryptocurrencies trading activities are increasing (Lim et al. 2019).

7.1.2 Directives of Development

The following considerations are related to the multiple linear regression models developed in the inferential statistics chapter (*Figure 7.3* and *Table 7.3*).

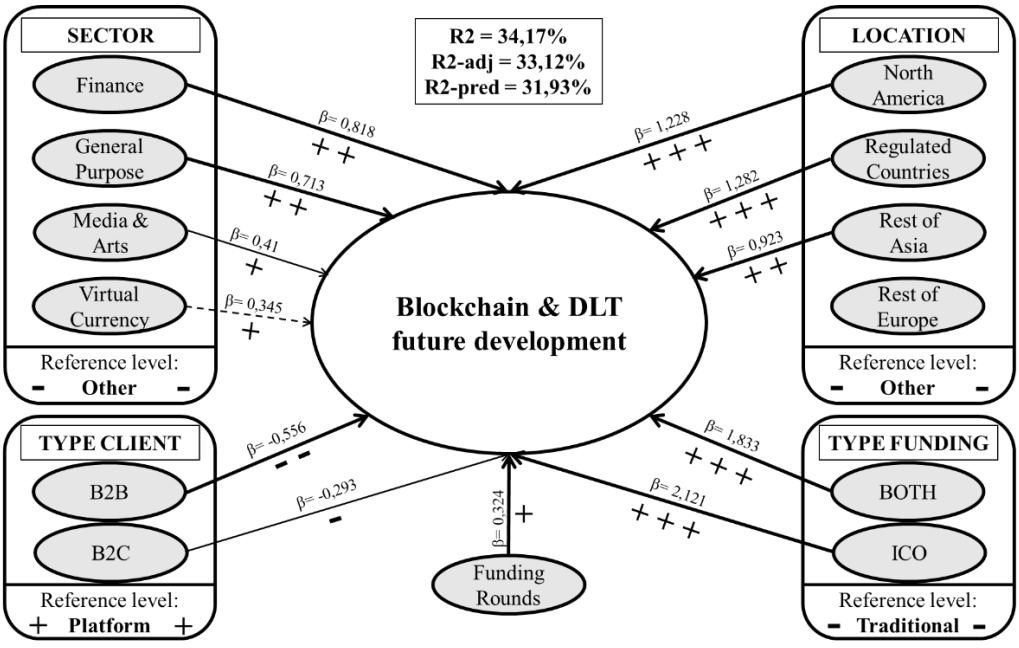


Figure 7.3 - Framework of the multiple linear regression model

	MODEL 1				MODEL 2				MODEL 3				MODEL 4				MODEL 5				MODEL 6				MODEL 7			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
Independent Variables																												
Sector																												
Sector_Finance	0,891	0,196	0	1,51																	0,66	0,197	0,001	2,05	0,818	0,172	0	1,56
Sector_General Purpose	0,71	0,178	0	1,64																	0,758	0,176	0	2,14	0,713	0,163	0	1,86
Sector_Media & Arts	0,629	0,231	0,007	1,34																	0,444	0,206	0,031	1,41	0,41	0,201	0,042	1,35
Sector_Virtual Currency	0,341	0,181	0,06	1,64																	0,179	0,2	0,373	2,7	0,345	0,185	0,062	2,3
Process																												
Process_Capital Markets					0,313	0,261	0,232	1,95													0,297	0,254	0,242	2,5				
cess_Data & Document Management					-0,416	0,236	0,078	2,45													-0,04	0,205	0,844	2,51				
Process_Payment					-0,09	0,252	0,721	2,09													0,225	0,233	0,335	2,43				
Process_Software development					-0,313	0,233	0,181	2,45													-0,084	0,211	0,69	2,72				
Process_Tracking & Supply chain					-0,542	0,39	0,165	1,28													-0,047	0,348	0,893	1,38				
Process_Wallet & Exchange					-0,059	0,242	0,807	2,28													0,43	0,245	0,08	3,17				
Methodologies_bc																												
Methodologies_bc_DLT									0,292	0,183	0,112	1,55									0,311	0,198	0,115	2,42	0,186	0,19	0,33	2,25
ologies_bc_Smart Contract/ Dapp									-0,31	0,152	0,042	1,53									-0,134	0,165	0,417	2,43	-0,234	0,159	0,143	2,27
Type_Client																												
Type_Client_B2B													-0,764	0,149	0	1,25					-0,489	0,143	0,001	1,52	-0,556	0,139	0	1,44
Type_Client_B2C													-0,469	0,145	0,001	1,25					-0,319	0,139	0,022	1,52	-0,293	0,136	0,032	1,48
Type_funding																												
Type_funding_BOTH																	1,971	0,236	0	1,08	1,805	0,233	0	1,11	1,833	0,232	0	1,1
Type_funding_ICO																	2,256	0,145	0	1,07	2,114	0,144	0	1,12	2,121	0,143	0	1,11
Control variables																												
Location																												
Location_North America	1,019	0,283	0	5,18	1,11	0,287	0	5,27	0,972	0,285	0,001	5,2	1,084	0,282	0	5,16	1,269	0,251	0	5,18	1,286	0,248	0	5,34	1,228	0,246	0	5,24
Location_Regulated countries	1,556	0,285	0	6,01	1,619	0,289	0	5,09	1,478	0,287	0	5,05	1,583	0,285	0	5,01	1,337	0,253	0	5,02	1,327	0,251	0	5,2	1,282	0,249	0	5,1
Location_Rest of Asia	1,069	0,341	0	2,36	1,168	0,345	0,001	2,39	0,989	0,343	0,004	2,38	1,11	0,34	0,001	2,36	0,984	0,302	0,001	2,36	0,96	0,297	0,001	2,41	0,923	0,296	0,002	2,38
Location_Rest of Europe	0,509	0,321	0,113	2,88	0,65	0,326	0,046	2,92	0,5	0,323	0,121	2,87	0,594	0,319	0,063	2,85	0,482	0,283	0,089	2,85	0,475	0,281	0,091	2,95	0,432	0,279	0,122	2,89
Funding rounds																												
Funding_rounds	0,36	0,051	0	1,02	0,365	0,051	0	1,01	0,343	0,051	0	1,02	0,357	0,05	0	1,01	0,348	0,046	0	1,08	0,323	0,046	0	1,12	0,324	0,046	0	1,11
R2	0,115				0,1038				0,1047				0,1153				0,3028				0,3464				0,3417			
R2-adj	0,1066				0,0933				0,0981				0,1087				0,2977				0,3316				0,3312			
R2-pred	0,0954				0,0802				0,0884				0,0996				0,2911				0,3155				0,3193			

Table 7.3 - Comparison between different regression model combinations

Sectors

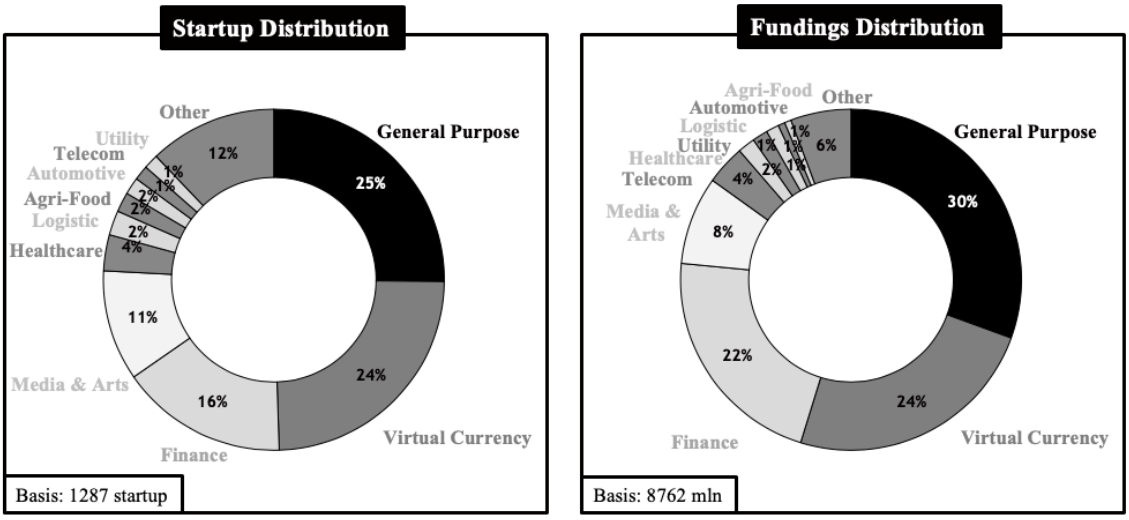


Chart 7.3 - Distribution of Blockchain and DLT startups and funding by sector

When performing an analysis based on sectors, what came up is that the startups that are being invested the most are those offering Cross-sectorial solutions. That means that most of the startups are focusing on the Blockchain itself and its radical innovation, trying to reach a sector-agnostic solution that is then deployable for the different sectors. Moreover, when considering the specific sectors, those that resulted in more relevant, both in terms of occurrences and investment, are Virtual Currency, Finance, and Media & Arts.

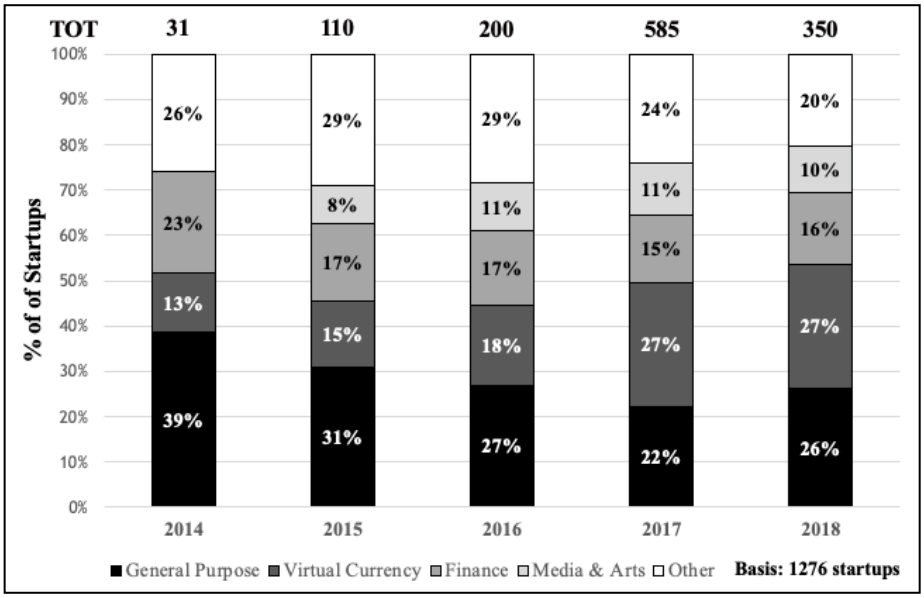


Chart 7.4 - the distribution of the birth of Blockchain and DLT startups over the years by sector

Looking at the percentages, the relative volume of General Purpose startups has slightly decreased from 2014 to 2017 and then experienced an increase in 2018. This trend is counterbalanced by an opposite one experienced by the less numerous industries, clustered in the category "Others," that represents only one-fifth of the total number of startups in 2018. Whereas, as far as concerned Finance and Media & Arts, their percentages have been almost steady during the years. Finally, the portion of those offering solutions concerning Virtual Currencies has grown substantially from 2017 onwards. This trend is a natural consequence of the hype generated around cryptocurrencies because of the aforementioned market value reached by Bitcoin in the same year. Therefore, the same values should not be expected in the following years since the opportunities of adoption, other than virtual currency, have been widely recognized.

Variable	Coeff.	SE	P-Value
Sector			
Sector_Finance	**0,818**	0,172	0***
Sector_General Purpose	**0,713**	0,163	0***
Sector_Media & Arts	**0,41**	0,201	0,042**
Sector_Virtual Currency	**0,345**	0,185	0,062*

Table 7.4- Regression results: sector

Testing *hypothesis 1* it was confirmed that Blockchain and DLT are likely to develop more in some sectors than others. (*Table 7.4*)

General Purpose displayed positive regression coefficients, validating the trends presented above. It confirms how Blockchain and DLT can be considered as general-purpose technologies; hence they can pervade many different sectors (Kane 2017).

Moreover, the financial sector has already been addressed as one of the most suited sectors for Blockchain and DLT adoption because of the inefficiency in internal processes and transactions (Nofer et al. 2017). Not surprisingly, Finance seems to be the sector in which the technologies will grow the most, according to the positive results obtained in the multiple regression model. This result is in line with what was concluded by Friedlmaier

and colleagues (2018), who identified the financial industry as already exploiting more advanced applications of the technologies, attracting more investments than other sectors.

Furthermore, Blockchain and DLT have been for long, associated with the concept of cryptocurrency. However, already Hughes and colleagues (2019) showed how these technologies have a more significant potential to disrupt all sorts of business operations. Accordingly, Momo (2019) considers the usage of cryptocurrencies as only the first era of Blockchain and DLT. Nonetheless, the results are showing that the technologies are more likely to develop in Virtual Currency than other sectors, highlighting that there is still a strong link with the usage of cryptocurrencies.

A less popular business application of Blockchain and DLT is in the Media & Arts sector, which comprises Gaming, Music, Social Media and Arts. From 2015, the industry has gained popularity. Furthermore, it might experience a further development in the technological applications, displaying a positive regression coefficient. It may be explained by the need for trust, transparency, efficient sharing of data and traceability of this industry. In the music sector, the management of digital rights has always represented a critical issue (O'Dair 2016). Whereas, in the Gaming industry, Osservatori Digital Innovation (2018) already identified the development of decentralized applications and the true digital ownership of digital content as the main opportunities of the sector.

To conclude, the analyses highlighted how there are some specific sectors, such as Finance and Media & Arts, in which Blockchain and DLT are expected to grow more than others. However, nowadays, the technologies are still living their first iteration, the age of cryptocurrency, and are better represented by the picture of Kane (2017) that addressed Blockchain and DLT as general-purpose technologies.

Processes

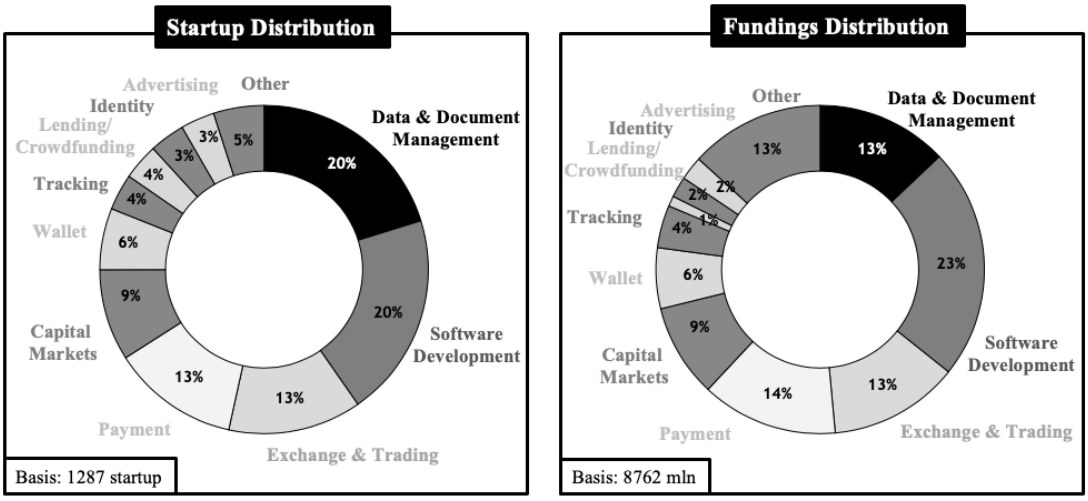


Chart 7.5 - Distribution of Blockchain and DLT startups and funding by process

Moving the focus on processes, they are first analysed from a general perspective and then declined in the various sectors, resulting in the business applications. The descriptive statistics on the former analyses shed light on the fact that **Software Development** is the process on which startups are focusing the most and attracted the greatest portion of funding. A significant percentage of these startups are represented by those who are trying to overcome the actual limitations of the Blockchain and DLT proposing new and improved protocols. On the contrary, those offering solutions in terms of **Data & Document Management**, even if widespread, are not the principal focus of investors.

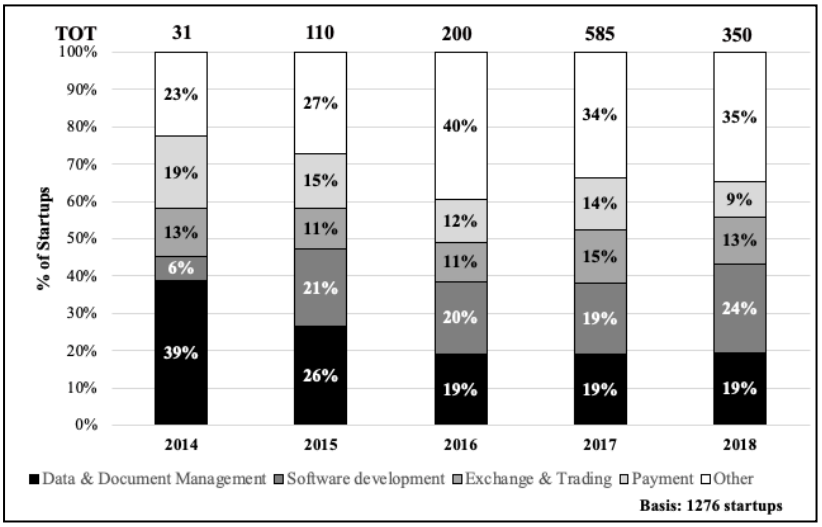


Chart 7.6 - the distribution of the birth of Blockchain and DLT startups over the years by process

Also, when considering the relative percentages during the years, opposite trends of these processes are registered. These results may be the consequence of the limits Blockchain, and DLT have presented, such as scalability, throughput, cost and those related to data safety and privacy. Indeed, they are limiting the advantages that the technologies bring, and, in most the cases, benefits do not overcome the costs. Therefore, these limits are making startups pivoting on software development for obvious reasons. Nonetheless, it is expectable that, once these limits are overcome, solutions on data & document management will experience a new increase because of the interesting opportunities they are offering.

A second major trend is deeply related to the usage of virtual currencies. Indeed, startups offering solutions in **Exchange & Trading**, **Payment** and **Wallet** were notably relevant. They are all solutions that are focusing on the expendability and management of cryptocurrencies, whose adoption has been growing in the last years.

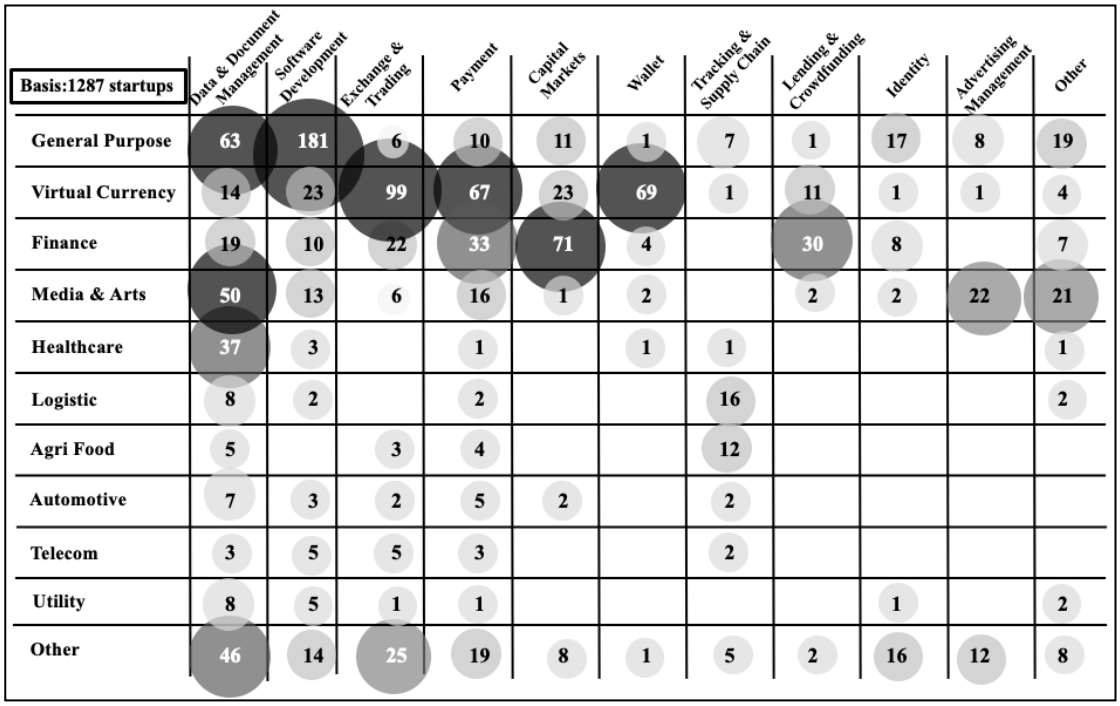
The last considerations regard **Capital Markets** and **Tracking & Supply chain**. The former proved to be one of the primary processes meaning that Blockchain and DLT are finding good opportunities in the issuing and negotiation of financial securities and tokenization of assets. As far as concerned the latter, these results are in countertendency with which is happening in most of the firms. In fact, from the analysis of the use-cases of these technologies made by "Osservatorio Blockchain and DLT" in 2018, which surveyed almost 600 use cases, solutions of tracking & supply chain were among the principal, representing the 22% of the sample. This is opening questions on the profitability of this market and on the possibility that it is already properly served by the existing solutions, most of which are provided by major tech companies such as IBM.

Given these considerations, *hypothesis 2* was tested to infer conclusions on which processes Blockchain and DLT will focus on. However, as shown in model 2 in *table 7.3* the results obtained showed no significance; therefore, there is no evidence that Blockchain and DLT are more likely to develop to improve some processes than others.

Variable 1	Variable 2	Correlation Index
Sector_General Purpose	Process_Software Development	0.503
Sector_Virtual Currency	Process_Wallet & Exchange	0.489
Sector_Finance	Process_Capital Markets	0.468

Table 7.5 - Pairwise correlation table

Moreover, *table 7.5* shows how some processes, even if considered from a general perspective, were highly correlated with sectors. C*hart 7.7* clarifies how the different sectors are mainly focused on some particular processes, highlighting the need to investigate the main crossings that, in turn, will identify the principal business applications.



Basis:1287 startups	Data & Document Management	Software Development	Exchange & Trading	Payment	Capital Markets	Wallet	Tracking & Supply Chain	Lending & Crowdfunding	Identity	Advertising Management	Other
General Purpose	63	181	6	10	11	1	7	1	17	8	19
Virtual Currency	14	23	99	67	23	69	1	11	1	1	4
Finance	19	10	22	33	71	4		30	8		7
Media & Arts	50	13	6	16	1	2		2	2	22	21
Healthcare	37	3		1		1	1				1
Logistic	8	2		2			16				2
Agri Food	5		3	4			12				
Automotive	7	3	2	5	2		2				
Telecom	3	5	5	3			2				
Utility	8	5	1	1					1		2
Other	46	14	25	19	8	1	5	2	16	12	8

Chart 7.7 - the distribution of Blockchain and DLT startups considering Industries against Processes

Business solutions

INDUSTRY	PROCESS	BRIEF DESCRIPTION	Number of Startups	% on the tot num of startups	Funding amount raised	% on the tot funding amount
General Purpose	*Software development*	overcoming Blockchain & DLT limits and proposing innovative protocols	180	13,47%	$1.837.384.783,00	20,97%
	Data & Document Management	optimization of management of any kind of data & overcoming data privacy issues	63	4,12%	$365.929.694,00	4,18%
	Identity	creation of self-sovereign identity to decentralize the management of documents	17	1,20%	$101.108.201,00	1,15%
	Advertising Management	connecting advertiser, publishers and users without the need of intermediaries	8	0,62%	$29.449.599,00	0,34%
Virtual Currency	*Exchange & Trading*	trading solutions and conversion in fiat currencies for cryptocurrencies	99	7,88%	$600.553.556,00	6,85%
	Wallet	management and storage of cryptocurrencies	69	6,38%	$509.437.528,00	5,81%
	Payment	let users pay for services and goods with their cryptocurrencies	67	4,48%	$545.518.531,00	6,23%
	Software development	the aim is to improve the actual performance of virtual currencies	23	1,65%	$193.524.941,00	2,21%
	Lending/Crowdfunding	borrowing and lending cryptocurrencies	11	1,01%	$74.420.000,00	0,85%
Finance	*Capital Markets*	tokenization of real assets and investment funds	71	4,99%	$669.919.329,00	7,65%
	Payment	cross-border and inter-bank transactions	33	2,44%	$380.498.611,00	4,34%
	Lending/Crowdfunding	connecting lender and borrower without the need of intermediaries	30	2,05%	$332.947.745,00	3,80%
	Data & Document Management	reducing the operational bueucracy for financial institutions	19	0,92%	$111.451.137,00	1,27%
Media & Arts	*Data & Document Management*	protection of copyrights and property rights with true digital ownership	50	3,09%	$339.462.655,00	3,87%
	Advertising Management	connecting brands and influencers and/or advertiser and publisher	22	1,83%	$121.260.000,00	1,38%
	Payment	cash-back, frictionless and more secure payment option	16	1,00%	$69.342.537,00	0,79%
	Software development	creation of decentralize applications such as gaming platform	13	0,95%	$91.012.784,00	1,04%
Healthcare	*Data & Document Management*	optimize the management of health data and sharing between patient and doctors	37	3,56%	$125.416.138,00	1,43%
Logistic	*Tracking & Supply chain*	certification of provenance and traceability of products	16	1,58%	$18.575.804,00	0,21%
	Data & Document Management	digitalization of documents related to the movement of goods	8	0,62%	$57.372.866,00	0,65%
Agri-Food	*Lending/Crowdfunding*	certification of provenance, quality and traceability of food products	12	1,04%	$18.207.263,00	0,21%
Automotive	*Data & Document Management*	make mobility data valuable	7	0,83%	$6.448.024,00	0,07%
	Payment	combination of more mobility-related payment in a single one	5	0,35%	$42.377.200,00	0,48%
Telecom	*Data & Document Management*	protection of data when using telecom services	8	0,26%	$167.860.300,00	1,92%
	Software development	democratization of internet access	5	0,50%	$42.195.000,00	0,48%
Utility	*Tracking & Supply chain*	tracking of renewable energy to sell in P2P exchanges	12	0,93%	$86.226.462,00	0,98%

Table 7.6 - Blockchain and DLT main applications in the diverse industries and processes

Table 7.6 gives a comprehensive understanding of the various business solutions of Blockchain and DLT across diverse industries. From the literature analysis, a general view on the different business applications was missing (Risius and Spohrer 2017; Morkunas et al. 2019). It is evident how some business solutions are more relevant than others when considering both the number of manifestations and funding.

	MODEL			
Variable	Coeff.	SE	P-Value	VIF
Sector				
Business solution_FIN_Capital	**0,797**	0,29	0,006	1,08
Business solution_FIN_Data	0,558	0,489	0,254	1,03
Business solution_FIN_Lending	**0,846**	0,424	0,046	1,04
Business solution_FIN_Payment	0,081	0,38	0,832	1,05
Business solution_GP_Data	0,391	0,297	0,189	1,08
Business solution_GP_Identity	0,196	0,537	0,715	1,02
Business solution_GP_Software	**0,682**	0,197	0,052	1,18
Business solution_H_Data	-0,408	0,433	0,346	1,04
siness solution_M&A_Advertising	0,806	0,556	0,148	1,02
Business solution_M&A_Data	0,02	0,308	0,949	1,07
Business solution_M&A_Payment	0,246	0,537	0,647	1,02
Business solution_M&A_Software	0,29	0,632	0,647	1,02
Business solution_VC_Data	-0,916	0,578	0,113	1,02
Business solution_VC_Exchange	**-0,493**	0,241	0,041	1,12
Business solution_VC_Lending	-0,058	0,704	0,934	1,01
Business solution_VC_Payment	0,18	0,283	0,525	1,09
R2	0,0293			
R2-adj	0,0127			
R2-pred	0			

Table 7.7 - Regression results: business solutions

Testing *hypothesis 3*, there is evidence that Blockchain and DLT are likely to be implemented more in some business solutions than others. Precisely, as shown in *Table 7.7*, those that resulted in significant P-Values and positive coefficients are General Purpose - Software Development and Finance - Capital Markets and Finance - Lending & Crowdfunding. On the contrary, a negative coefficient has resulted in Virtual Currency - Exchange & Trading.

The positive result of General Purpose - Software Development is giving valuable insights on Blockchain and DLT and their state of innovation. Indeed, these solutions are represented by the development of new platforms or the improvement of extant ones in order to overcome the limits that the technologies are experiencing, such as scalability, throughput, cost and privacy. They are proposing innovative architectures by combining

in different and innovative ways the main pillars of Blockchain and DLT: Network, Consensus Algorithm, Structure of the database, Transactions, and Assets.

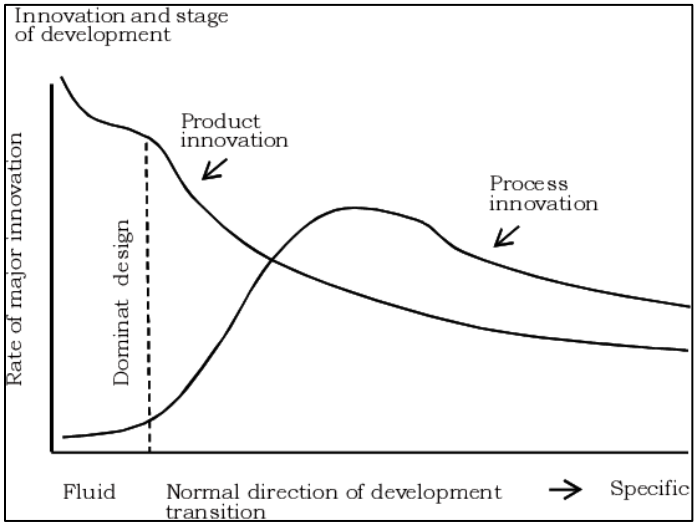


Figure 7.4 - Life cycle model (Abbernatty and Utterback 1975)

This situation is confirming other studies that considered Blockchain and DLT as still in the fluid phase (Habbestad and Karde 2017, Ughetto and Levis 2018), in which there is still no evidence of standardization, and a Dominant Design has not yet emerged. Indeed, many firms are proposing their architecture. To conclude, given the high number of possible combinations of the main pillars, the different needs and the different usage identified across the diverse industries led to confirm the conclusion of Habbestad and Karde (2017) that argued that "dominant designs have the potential to emerge for Blockchain platforms, but will probably differ across use areas, industries, and value network levels." Additionally, the emergence of standardization will be a first driver that, together with governance and regulations, should lead to mass adoption of Blockchain and DLT (Hamida et al. 2017)

Further discussions are on the other business applications that resulted more likely to be developed in the future.

For what concerns the Financial sector, solutions that bring enhanced transparency and reliability in credit and lending, enabling reduction of costs and open access to microcredit, are those who showed significant chances of growth. Indeed, thanks to

Blockchain and DLT, it is possible to reach 31% of the global population, the so called "unbanked," that, currently, does not have access to financial services (Morkunas et al. 2019; Network Digital360 2018). With a similar positive coefficient, the crossing Finance - Capital markets shows good chances to grow more than others. These solutions include the tokenization of real assets and investment funds and allow users to invest with their fiat money or cryptocurrencies.

Finally, the business solution Virtual Currency - Exchange & Trading, which is one of the most frequent, has a negative regression coefficient in respect to the less frequent solutions. This finding is in countertendency with common sense. The market is highly interested in investing in cryptocurrencies, attracted by the potential exchange returns (Hughes et al. 2019). Probably, this result is due to the high concentration of this market that is making it less attractive.

The methodology of use and type of client

As far as concerned, the *typology of usage* of Blockchain and DLT, **Smart Contracts,** and Decentralized application are the most widespread solutions.

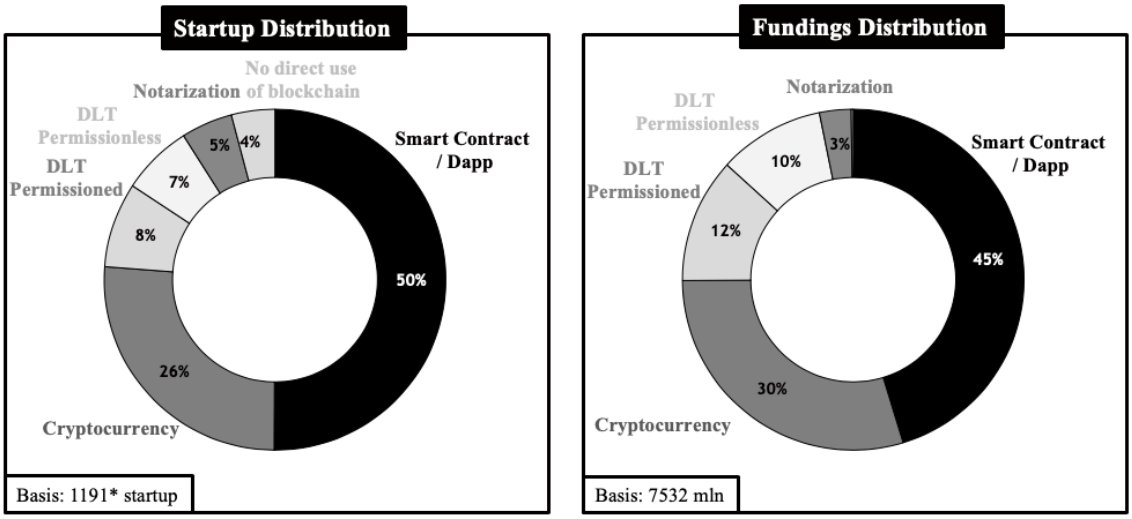


Chart 7.8 - Distribution of Blockchain and DLT startups and funding by platform usage

This is not surprising, due to the numerous implementations in various sectors that solutions, including smart contracts, can have. Smart contracts are programmable and,

thus, suitable for many diverse applications. This consideration is making them a great opportunity to create a new source of values that is what startups are looking for.

Moreover, as aforementioned, solutions concerning Blockchain and DLT are still related to the concept of **cryptocurrency** and their usage. Their diffusion and level of investment is further proof of this statement.

To conclude, startups that are creating **new platforms** and thus, exploiting the full potential of Blockchain and DLT, are those attracting a higher level of funding, representing a further confirmation of the infancy of the architectures.

Testing *hypothesis 4*, there was no evidence that Blockchain and DLT are likely to develop more for some methodologies of use than others (see model 3 in *Table 7.3)*.

Moving the focus on the ***type of client*** that the startups are addressing, the results show that Platform-based solutions are the most widespread. A similar share is represented by solutions that are targeting the final customers and a lower one for the B2B market.

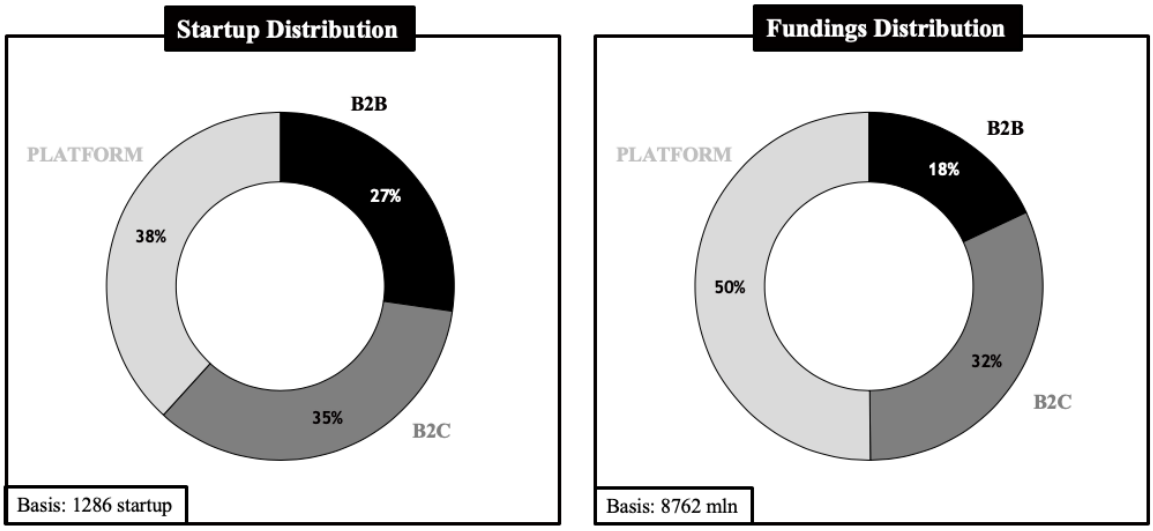


Chart 7.9 - Distribution of Blockchain and DLT startups and funding by type of client

When considering the level of investment, it is notable how Platform raised half of the total amount of investment. Whereas, B2C solutions raised almost an equal share compared to the distribution of startups. Finally, B2B solutions are not only the least numerous but also the least invested.

Testing *hypothesis 5*, B2B and B2C markets have negative coefficients with P-Values < 0,05 (*Table 7.8*). These results are exhibiting that there is evidence that Blockchain and DLT are likely to progress in the development and management of platforms.

Variable	Coeff.	SE	P-Value
Type_Client			
Type_Client_B2B	**-0,556**	0,139	0***
Type_Client_B2C	**-0,293**	0,136	0,032**

Table 7.8 - Regression results: type of client

One of the main pillars of Blockchain and DLT is decentralization. This, in turn, is reducing the necessities of middlemen in many diverse industries and services by creating platforms.

Type of funding

Finally, a discussion concerning the fundraising method is displayed. Specifically, the discussion focuses on the ICO phenom and different sources of investments (mainly venture capitals). The analysis of the distribution of different types of investments in the Blockchain startup ecosystem is a new field (Friedlmaier et al. 2018).

Variable	Coeff.	SE	P-Value	VIF
Type_funding				
Type_funding_BOTH	**1,833**	0,232	0***	1,1
Type_funding_ICO	**2,121**	0,143	0***	1,11

Table 7.9 - Regression results: type of funding

ICO funding presented a very highly positive coefficient of 2,121 (logged coefficient) in comparison to the baseline category represented by traditional investors (*Table 7.9*). This result confirms *hypothesis 6*, which stated that the ICO funding method is likely to have a greater impact on the future development of Blockchain and Distributed Ledger Technologies compared to other funding sources. Hence, in line with the report issued by Strategy& in June 2018 (Diemers et al. 2018), it is shown how, for Blockchain startups and other technology companies, the ICOs, on average, tend to raise more funding compared to traditional investments such as venture capitals and business angels, probably

due to the broader reach of the campaign. As expected, the regression coefficients related to the application of different types of fundraising methods are in line with the one related exclusively to the ICOs. It could be the case that the business applications of the technologies have attracted greater interest. Among the 57 startups which received funding both from ICOs and venture capitals, only 13 started with ICO and received a follow-up investment. Leveraging on the similarity between ICO and crowdfunding, it is in line with what stated by Ryu and Kim (2016) about follow-up venture capital investments after a crowdfunding campaign; the likelihood to receive them is scarce.

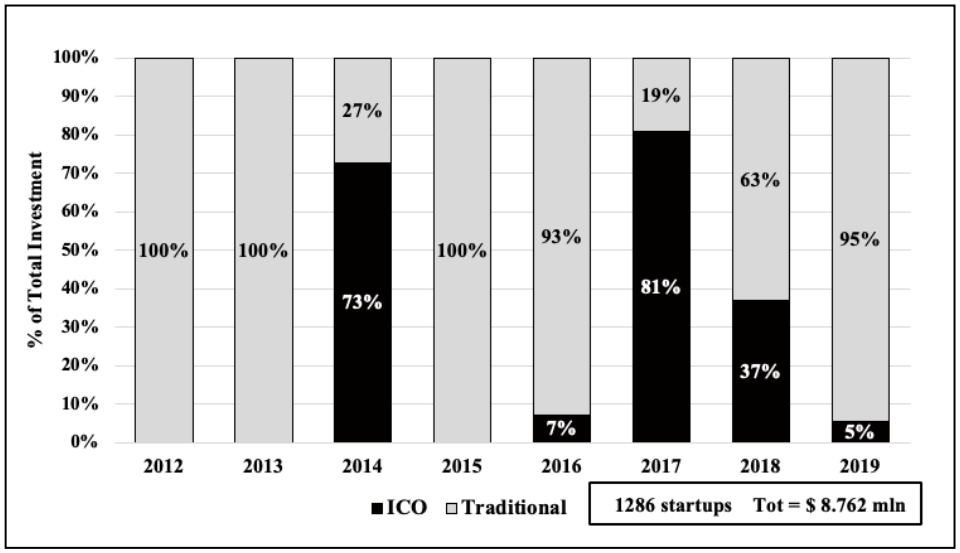


Chart 7.10 - Percentages of Investments by the typology of funding over the years

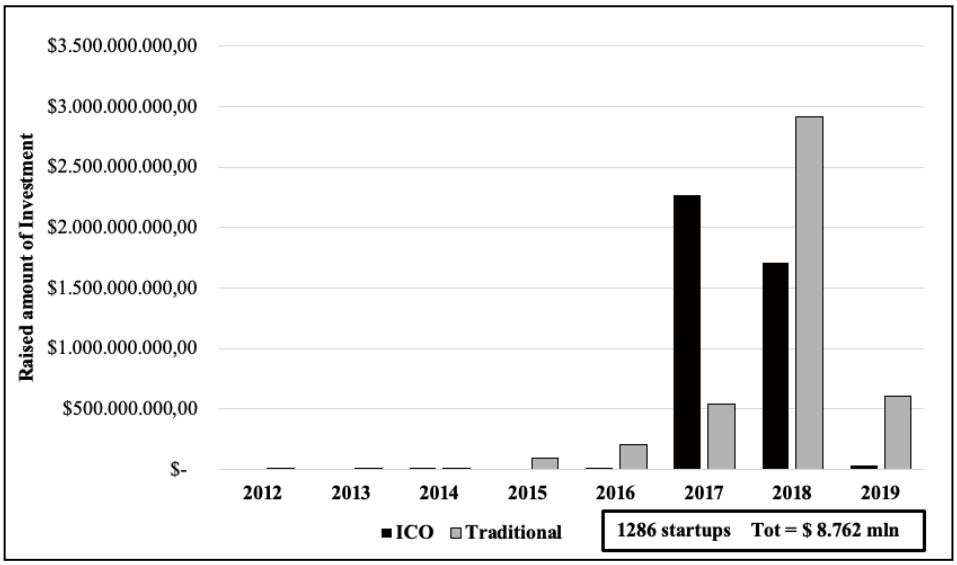


Chart 7.11 - Distribution of Investments by the typology of funding over the years

ICO is one of the primary sources of investment for Blockchain startups. However, traditional investments are still more widespread than ICOs representing more than half of the sample. Traditional investors had invested almost $ 3 billion on Blockchain startups. The innovation in entrepreneurial finance brought by the development of the Initial Coin Offering allowed Blockchain startups to exploit this new fundraising method. Ethereum Foundation started the trend in 2014; however, the peak was reached in 2017.

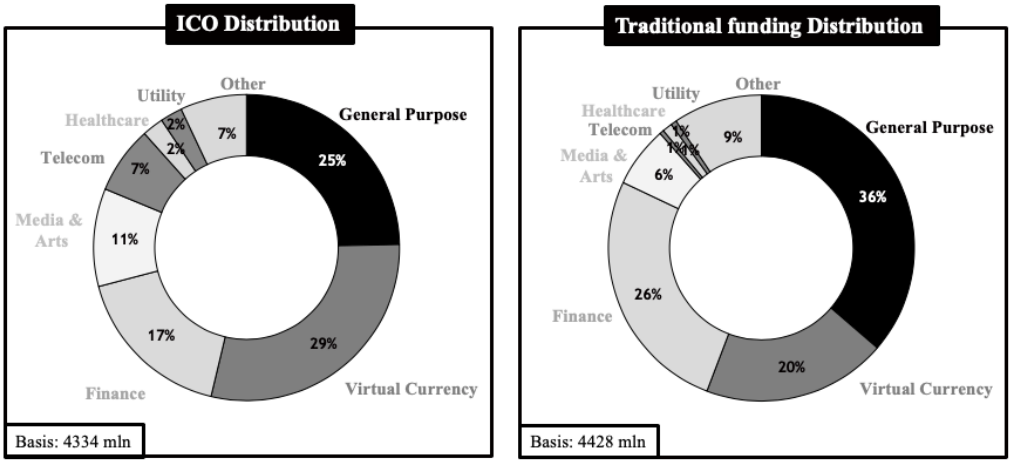


Chart 7.12 - Distribution of Investments by the typology of funding in the diverse industries

When comparing the distribution of Traditional funding against ICO by sectors, it is evident how venture capitalists prefer more established industries, such as the financial sectors and startups oriented at the development of software or IT infrastructures. On the other hand, ICO campaigns are developed by innovative startups, highly related to the usage of tokens. Two regression model has been developed to compare how the future evolution of Blockchain and DLT might vary according to the typology of funding received.

	ICO				Traditional			
Variable	Coeff.	SE	P-Value	VIF	Coeff.	SE	P-Value	VIF
Sector								
Sector_General Purpose	0,183	0,298	0,54	1,82	-0,247	0,21	0,24	1,83
Sector_Media & Arts	0,229	0,356	0,521	1,5	-0,581	0,273	0,034	1,4
Sector_Other	0,154	0,325	0,637	1,65	-1,032	0,217	0	1,76
Sector_Virtual Currency	0,625	0,315	0,049	1,71	-0,801	0,21	0	1,83
R2	0,0246				0,0395			
R2-adj	0,003				0,0344			
R2-pred	0				0,0267			

Table 7.10 - Regression results comparison in sectors: ICO vs. Traditional (RL: Finance)

The results obtained by the descriptive analysis brought to the decision to compare different reference levels. The most interesting finding has come out while comparing the sectors Finance and Virtual Currency (*Table 7.10*), which confirms *hypothesis 7*: the sector might have a significance in which type of funding method is received. The result goes against what has been stated by Fisch (2019), who, in his study on the factors influencing the total amount received from ICO campaigns, suggested that there were not evident variations between industries. The regression coefficients difference shows the divergence in the investment approach of ICO investors and venture capitals. The latter analyse the project deeply and interact with people in the team before investing, preferring long-term investments in already established areas. The negative coefficients in comparison to Finance as a reference level demonstrated that the financial sector is likely to be the preferred target, being one of the first in exploiting the technologies in business processes. This finding confirms what stated in the literature; for instance, Bucovetchi (2018) predicted that in the future, the investments in the financial sector will sharply increase. On the other hand, the only inference that can be drawn about ICO investors is that they tend to prefer the Virtual Currency sector compared to the Financial one. This finding may be biased by the fact that the foundation of the operation of the ICOs and the Virtual Currency industry is the token. (Fisch 2019).

7.2 Implications for professionals

Briefly, the contribution of this thesis has been to analyze a comprehensive database of a globally operating startup within the Blockchain and DLT ecosystem and to predict the innovation path of these technologies with an inferential analysis. Therefore, implications are coming from both analyses and may be useful for different actors.

On the one hand, *Managers* are provided with a comprehensive landscape of how the technology may be used across diverse industries and regions. Precisely, the detailed analyses of the sectors and the main processes give them guidance on the different Blockchain and DLT and solutions in existence today and their amount of funding raised. Furthermore, they will be able to understand which are the directives of the development

of Blockchain and DLT. Which, in turn, will represent support to direct the design of use cases properly.

On the other hand, it may be useful for *Entrepreneurs* that will find interesting insights on which are the solutions that are considered most attractive. Therefore, they will be able to understand whether the characteristics of the new venture are consistent with the direction that the innovation of the technologies are undertaking. Indeed, they will understand if they are going in a more secure in an unexplored or previously less successful domain.

Finally, the analysis of the distribution of investments across industries, processes, platforms, and regions may give insights for venture capitalists and investors on which are the solutions that are raising most of the attention.

The next paragraph presents the limitations of the research and suggestions for future steps for researchers.

7.3 Limitations and future research

This dissertation was not extent from limitations that, in some cases, represent possible opportunities for future researches. First, the technical aspects of the Blockchain and Distributed Ledger Technologies have not been deeply analysed. The analysis was focused on the business applications of the technologies, which led to a comprehensive analysis of the business solutions and the future development of the technologies in the business domain. However, by considering technical features of the applications may give more specific insights on which protocol will be more representative of the next years, for example.

Moreover, the analysis has been carried out only considering the startup ecosystem, which represents an advantage because of the renowned innovativeness of this type of organization. However, incumbents, in different industries, are adopting the technologies for different use cases. These projects are not considered in this study. It would be interesting to perform a similar analysis on a database built exclusively with use cases to see and compare the results. Another limitation is that, although business models are

frequently cited in the study, a comprehensive literature review on the theme has not been performed. It would be interesting to develop detailed business models for each business solution highlighted by the empirical analysis of this study. In terms of methodology, the same analysis may be performed gathering data not exclusively from Crunchbase but using other sources, to provide a complete vision of the Blockchain startup ecosystem.

Furthermore, in the inferential analysis, the multiple linear regression model might have been spoiled by the problem of reverse causality. However, the absence of panel data led to the impossibility of analyzing its presence. Therefore, the suggestion, for future researchers, is to try to find historical data to be used as panel ones. This research can provide support. Another limitation is the usage of the investments as an approximation of a qualitative measure, the innovativeness of factors.

From the findings of this study and due to the novelty of the domain, there are potentially interesting future researches. Why, when and how Blockchain and Distributed Ledger Technologies will reach mass adoption? Are Blockchain and DLT conveying to a dominant design? Furthermore, further investigation of ICOs is suggested. First, this research has not been possible to provide results on the comparison between ICO and venture capitals due to the lack of significance in the results. Second, the number of ICOs was relatively low, compared to the analyses studied in the literature. Therefore, it is suggested to follow the research line delineated by researchers (e.g., Giudici et al. 2018) and gather a significant sample of ICO campaigns to analyse empirically and quantitively the database. To analyse the token price after ICO to understand the investors' convictions and to analyse the advisors in the ICO campaigns.

Further investigations should be carried out specifically on single sectors. For instance, the Media & Arts sector appeared to be interesting both in the present and in the future. Finally, to model the regulations in inferential analyses in different ways, instead of the geographical location of the headquarter of the startups.

7.4 Conclusion

Blockchain and Distributed Ledger Technologies have evolved from technologies underlying the cryptocurrencies to widely known innovations in the business environment. They are considered among the top emerging technologies of the decade. The rising interest in the technologies and the novelty of the theme have led to deepening the subject, and the objective of the research has been developed. To investigate which are the directives of development and innovation of the Blockchain and Distributed Ledger Technologies and their main business applications. For the purpose of the study, an empirical investigation of globally operating Blockchain startups and their raised amount of investment has been used to make inferences about the directives of the development of Blockchain and DLT and their future use in diverse industries. The activity of data collection and categorization of the database has been made in collaboration with "Osservatorio Blockchain and Distributed Ledger" from Politecnico di Milano. They provided a sample of startups, a framework for data categorization and support in the research. The final result of the data collection phase was a census of 1287 Blockchain startups, which raised a total of $ 12,96 billion in funding. The analysis of the rate of adoption of the technologies led to position them in the middle of the categories "Innovators" and "Early adopters" in the S-shaped curve and in the "slope of enlightenment" in the Gartner's Hype Cycle. In the next years, further growth in the number of startups operating with Blockchain and DLT may be expected. In terms of geographical distribution, the headquarter location displayed positive correlations when the startups were located in North America or in countries with special regulations related to the Blockchain and DLT and the ICOs. Some sectors appeared to be more representative of the future of the technologies. In particular, Finance, Virtual Currency, General Purpose, and Media & Arts. In terms of business model characteristics, startups that manage and/or developed a multi-target platform appeared to be more representative of the future of the technologies than purely B2C or B2B ventures. Furthermore, the research identified primar business applications of Blockchain and DLT, among them, General Purpose – Software Development gave interesting insights into the state of development of the technologies. In accordance with the reviewed literature, there is no clear evidence

of standardization; therefore, the dominant design has not yet emerged. For what concerns the Financial industry, it might develop more in the Capital Markets domain and the development of microcredit. Thanks to Blockchain and DLT it is possible to reach 31% of the global population, the so-called “unbanked,” that, currently, does not have access to financial services. To conclude, ICOs are more likely to drive the future development of technologies.

The combination of empirical investigation, descriptive analysis and the development of a regression model grants the uniqueness and relevance of this work. The results can be used by managers and entrepreneurs to understand whether their understanding of the future innovation path of Blockchain and Distributed Ledger Technologies is in line with the direction taken by the startups or not.

The unexpressed potential of Blockchain and DLT is enormous, and despite not all institutions have understood the real benefits that these technologies can bring in the business world, many have realized their disruptive capabilities, both in the professional and academic domains. However, a critical question remains unanswered: When will Blockchain and DLT scale-up?

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