A Survey of Blockchain Technologies for Open Innovation

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A SURVEY OF BLOCKCHAIN TECHNOLOGIES FOR OPEN INNOVATION

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Abstract — Blockchain technology, initially devoted to power the bitcoin is growingly proving its applicability in many other usages. At the same time, the recent definitions of open innovation describes it as an 'across boundaries' process that distributed reliable solutions backed by blockchain technologies and derivatives are meaningful to. There is such a complex web of archaic processes, legacy systems, and misaligned incentives intra- and inter- company within the value chain of an industry, and extensively to open innovation, that if you stand any chance of innovating it, you really need the ability to orchestrate and move multiple stakeholders, in multiple organizations, at the same time, for the right reasons, in a non-threatening, trustable, and efficient way.

Moreover, the distributed nature of open innovation meets the distributed nature of the blockchain technology. This is especially true for the open innovation platforms, because they show limitations that demand reinvention on the basis of renewed confidence and expectancies. With this perspective, their synergies with blockchain technological approaches are worth of being surveyed in this paper, and their future usages forecasted.

1. Introduction

During the past few years, a new technology – blockchain – has developed which is expected to replace many current digital platforms. It first came to light in the late 2000's as the architecture for bitcoin, the best known virtual currency. But, as with the Internet, the Web and other major technologies, the blockchain technology (BT) has now transcended its original objective. It has the potential to revolutionize the finance industry and transform many aspects of the digital economy ("Blockchain and Open Innovation", 2017). The Open Innovation (OI) and the IP-industry (Intellectual Property) will also be affected so here we will address the issues relating to the adoption of BT in OI that will be discussed in this paper.

Nowadays, more than ever, Bitcoin is thriving, with a current market cap of over 100 billion USD[6] and its value has risen about 700 percent on a year-over-year-basis, so that the price of one Bitcoin (BTC) today is well over 5000 USD. Additional blockchain-based so called cryptocurrencies are being constantly issued, such as Litecoin, Monero, Dash and Zcash, of

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6 As of November 1, 2017

which many have reached an impressive market cap. These currencies are gaining acceptance as payment by serious market actors such as Amazon.

The BT, however, supports much more than cryptocurrencies. With the launch of the Ethereum platform and the related virtual currency Ether (ETH) in 2015, it is possible to build blockchain-based applications for use within practically any sector. These are used to record any transaction of value through smart contracts, whether it is current "fiat" money, commodities such as gold or oil, energy, real estate contracts – or for that matter – intellectual property rights (IPR) that are central in OI. In this paper we'll start with IP to later cover all potential applications of blockchain to OI.

An advantage of using the BT for transactions is that it allows for instant, decentralized, and secure transactions, for which there is no need for intermediaries such as brokers, agents, etc. Data stored on the blockchain is generally considered incorruptible. The innovation is ingenious and desirable, making the development seemingly unstoppable, in a similar way to autonomous or non-fossil fuel-driven cars becoming the future.

Numerous blockchain-based applications have already been developed into their proof of concept for their adoption or are under development in 2017. Many of these are funded through so-called ICO (Initial Coin Offering) or otherwise name tokens crowdsale at which value tokens are issued and distributed after payments with other virtual or fiat currencies. The tokens give the investor a stake in the company behind the application, or the opportunity to trade the token on cryptocurrency exchanges. In this way, considerable amounts have been raised. The blockchain start-up filecoin.io, for example, raised over 256 million USD. The amount of capital being pumped into this new industry also speaks for the importance and continued development and adoption of the technology.

At this still early stage, the upcoming paradigm shift provoked by BT has been recognized by financial institutions. Some of these have therefore started to enter into partnerships with blockchain companies, engaged in own development and have even started to file patent applications for BT innovations, in the meanwhile. There is a lot of creation of IP on the BT subject ("Blockchain Technology", 2017) according to the increase of the number of patent and trademark applications relating to BT. Currently, when searching the EPO's database Espacenet.com, the search returns 174 patent filings that mention the word "blockchain" and 73 that mention "bitcoin". Years ahead, these breakthrough patents may prove valuable. The millions of lines of code written can also constitute highly valuable IP, protected by copyright, database protection or kept confidential, despite the most of the projects are published in open source.

Following the theoretical introduction, this paper aims to further elaborate on the theoretical grounding in order to give a brief summary of prior research and highlight potential areas for future research. Additionally, we seek to establish a common understanding of the theory within the field of OI regarding the BT. Within the OI research area, BT is still considered a novel innovation and has yet to become a part of the mainstream OI research. This is furthermore supported by the general landscape, whose primary focus has been on the blockchain as a cryptographic economic system, e.g. Bitcoin (Glaser & Bezzenberger, 2015; Wörner et al., 2016). We also consider the amount of literature within the area as an important factor when evaluating the matureness of the concepts. We find that the concept of bitcoin with 24,500 results has been explored similar to blockchain with 17,500 results on Google

Scholar. That has grown by 10 in only one year from 2016 regarding the first searchers of (Johansen, 2016). Still there is gap of understanding the BT in OI. This paper tries to provide a novel perspective on the BT by examining current research on BT and by combining this with the other OI concepts such as blockchain as a platform, ecosystems, innovations, and technological features.

1.1 Literature Review

This paper will depart from (Tapscott, 2016) and (de la Rosa et al., 2016) will have emphasis on reviewing articles of high quality combined with the most recent posts in social media.

This paper focuses on the main OI contributions within the largest academic journals and within the majority of OI conferences (WOIC, OIS, OI2.0 etc.). However, we will also look at the general research contribution on e.g. Google Scholar to establish a general baseline of the topic to identify all relevant literature, due to the novelty of the technology. With the identification of relevant literature, we will analyze and synthesize the results found in the literature in order to identify gaps and propose paths for future research, and we will include the technological aspects of the technology.

Lastly, we will focus solely on the technology behind, the BT, rather than the economic use cases of the technology (e.g. Bitcoin).

1.2 Topic Conceptualization

The main concept of this paper is focalized around the BT, which we previously defined as a "[…] shared digital ledger". Based on the blockchain, we will take a deeper look into two sub concepts; platforms and ecosystems to establish a common point of reference for our literature review. With this setting, we will look at how the current and previous literature describes the blockchain in a platform context. Hence, our main search will be aimed at finding literature that describes the BT as an enabler for ecosystems, or the BT as a future platform in mainstream research. Accordingly, we have chosen the keywords; Blockchain, Technologies, and Platforms for our literature search.

1.3 Literature Search

First, a common ground by searching generally for the concepts across various platforms to identify a knowledge base as the foundation for the literature review was stablished. As established above, the primary focus has been on the keyword "blockchain" "technology" and "distributed ledger", due to the fact that extensive literature exists on "platforms". Second, when the common ground has been established, we identify the primary drivers within the OI research field (Chesbrough and Bogers, 2014) (Bogers et al., 2017). We take foundation in the senior scholar's basket of journals, in which we identify the basket of eight, consisting of the essential journals within OI research. However, we note that due to the exclusion of technical papers, we cannot claim to be exhaustive, being it such an emerging research area.

During our general search, we start out by searching for literature on Google Scholar to create a quick overview of the research topic and reach many valuable social media publications.

However, as the topic is considered so novel, we also checked the main conference publications within OI to ensure that the topic has been exhaustively examined.

1.4 Objective of the Paper

The goal of this paper is to conduct a literature review of the current literary landscape of BT within the field of OI. We will look at the BT, and analyze prior literature in order to identify gaps in the current literature.

Due to the novelty of concepts and the underlying technologies, we provide a new overview on recent developments and related literature in this book (Tapscott, 2016) (de la Rosa et al., 2016) (Johansen, 2016) and strive to explore the related concepts in the literature. Through exploration of the concepts, we dive into the blockchain utilization as a technological platform for an upcoming ecosystem of applications and software and look at the theoretical features of the technology as a foundation for this paper. Thus, we enhance the understanding of the technology in other contexts throughout the literature and explore the current contributions to the literature.

This study has implications for both researchers and practitioners. For researchers we seek to open research lines on enablement of the BT as a platform-centric technology for ecosystems to flourish as those of OI. For practitioners, we illustrate that it is crucial to keep developing on the technology, as research indicates that we have still not reached the tipping point of the technology.

Hence, this paper aims to answer the following research questions:

- Is the BT able to establish itself as a mainstream technology for OI ecosystems based on its current capabilities?
- Does the BT contribute with enough technical capabilities to be make OI considered a sustainable platform and reach mainstream adoption?

The paper is structured as follows: Section 2 contains a further introduction of the concerns in IP, Section 3 does it on OI, while Section 4 analyses and synthesizes the key findings in scouting the first applications to OI. Section 5 discusses further potential future applications of BT to OI., and Section 6 is devoted to the final discussion.

2. On Open Innovation

OI is already happening everywhere, only it's a matter of volume or perspective. After having for so long kept it solely for their local partners, companies are now expanding the scope, especially through digital tools, into a universal approach which is spreading in all directions. Enterprises are now targeting individuals and small organizations: so user–customers become 'co-creators' and are involved… OI has limitations and so should reinvent itself on the basis of renewed confidence and values where ethics prevail.

Acknowledging that BT is definitely happening everywhere, it is interesting to see how OI can interlink with blockchain, and the most interesting aspects for us here is its transformation power of the innovation processes (Johansen, 2017). Using BT can be a step closer to a

radical re-think of the way we conduct business and engage in competition ("Cryptoeconomics", 2017), that is precisely one of the matching goals of OI.

To understand BT, it is useful to step back to realize that Business – and Governments – never operate in isolation. They are participants in a business network ("Global Supply Chains", 2017). Ownership of assets pass across the network in return for payments, governed by contracts. Network participants currently keep their own ledger – recording all assets they own and updated on when asset ownership changes. Whilst well tried and tested, this process is very inefficient, often piling cost on cost.
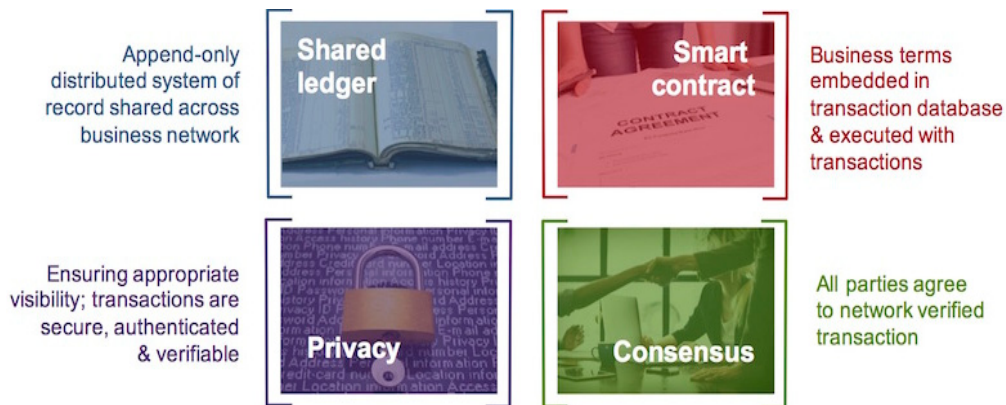
Figure 1 – Components of BT for Business

BT provides the business network with the ability to agree that a transaction is valid; an audit trail of asset ownership over time; a shared ledger ("record book") that is tamper proof, and guaranteed finality of transactions. Government oversight, compliance & audit can be part of the same network.

The main obstacle with the BT is its governance challenge. Inevitably, the issue of private, closed ledgers run by a consortium of companies will arise. Therefore, it is crucial to design blockchain applications that ensure free access, competition and OI in public blockchains with no single entity controlling it.

It is perhaps early to know if the BT will become a major transformational innovation but worth enough to survey what is being developed for OI so far with numerous recent announcements that represent a serious milestone in that direction. As we have seen with other successful innovations, collaborations among its technology developers and users are absolutely necessary to get the architecture right, as are open standards, open source implementations, and a governance process embraced by all. In a few years, the BT has already transcended its original objectives. It will be very interesting to see how it all plays out in the years to come, and here we will discuss our vision for its application to OI.

3. Platformization

In today's networked age, competition is increasingly over platforms. Already many OI and cooperation platforms play in the market. However, the successful set up and operation of an OI-platform could not be taken for granted accordingly the negative experiences were made so far. Simple databases where partners for technological cooperation are sought proved often

to be inflexible and eventually unsuccessful. What are the online values that make a difference? Platforms also rely on the power of network effects — as they attract more users, they become more valuable.

Indeed, an increasing number of industries organize their activities along the structure of central platforms surrounded and/or complemented by networks/constellations of other organizations, which technologically and strategically depend upon the core platform (Gawer and Cusumano, 2014). In today's context, increased pervasiveness of digital technologies and connectivity, combined with a global worldwide and distributed supply of ICT skills (Chesbrough and Bogers, 2014), has made the platformization trend even stronger.

This is happening for OI and for Blockchain at the time, and the two platforms concepts must converge. This survey analyses possible paths and trends of convergence.

On the governance of OI and BT platforms, ("Blockchain Governance", 2017) writes that at the heart of the problem, as always, lies the governance challenge, namely who dictates and enforces the rules as well as who do we hold accountable when things go wrong. What the developers with strong IT capabilities are failing to understand is that the public wants to place trust in the institutions operating the "conventional" platforms, especially when they are operated by real people, so that they could be held accountable. For instance, Airbnb was built on a notion that people organize and arrange themselves, but soon enough the trust issues emerged – bad consumer experience, fraud, vandalism, etc. Soon Airbnb found itself transformed from a tech company and a platform to rules and standard authority. As long as blockchain's governance challenges are not thought through, BT truly transformative potential will fail to be realized.
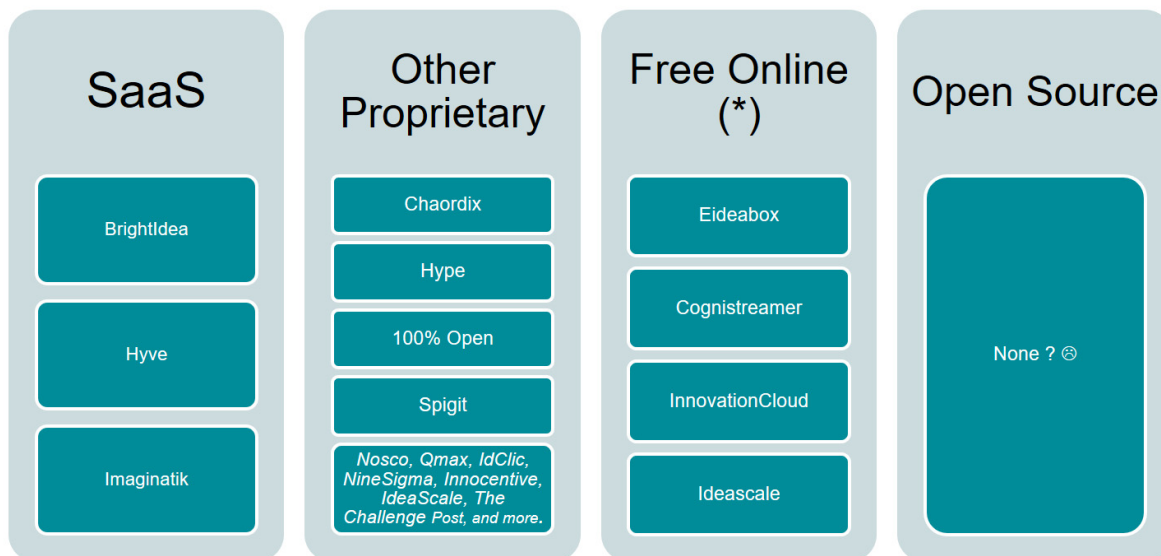
crowdsourcingweek.com/blog/10-indispensable-open-innovation-platforms-global-corporations
(*) www.innovation-post.com/top-5-free-online-idea-management-software, there are very many

Fig. 2 – The technologies adopted by the main OI platforms

In the case Hyperledger, it is a Linux Foundation project to render a BT factory for business. Its goals are a collaborative effort created to advance BT by identifying and addressing important features for a cross-industry open standard for distributed ledgers that can

transform the way business transactions are conducted globally. Anyway, the trend for the adoption of BT for OI will have the proper momentum for active and healthy OSS communities building up the OI platform for the whole types of users in the following 2018-2025 years towards its widest, global adoption. And we foresee that BT and Open Source share the core values of the future OI, which none is today still claiming.

OI online platforms would greatly benefit from blockchain matching as it would serve as a security asset for identity validation and IP issues related with innovation property rights. This is what we are going to see in the following sections.

4. The IPR as the first wave of BT Applications to OI

When talking about OI and blockchain the concept of coopetition comes into the picture. Indeed, with the new practices of data science, classification algorithms and artificial intelligence, one realizes that to take advantage of a market it is in the interest of competitors to pool their data. This involves a new form of governance based on the principle of a collective data store to allow such sharing.

Full OI is not right for all use cases, not organizationally easy, and will not be possible when strong competitive forces exist in the network. But we would argue that the most transformational value can be realized when OI, BT, and further insightful technologies backed by open source can be brought together.

The challenge is no longer consolidating data, but privacy and the ability for market players to decide the level of information they are willing to share with their competitors.

This type of governance combining OI with coopetition is relevant to many sectors. In the case of Ledgys.io, they offer a cross-platform to build market-oriented applications and are working on the following topics: sharing a database of CVs showing the experience candidates have gained in an industry, sharing metrics on quality of service between common suppliers (carriers, producers), new approaches in crowdfunding, etc. So in the logic of OI, innovation marketplaces can be created (in pharmaceuticals, for example, or in the field of patents) or warehouses of code shared between competitors in which developers' contributions are assessed and paid for by the community. The economic interest in this approach is that competitors share the basic elements of their R&D.

Surely the current development on BT has not reached its technological plateau and the burden of proof lies with the innovators.

Meanwhile, in the BT, being trust-free is a central feature of people's relationships. The Economist describes blockchain as "the trust machine," indicating that it takes care of trust issues between individuals ("Economist", 2015). In other words, the economic system, which is built on BT, runs without people, thus making a transaction "trust-free." Historically, trust has underpinned business, often involving a reliable third party, which is expensive. BT provides a viable alternative to eliminate intermediaries, thereby lowering operational costs and increasing the efficiency of a sharing service. With BT, the world's core commercial interactions can be re-imagined; the door to invent new styles of digital interactions in trust-free sharing services has been opened.

The dynamic of people and companies being trust-free in blockchain business services is based on transparency and privacy in the service relationship between humans and technology. BT enables people to access the records of every transaction they make, as it permanently records transaction history at every node of the blockchain ("SpendMatters", 2015). Furthermore, blockchain transactions are recorded using public and private keys (i.e., long strings of characters that people cannot read); thus, people can choose to remain anonymous to protect their privacy while enabling third parties to verify their identity ("Economist", 2016).

Due to the change in the trust model of BT, the service relationship between the elements of human and organization in blockchain sharing services has become democratized. Now, trust is not placed in an individual but rather distributed across the entire population. The use of central authorities is replaced by a community of peers in the form of a peer-to-peer network; no one can unilaterally take actions on behalf of the community. In such a democratized context, governments cannot manipulate an election by coercing individuals, and corporations cannot unilaterally break the rules of the system.

Automation in blockchain sharing services is the most salient feature of service relationships between organizations. Based on the features of being trust-free and democratized, BT has enabled business transactions with strangers without the need for a trusted intermediary; meanwhile, software can automate much of the transaction process, allowing contractual promises to be enforced without human involvement. The automation of doing business in blockchain-based business services has attracted significant interest in various industries.

Moving on the IP, it is under the most severe attack in modern Internet. A fundamental challenge of the internet is that if you are a creator you are getting a raw deal. When you put your stuff on the internet you are probably not going to get paid, or at best you are only getting a fraction of its value: Ads are a solution to monetization that do not pay off innovation. And this for SME (Small and Medium Enterprises) is a big concern and barrier to adopt collaborative innovation with whatever company that might run away the consortium with its IP and take advantage of alien work. Thus the first applicability at large of the great features of BT to OI for the *IP Protection for Lowering the Adoption Barriers on OI.* Some IP related functionalities that BT contribute to are:

Timestamping, proof of existence or notarization – Timestamping on top of BT relies on the use of cryptographic hashes that are somehow inserted into the blockchain through the data the transactions being recorded. Hashes may correspond to documents, IP assets or whatever digital file that need to be timestamped, proved or notarized. Since transactions include the date, and they are agreed upon in a distributed manner, the transaction including the hash will the proof of existence for such file.

IP registry services – IP registries provide official mechanisms to register and prove authorship of analogue and digital content. They usually depend on countries governments and they are regulated by their corresponding legislations. Although registration is not mandatory, it is useful to ensure authorship and protect author rights (copyright). However, in the latest decades, several centralized online alternatives have been developed which, through timestamping mechanisms, can provide similar levels of protection. Some of the advantages of such registries is that records become more trustworthy and they can be updated and shared immediately. Useful applications can then also be built on top of these

records without having to await or physically verify the data. This is the case, for example of safecreative.org. With the advent of BT, a new wave of decentralized IP registries and services have arisen, which may at some time replace their current centralized systems, enabling the records not to depend on the operation of a single entity offering the centralized service. IP registry services can range from the simplest, just covering authorship recognition, to more sophisticated services enabling access to content, licensing and other advanced features that will be discussed below.

Record keeping – BT are not suitable to keep large amounts of data. First, because this would make the blockchain size to increase in an uncontrolled way and since the blockchain is needed by each node and user willing to verify transactions, this might rapidly become unmanageable. In the case of Ethereum, for instance, there is another element that would make it impossible to store files on the blockchain, which is the transaction and computation costs, far more expensive than cloud storage. However, alternative mechanisms have been conceived to be able to link files from the blockchain itself through the use of hashes and addresses. For example, the InterPlanetary File System (IPFS) is a peer-to-peer protocol under BT.

Licensing – Licensing determines the rights and conditions under which someone can make use or access some content or work belonging to the copyright owner. There are some well-known licensing schemes, such as Creative Commons and GNU, to name a few, but licenses might contain any kind of free, paid or attributed use of the content. Decentralized licensing applications rely on the deployment of smart contracts, which can be implemented thanks to initiatives such as Ethereum.

NDA management – Non-disclosure agreements are well-known and widespread instruments that are used in OI in order for the collaborating entities to establish a trusted environment. NDAs establish the background knowledge each party is willing to communicate to others and each party recognizes and proves this happened by stamping a signature on top of it. The NDA management ends to be, in many cases, a long process in which companies involve their legal departments and exchange documents back and forth. Some initiatives relying on BT have been developed to ease this process and to be able to prove that an NDA was signed.

Access control – Access control relies on giving and controlling access to some content to predefined users. Access control might be used in combination with licensing or with the signature of a NDA, after which content can be disclosed. BT enable the implementation of access control mechanisms through the combined use of smart contracts, record keeping solutions and encryption mechanisms.

Industrial property registry (trade secrets, patents, trademarks) – Complementary to IP registries, there is another category of functionalities and applications focused on the protection of industrial property. Here the goal is to register IP assets on the blockchain to prove existence, integrity and ownership. In fact, to some point, timestamping and proof of existence would suffice, but it is not enough when we need to keep the files and metadata associated to the IP asset.

Traceability – BT and timestamping services can be used together to create an auditable trail of content ownership from creation through to the transfer of rights and beyond.

Citations tracking – Citations are relevant to determine how existing content is used to create new content and recognize contributions from other predecessor knowledge. This is

applicable to creative chains, where contents evolve through derivative works, but also to the scientific community (e.g. paper citations) and also to the IP world to recognize how a project, design or content is the result of different previous knowledge or contributions.

Rewarding mechanisms – Thanks to BT, but also to the advent of blockchain-based currencies, it is possible to design specific cryptocurrencies to reward or promote some behaviors among the cryptocurrency community users. The fact of owning a specific cryptocurrency, other than the Bitcoin, enables the currency designers to determine when new currency is issued and to whom, which can be used to generate rewards and incentives. Just to name a few, users registering their assets in an IP registry might be incentivized with new coins, or users being cited in the registration of a new knowledge asset might be rewarded for the usefulness of their knowledge.

Thus examples of applications currently in development for the protection of visual and create content are:

Blockai.com helps artists claim their copyrights and protect them for free. As well, helps them find out who is using copyrighted art or photos on the internet in seconds. An artist puts their work on blockchain, such as digital art or photos, so that the timestamp is uploaded in the blockchain and give him a copyright certificate as proof. All of which is visible on their public profile, for example, https://blockai.com/martinhsu. For every copyright they've claimed, we scan the web and show them where it's being used to find copyright violations and take action. For example, https://blockai.com/martinhsu/matches .

Blocknotary.com – is an iPhone app for the easy notarization of photos using Bitcoin and the Factom protocol. Block Notary app enables the storage of the digital fingerprint of the user's photos in the public ledger.

Copyrobo.com helps secure copyright anywhere in the world with Blockchain & Qualified Authority based time-stamping in less than 60 seconds. They use BT and Qualified Timestamps to help the prove and manage of copyrights, so that one might share his creative content easily and securely. It also offers a customizable solution for sharing the copyrighted information with the world—to deter infringement and encourage licensing. Copyrobo's solutions are compatible with all evolving worldwide laws, rules and regulation that govern copyright protection, with special rules applying to the European Union and other countries.

Proof of Existence (po.ex) - is an online notary public service that allows its users to upload digital documents and get them verified by the blockchain without exposing the content. The service is recommended for people with legal training and licensed by the state to authenticate the signing of documents. It uses a distributed computing network to transfer the virtual currency from computer to computer. The benefits of Proof of Existence include anonymity, privacy, and getting a decentralized proof, which cannot be erased or modified by third parties or governments.

Signatura.co - The world's most secure and resilient digital signature platform. Immutability and programmable signing provide important improvements to digital signature and notary platforms. Signatura.co uses the Bitcoin blockchain to take advantage of these properties, while Rootstock-based smart contracts are planned for sequential signing and other advanced features.

For the IP industry in OI as we know it, and stated in (de la Rosa et al., 2016) BT is expected to open up a range of possibilities as well as challenges. Some of these are already underway, while others may take considerable time due to e.g. regulatory constraints and the need for wider recognition within the IP community.

So, in the one hand, we have BT, which is most certainly here to stay and its possibilities seem endless. It is therefore a good time to start exploring what potential opportunities or risks that blockchain may create for business. And this paper tries to make a survey of these applications in OI other than the IP protection.

On the other hand, we have OI, that is a paradigmatic change in the way innovation is performed that is object of disruptive improvement with the advent of the internet, the crowdsourcing, and the artificial intelligence, in the century of the online platforms. Involving other parties when developing new products and technologies can be of great added value. Think for instance about cooperation with other firms in a sector, suppliers, universities, and of course end-users.

It is quite useful for our survey of BT for the OI, using the most recent definition of OI (Chesbrough and Bogers, 2014) as "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries" (p. 17), in which OI is essentially a concept that resides at the level of the organization. Accordingly, they suggest aligning the OI process with the organization's business model. While the original concept of OI is firm-centric, the literature links it to various related innovation phenomena, such as users as innovators (Bogers, Afuah, and Bastian, 2010; Piller and West, 2014) or open source software development that do not necessarily consider the firm as the focal level of analysis.

So, as said, one of the most obvious applications of BT is as a registry of IP rights, to catalogue and store original works. Remark that, in the UK, copyright is unregistered and comes into existence automatically on creation of an original qualifying work. This means that, unlike registered trademarks which can be recorded and viewed on various registries around the world, there is often no adequate means for authors to catalogue their works.

As such, ownership can be hard to prove. It can also be difficult for authors to see who is using their work, and equally difficult for third parties using a work to know who to seek a license from. The result of this is that authors are often unable to stop infringements or to make the most of monetizing their works ("Blockchain solutions", 2017).

In Harvard Business Review, ("Global Supply Chains", 2017) writes that the fundamental advantage of the BT is that it resolves problems of disclosure and accountability between individuals and organizations whose interests might not be the same. Mutually important data is recorded in real time without a single entity organizing and controlling this process.

The literature on platform-based ecosystems, points us to important dimensions of 'openness' of governance, such as control over IP, access to the technology, and also social factors such as transparent information policy. As well, works like (de la Rosa et al., 2016) develop IP friendly spaces with the platform nir-vana.eu. Admission control schemes and other quality of service mechanisms might help online service-level agreements for IP 7. There are

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[7] https://en.wikipedia.org/wiki/Smart_contract

blossoming services like Stampery.com, monegraph.com or artinpocket.cat to assure types of intellectual or digital assets protection in art8, or in the case of creative chains, creativechain.org and ascribe.io for copyright or Bernstein for IP protection, of the most recent ICOs with novel currencies for IP protection.

Using blockchain as an IP registry may help give clarity to copyright authors, owners and users. By registering their works to a blockchain, authors could end up with tamper-proof evidence of ownership. This is because a blockchain transaction is immutable, so once a work has been registered to a blockchain, that information cannot ever be lost or changed. In theory, third parties could use the blockchain to see the complete chain of ownership of a work, including any licenses, sub-licenses and assignments.

Recently, law firms are partnering with Blockchain platforms ("Blockchain technology", 2017). In Europe and most countries, the rights to the invention belong initially to the first person to file a patent application ("first-to-file system"). Therefore, the application date is very important in the patent process. Prior to this date, no protection is provided and unfortunately it can happen that a company is overtaken and finds access to a technology blocked by a better-organized competitor. A right to exploit the invention can only be granted by proving that serious preparation was made with a view to exploit the invention, which is often difficult to prove when the invention has been kept confidential within the company. There also exists a need to prove a date of creation in terms of copyright. In this case, the work or the software is protected from the date of conception. However, the next question is how can this be proved at a later date? Various solutions exist to guard against these risks and to be able to prove at any time the conception of an invention, a software or an artistic work. The safest way is to deposit a copy of the creation at a notary. Costs are generally limited, however this is a cumbersome procedure, particularly for companies that create inventions or lines of code every day that are worth protecting.

The law firm P&TS (Switzerland) has for example an agreement with the Bernstein.io Technologies GmbH (see below) which offers notarization services for invention announcements based on BT, in order to establish irrefutably the possession of an invention or a work. The downloaded document remains confidential, but it is possible to prove at a later date that it existed at the date it was uploaded and that it has not been modified. It is also possible to request the publication of this document if required and to use it as a defensive publication to prevent a third party from obtaining a patent following this publication.

Next, a selection of application for the IP industry in OI follows:

Originstamp.org – it can be used to and prove the possession of digital files based on timestamps inserted into the Bitcoin blockchain.

IPSeeds.net – enables researchers and the industry sign online NDAs and securely exchange data. To do so, each member is registered and certified as the first step to notarize IP and post non-confidential information (IP Summary) for reference with indication of partnership types such as licensing, technology transfer, co-development or fund raising. Interested parties can search and find interesting IP and once the NDA is signed, data can be exchanged

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[8] https://erikk.quora.com/Learn-the-Blockchain-Ownership-Space-contracts-IP-art-cars-photos-and-other-digital-assets

confidentially through encrypted files. IP and IP exchanges are inserted into the blockchain and can be used as a proof of ownership, existence and disclosure.

Agrello.org – Smart blockchain-proofed contracts and recording may spell the end of backdated documents with e.g. invention dates and assignment dates. They will add reliability to the IP system to the benefit of IP owners and stakeholders. Agrello.org, based in Estonia, has received considerable hype lately. The company is developing an application for legally binding smart contracts, which are produced with the assistance of artificial intelligence and reflected in a public blockchain.

Bernstein.io – Bernstein Technologies ("Notarization of IP documents", 2017) is a Munich based company offering blockchain based solutions for intellectual property management. Bernstein.io allows companies to manage the whole innovation lifecycle by creating a trail of records on the blockchain. Inventions, designs, proofs of use can be quickly registered and a blockchain certificate will prove ownership, existence, and integrity of any IP asset. Using Bernstein companies can secure trade secrets, prepare a strong prior use defence or reliably disclose inventions. Most notably, all notarized information will remain private thanks to a cryptographic layer.

	Timestamping PoE, integrity & notarization	IP registry	Content Metadata	User Authentication	Record keeping	Access control	Licensing	Traceability	Citations tracking	Rewarding mechanisms	Own currency	NDA management	Industrial property registry	Proof of receipt
Blockai.com	✓	✓												
Originstamp.org	✓	✓												
Poex.io	✓	✓												
Bitcoin.com	✓	✓												
Blocknotary.com	✓	✓			✓									
Copyrobo.com	✓	✓			partly[1]									
Signatura.co	✓	✓		✓	?									
Po.et	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			
Creativechain.org	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
Ascribe.io	✓	✓	✓	✓	✓	✓	✓	✓						
IPSeeds.net	✓	✓	✓	✓	✓	✓		✓				✓	✓	
Agrello.org											✓			
Bernstein.io	✓	✓	✓	✓	✓							✓	✓	
Stampery.com	✓	✓						✓					✓	✓
Witcoin.io	✓	✓	✓		✓			✓	✓	✓	✓		✓	

Table 1. Comparing blockchain IP solutions

[1]Relies on external cloud storage solutions (dropbox, gdrive, box), email or FTP server

Bitcoin.com launched Blockchain-Based Notary Page onto notary.bitcoin.com and upload a document. It is then etched onto the Bitcoin blockchain. Bitcoin.com notarized Satoshi Nakamoto's white paper[9] as its first document proof.

Stampery.com - enables users to notarize digital transactions and certify the existence, integrity, and ownership of any file or communication. Stampery is a verification and certification platform that generates legal proofs for all its customers' sensitive documents using bitcoin's blockchain. Its service can be used to attest the integrity, existence, ownership, and receipt of any file or communication as well as to certify digital transactions to generate audit trails, protect its customer's IPs, and to prove proprietorship of digital assets. Stampery charges a service fee from its clients depending on the number of file transactions and utilization of storage space on a monthly basis.

Witcoin.io - is a next generation of IP recognition and exploitation by means packaging whatever IP stuff into a smart contract named "wit". Thus the wit is a full intelligent object with referrals and citations to existing knowledge that is worth acknowledging. The disclosure of a wit is at a fee in witcoins tokens that are distributed to the cited wits. This modern approach, inspired in the scientific paradigm of paper publications, has the value on focusing in the knowledge movement rather than in the knowledge stagnant, thus it does not demand proof of ownership but Proof of Genuineness, so that everyone that is perceiving value in a wit but might not exploit it, at least might pass it on to those who might make sense of it.

5. Scouting Future Application Domains to OI

This section scouts future application domains that might very likely happen from the point of view of the key elements of OI: people, companies, collaborative innovation, peer-review, knowledge and data sharing, and more.

First of all, we should highlight that *Blockchain (and Ethereum) is OI itself!* A large group of developers work in open source (OS) for the development of the blockchain platform, and the community decides its future. Several forks and altcoins come up to match the innovation needs as well as the main branch of blockchain is growing steadily. Hard forks are happening everyday as a proof of the healthy community that is introducing innovation in every direction with or without permission.

It is more than OI that involves cooperation between firms and sharing certain IP. There is still substantial social motivation for many contributors and such it is a hybrid model. And now that banks and big consultancy firms are entering into the BT, they apply the OI. As an example, Barclays is building an OI platform that allow the bank to engage a wide array of builders and thinkers in the BT industry, putting its money where its mouth is, cutting tens of thousands of jobs in traditional areas and doubling down on technology, notably by launching the Barclays Accelerator (Tapscott, 2016) As said, many other big and not so big banks, consultancy firms, and industries are following.

The Ethereum foundation, after its successful crowdfunding in 2014, has been funding some many projects with a constant soar of innovation towards the development of this platform.

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[9] https://bitcoin.org/bitcoin.pdf

A smart contract is a solution that utilizes BT to create contracts between two or more participants, implemented as programmes on the Blockchain checked with similar consensus and validation schemes over the execution of the programmes. Similarly, to the use of Bitcoin Blockchain, smart contracts are implemented in a decentralized environment, where contract terms are executed by the Blockchain system when the terms are fulfilled. Once a preprogramed condition of the contract is met, the corresponding contractual provision is executed. They allow two partners to establish a business relationship without any authority or central intervention. In other words, the honesty of a transaction is secured and guaranteed not by the agents, but by the system itself. Smart contracts lie on a computer coding: programs that formally encode conditions and results. Said code requires agreement of the contracting parties. Ethereum, being a more advanced BT version, works with ether, a virtual currency used to pay for the execution of smart contracts that can consume significant resources. Volunteers earn the ether when validating transactions, securing the network in the meantime.

A smart contract may contain the agreement entirely in its code, or extend a natural language contract with encoded performance or with encoded payment mechanism. There are frameworks that help implementing smart contracts such as OpenZeppelin, Solidity, Enterprise Smart Contract Framework, Embark or Populus. Smart Contracts Alliance ("Smart Contracts", 2017) presents 12 smart contact use cases which are as follows:

- Digital Identity: for individuals to control their digital assets;
- Records: for storing digitized filing, enabling auto renewal and release process;
- Securities: enabling automated payment of dividends, removing operational risks;
- Trade Finance: faster approval and payment initiation;
- Derivatives: enforces standard set of rules and conditions for a transaction thus eliminating duplicate recording and verifying processes of each parties
- Financial Data Recording: results uniform, accurate, transparent recording of financial data;
- Mortgages: enables automated payment processing and release of mortgage;
- Land Title Recording: deters fraud and transparency of property transfers;
- Supply Chain: provides reliable tracking of the goods from the factory to the store;
- Auto Insurance: recording the policies, driving records and reports, provides instant processing in case of accidents;
- Clinical Trials: increases visibility while preserving privacy;
- Cancer Research: improved data sharing across sectors while maintaining patient privacy.

And further future applications we foresee in the deployment of BT to enable OI are:

5.1 Voting-Partner Match Acceleration

Regarding partner match, BT offer good proposals for online dating and networking apps. Popular websites like LinkedIn provide a way for people to make career connections with others in a more business-like, professional way. They are beneficial in many ways, but at

the same time, online business profiles are more for show that anything else. Like a clever resume, LinkedIn profiles are not always what meets the eye–just ask corporate recruiters. To be sure, it is still entirely online, but there is a more personal touch to networking websites than a simple email or business card. Yet the rapid growth in dating apps and networking websites has also come at a cost. Many have documented some of the pitfalls of online dating. Everyone has stories of being "catfished" and stalked, and unfortunately several people have been seriously harmed. There is a certain thrill to it–swipe right or left and start a conversation with a total stranger. It becomes a game.

Blockchain companies are offering innovative alternatives to online matching apps and websites. The basic premise is the same–make connections with others as a way to pursue mutual interests, whether it's a relationship, a fun night out, or a long lasting business partnership. The difference is that the platforms run on blockchain technology, which holds significant advantages in matching over traditional connection apps and websites ("Blockchain Matching Platforms", 2017).

For example, novel more transparent ways to vote for ideas and help people match people and ideas is My. Inwibe©, an OI platform for intelligent matching and personalized services and support, organized by company typology and based on a network of peer-to-peer experts, it leverages artificial intelligence and BT to better face the difficulties related to their development path and their structural problems, so to accelerate the time-to-market of their common projects and solutions. The platform includes WIBEmeUp©, a voting application based on blockchain, which can be used to animate meetings, pitch sessions, and OI events. This might have good impact to important OI platform like Hype.com, 9sigma.com, Ideascale.com, and more.

5.2 More Accurate Collaboration Contracts.

As a consequence of the former application on Ethereum and derivative dApps, the collaboration contracts will be decentralised and perhaps will give a more balance power to SME regarding the big companies that might get the most of the collaboration rights with their financial and Human Resources (HR) muscles. With the application of smart contracts, the financial agreements and milestones in the projects are accurately set and easier to do follow up and fulfilment.

A part from the intensive innovation happening in fintech, (Khan et al., 2017), there are possibilities to link smartly the workflow of OI across societal boundaries by making an "agreement" of what every player and role has to do in the process of collaborative innovation, when, and what corrective actions to apply, rewards or penalties, in the case whether milestones and tasks are achieved.

Thus, one might develop the funnel of OI proposed by Chesbrough in 2003, towards something more update like (Chesbrough and Bogers, 2014) and programmed, thus we advocate the novelty of this smart OI contract paradigm implemented as a protocol in smart contracts: From
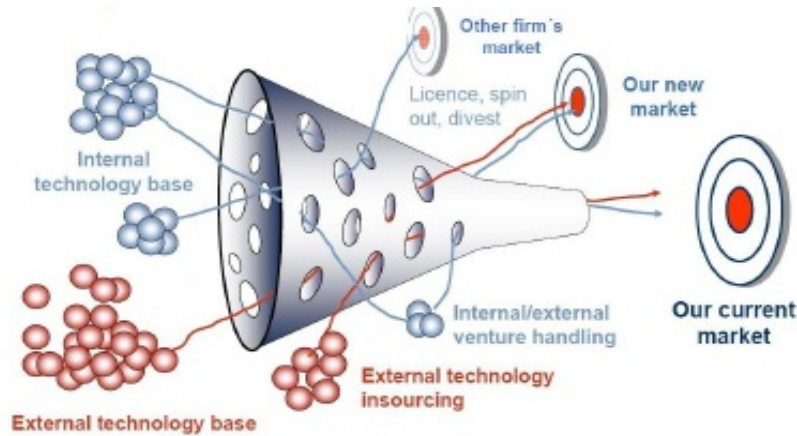
To this protocol in a smart contract :

```
Contract SmartOI {

    address user1, user2, …;
    address public company1, company 2, …;
    bool COLLABORATIONaccepted;

    event thereisMILESTONE();
    event acceptMOVEFORWARD();

    function IPdisclosure (address _user, address _company, string disclosedIP) {
        user = _user;
        company = _company;
        disclosedIP = _disclosedIP;
        block.timestamp (disclosedIP) // Timestamp of the current Block
    }

    function InviteCompany (address _company) returns (bool, address) {
        return COLLABORATIONaccepted;
    }

    function MILESTONEachieved () {
        if (InviteCompany (company2) and IPdisclosure (user1, company1, disclosedIP) {
            thereisMILESTONE = true;
            }
    }

    function Success (company1, company2) {
        if (InviteCompany (company2) and thereisMILESTONE) {
            acceptMOVEFORWARD = true;
            reward (user, user2);
        }
    }

    function Reward (user1, user2){
        user1.send(1 ETH); user2.send(1 ETH)  // rewards for the success to the users on behalf
of their companies.
    }
}
```

Any further details of the smart OI funnel will be a child smart contract that inherits this first smart contract as a protocol, so that this is the first time an OI funnel is implemented in BT as a Smart Contract.

In fact, most of the development of distribution chain of the smart contracts could be easily adapted to the funnel of OI. For a number of industry sectors (retail, auto, electronic, aviation, chemical), digitalization of supply networks has been, and still it is, an important issue for more than two decades. By analyzing the business requirements and the current readiness of integration it seemed to be already a significant gap in many functionalities. Despite of intermediates (EDI operators) including banks (SWIFT operators) have been operating and collaborating in this area over two decades, but services still lack some fundamental functionalities (e.g., standards, timestamping of transactions, monitoring and tracking of information flows and secure end-to-end delivery of information) in the general provision and many of these missing functionalities have to be embedded in BT. From an academic perspective, many-to-many integration models like private cloud (ERP/Hub companies), public cloud (ERP/SME) and public cloud (Intermediate/Blockchain) are the most cost-effective integration models. This supports the theory of transaction cost economics, in which companies make "buy" decisions and outsource operations to the market (Williamson, 1983). The open source BT seems to offer functionalities beyond those of current legacy technologies; additionally, this technology offers data security and cost-effective transmission of transactions in peer-to-peer networks with no central system. In this way, BT simplifies B2B integration and enables micro level IoT integration.

Someday, it will impact back to OI.

5.3 Fair Contests with Decentralized Management and Governance.

The development of smart contracts to give further transparency for the ideas contests of any type so that more clear rules and secured rewards are publicly announced. Remember that the smart contracts are standalone programs encoded on the Blockchain that execute all or part of a contract without any human intervention, thus contribute to decentralized management and more transparent governance that might be enabling further the OI.

As said, BT is a new institutional technology of governance that competes with other economic institutions of capitalism, namely firms, markets, networks, and even governments. (Davidson et al. 2016) present this view of BT through a case study of Backfeed, an Ethereum-based platform for creating new types of commons-based collaborative economies. This case was developed for evaluating contributions to projects on a network. Backfeed introduces a social protocol on top of blockchain-based infrastructures to coordinate individuals through the creation and distribution of economic tokens and reputation scores. Its purpose is to eventually allow for the emergence of meritocratic systems and emergent alternative economies that can variously augment or substitute for extant modes of economic governance (i.e. provided by hierarchies or markets). At its core, Backfeed is an engine for decentralized cooperation between distributed agents. It implements a Social Operating System for decentralized organizations, enabling massive open-source collaboration without any form of centralized coordination. Backfeed builds upon the power of open-source collaboration and enhances it with a distributed governance system for decentralized value production and distribution. A peer-to-peer evaluation system

is used to determine the perceived value of each contribution in a decentralized fashion, in order to allocate influence and rewards accordingly.

As well, the private governance mechanisms facilitating the entrepreneurial discovery of uses for a new potential general purpose technology, blockchain. The BT contribution is to outline and analyze three main types of private governance mechanisms in which crypto-entrepreneurs undertake non-price coordination with others, including bitcoin embassies, hackathons and online forums. The heterogeneity of what are name as *blockchain innovation commons* (Allen, 2017) comes up across multiple institutional dimensions, with greater impact of the economics of the early stages of new technologies.

5.4 Smart Cities and Open Data boosted by Blockchain Technologies

Cities account for the bulk of countries' economies and wellbeing as well as they are the focus of administrative, organizational, logistical, social, and environmental problems. All these issues happen simultaneously and are inherently distributed. The best solution to these problems is the development of smart cities, a concept that refers to using Information and Communication Technologies (ICT) in city administration and services to improve aspects such as efficiency, security, the environment, citizen participation, the economy and others. Of course OI plays a central role in how all these trends interconnect themselves and take benefit from each other.

In cities, governments are responsible for governance, the economy, social issues, mobility, security, culture and the environment. These activities consist of a myriad of different processes that require management of big amounts of data and a high frequency of registration and documentation, and their transparency and security are essential. BT offers a technology to establish this process, as one of its main characteristics is a neutral, non-hierarchical, accessible and secure information database in environments where there is currently no confidence among the actors. In a first instance, this makes it ideal for avoiding corruption and creating transparency in dealings with the government, but later it creates the conditions for OI soaring.

The idea of smart cities is based on the digitization of the systems that surround us, which has created the information society in which we live. The Internet and the Internet of Things (IoT) have transformed us into a hyper-connected society, both among people and machines. And other technologies such as artificial intelligence and robotics are starting to become a real part of our lives. Furthermore, new social trends demand greater administrative efficiency, as well as more direct models for citizen participation, greater transparency, and greater access to public information. Together with the development of big data and open data, these new social technologies are transforming governments, the way public services are provided and how access to information is offered in cities.

It is a must for OI to have access to bare data as well as pre-vetted data, so that new innovations within the smart city might soar. Blockchain would have a great impact in city organizations and its infrastructures. Allow all city agents to share data with high degree of privacy so that new open data policies might be developed at different levels to boost innovation. In the survey of (Korpela et al., 2017) of the rapidly developing BT as a new document exchange solution, we found that its ledger, security and smart contract platforms, as well as software connectors, offer tools to build a cost-effective Digital Supply Chain

(DSC) network. In this context, we considered trade finance, as we believe that DSC transactions may occasionally require financing, consulting, and more services that need to be integrated to the DSC network. BT appears a good fit for such integration. In the same Korpela et al. survey, participating business managers generated many ideas for integration supported by BT: The blockchain ledger and smart contracting for processing the transaction were seen as the most valuable functionalities (88%). Time stamping functionality, which is mostly missing from intermediate services, seems a promising blockchain functionality for integrating (B2B) business and (M2M) IoT transactions. Data-encrypting private and public keys enable secure data transfer and digital signatures for smart contracting. However, DSC integration requires standards for system interoperability, which BT itself does not offer yet despite of it is going cross-boundaries of organizations so that several actors work together simply, and therefore it is creating the conditions to the development of OI.

As a consequence of the more open data point, the OI for smart cities will greatly get enhanced by the BT thanks to the combined push of the open data and the Internet of Things (IoT) where new protocols like IOTA (Popov, 2016) will give extra boost to the collection and sharing of smart data thanks to this crypto protocol of third generation. According to ("IBM", 2015) adopting distributed computing to process hundreds of billions of IoT transactions that occur daily can significantly reduce costs associated with installing and maintaining large amounts of centralized data; thus, BT has democratized devices in terms of distributed computing, which will ensure the future of the IoT.

As well, there is up the *blockchain innovation commons*. These innovation commons can be understood as private governance mechanisms to facilitate the crypto-entrepreneurial process of discovering uses for BT (Allen, 2017) that go well towards the objectives of the smart cities (See table 2).

Type	Description	Examples
Blockchain 1.0	Currency	Bitcoin, Litecoin, ETH, et al.
Blockchain 2.0	Contracts	Financial services contracts, Smart property, Smart contracts.
Blockchain 3.0	Justice applications beyond currency, economics, and markets	Digital Identity, Blockchain government, Domain name systems

Table 2 — Examples of BT applications (Allen, 2017)

The Smart City agenda of integrating ICT and IoT, computer infrastructure to improve the efficiency and adaptability of city governance has been shaping urban development policy for more than a decade now. A smart city has more data, gathered though new and better technology, delivering higher quality city services. The BT could shift the Smart City agenda by altering transaction costs with implications for the coordination of infrastructures and resources and encourage OI as said in previous section. Like the Smart City the Crypto City utilizes data informatics, and is coordinated through distributed rather than centralized systems. The data infrastructure of the Crypto-City can enable civil society to run local public goods, and facilitate economic and social entrepreneurship towards OI (Potts et al., 2017)

In fact, the several technologies associated with the "smart city", such as electronic sensors or urban control rooms and city labs, as well as emerging technologies, such as blockchain,

that enable peer-to-peer service delivery (Pazaitis et al., 2017) are becoming more central to the ways citizens engage with public-service delivery (Lember, 2017) under the schemes of OI dedicated user/citizen-innovation, technology, and living labs to accelerate technological innovations in the public sector. All these approaches aim at putting user experience at the center of the public sector innovation processes, however, these experimental units and methods are still far from becoming an organic part of the public sector and its change.

All these contributions of BT leverage the OI in smart cities (Sun et al., 2016) as user innovation with the participation of civil servants and public and private bodies.

5.5 Further Funding with Virtual Currencies.

As stated in (de la Rosa et al., 2017) the virtual currencies powered by BT that are linked to OI might create novel funding schemes for OI across organizational boundaries. The underlying innovation of crowdfunding through a sale of digital tokens, verified through a novel use of blockchain technology. It is refreshingly independent of our modern banking and fundraising mechanisms.

The growing popularity of cryptocurrencies started from usual ICO (initial coin offerings) tokens. Today, they have changed our imagination about the stock market. An ICO is what you could get provided that bitcoin and Kickstarter had a baby — a crowdsale of a new crypto asset, with a cryptocurrency like bitcoin being one type of crypto asset, but notably Ether or Waves imposing their rule for the crowdfunding, that powers some kind of peer-to-peer blockchain network.

There are so many cryptocurrency ICOs going on these days, it becomes difficult to keep track of everything, but the fact is that for the first time in the technology's short history, blockchain entrepreneurs are now raising more money through initial coin offerings (ICOs) than traditional venture capital investments.
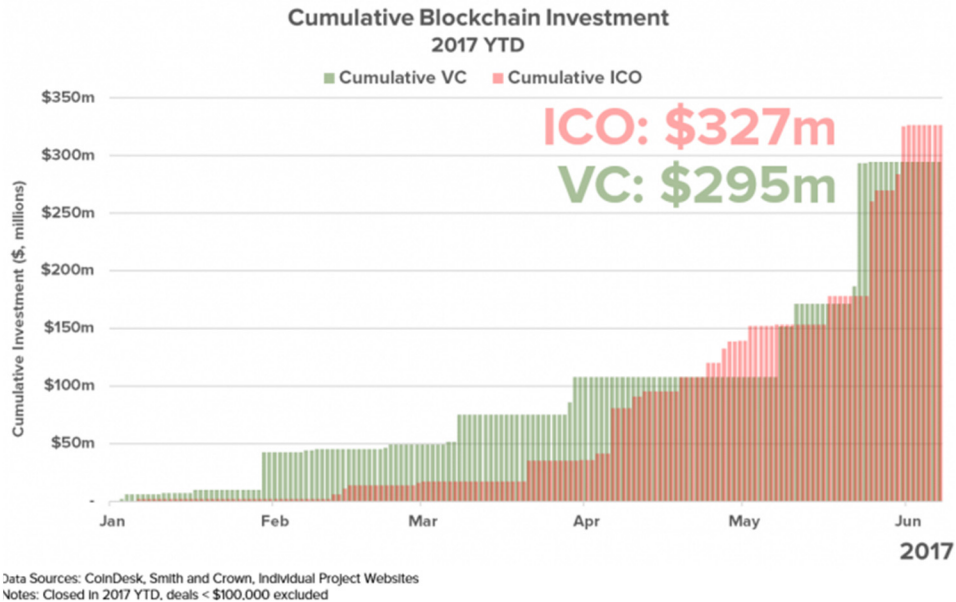
So far in 2017, blockchain entrepreneurs have raised $327m through ICO offerings, a figure that now exceeds the $295m raised through VC funding, according to CoinDesk data.

WeiFund ("Weifund", 2017) is an example of new services that provides crowdfunding solution on the Ethereum ecosystem. The WeiFund contracts implement the core mechanics of crowdfunding. Using smart contracts donations can be turned into complex agreements including refunds if the campaign goal isn't met. Novel leading fintech companies like Funderbeam, despite of pioneering the application of the Blockchain for secondary markets of SME shares, now they plan to go for the ICO services.

Analysis shows the development was spurred by big gains in Q2, as entrepreneurs raised $291m through ICOs, compared to just $187m in traditional funding over the same period.

Overall, the totals are a far cry from 2016, when the nascent funding mechanism accounted for less than half of the nearly $500m of venture capital invested into startups. In the first quarter of 2017, for example, ICOs raised to just under a third of entities seeking VC funding.

In the months since, however, this trend has reversed with ICO investment totals growing over 800% and soaring past venture capital funding.

Cumulative Blockchain Investment
2017 YTD

■ Cumulative VC   ■ Cumulative ICO

ICO: $327m
VC: $295m

Cumulative Investment ($, millions)

$350m
$300m
$250m
$200m
$150m
$100m
$50m

Jan   Feb   Mar   Apr   May   Jun

2017

Data Sources: CoinDesk, Smith and Crown, Individual Project Websites
Notes: Closed in 2017 YTD, deals < $100,000 excluded

Fig 3. Comparing VC with ICO funding inn 2017 (by Coindesk)

4G Capital ("4G-Capital", 2017) provides instant access to credit for small business growth in Africa, and has developed a concept dApp for the use of smart contracts. Donors would be able to use the dApp to fund small businesses in Kenya using digital currency. The money lent would be converted and disbursed to the businesses using 4G Capital's transactional system.

And witcoin.io tries to tokenize the space of knowledge exchanges in OI applied by means of nir-vana.eu so that new liquidity will be available for consultants and more people and with the promise that "no good idea nor great project will be left behind".

5.6 Digital Consultancy related to OI

As the cases proposed by 9lenses.com or nir-vana.eu where the innovation consultants get digital making easier the necessary open knowledge exchanges with traceable authorship, more clear contracts, enhanced big data, and more abundant funding for the proper knowledge, that is possible with the right combination of blockchain related technologies and the innovation consultancy (Brunswicker, S. and Vanhaverbeke, W., 2015)

As a conclusion, there are several works on building a product or prototype that addresses a specific problem of OI from the point of view of BT, as for example and notably within the DRM (Digital Rights Management) or ET space ("Blockchain and Open Innovation", 2017). These two key areas are ripe for change and blockchain and smart contracts have the potential to bring about notable enhancements in productivity, transparency and risk management.

Digital technology is no longer viewed as a mere tool in the support of organizations, but rather as a disruptor that will create new organizations and replace many unwilling, or unable, to innovate. Organizations now find themselves embracing a digital age, where a new generation of technologies is focused on leveraging greater customer engagement, bringing further flexibility and agility to standardized, and centralized, operational processes, and providing new strategic opportunities to organizations by reconfiguring business models,

creating new products and services and in some cases disrupting and reinventing entire value chains and industries. To this end, organizations are increasingly becoming more virtual-oriented, with many products and services gaining in digital presence, structures and hierarchies becoming more porous and horizontal, and industry sectors more garmented, where many competitors are reaching across value chains to collaborate and innovate in novel ways (Scott et al., 2017).

5.7 Blockchain in Education for OI

The platformized dimension of both BT and OI has several dimensions, being the education one of the newly ones as ("Platform design whitepaper", 2016). As education becomes more diversified, democratized, decentralized and disintermediated, we still need to maintain reputation, trust in certification, and proof of learning. The "increased focus on relevance and employability may also push us in this direction, as we also need more transparency; blockchain could provide just such a system: a massive open, online, secure database." ("10 ways", 2017). BT can be used to place certificates, badges, proof of learning to a blockchain database to stop issuing fake certifications, necessary for the digital consultancy dimension discussed above for the OI development. As well, Sony Global Education adapted BT to the educational field and has developed technology that enables open and secure sharing of academic proficiency and progress records. MIT Media Lab has published a paper (Nazare et al., 2016) on researching the attributes of using distributed ledger technology with digital certification for the education.

5.8   Bot-powered OI

In the past few years, online services have become the most important tools for the interaction between people. New technologies allow instant communication with anyone in the world, anytime. The Web is full of new social applications for communication that are powerful and world–changing. This new age of social systems on the web governed by both computational and social processes is growing and evolving quickly. It is mandatory to strengthen the cooperation between the Web and the AI researchers to build together smarter systems with the aim of amplifying the capabilities of the people while on the social networks. Soft bots operating in the OI Platforms will soon become a reality. Bots will aim at speeding up discussions carried out by groups of users which share a virtual space in a social network for collaborative or OI. Considering that nowadays, the amount of discussions, debates and decisions taken through the web are far superior to the ones performed in the physical world, then the AI powered online social platform is a place where social machines share discussion spaces with human users with the objective of helping them to create and innovate (El-Fakdi and de la Rosa, 2016). The softbots must understand human and project needs during the development of any kind of conversation and offer them help, by doing administrative stuff on the web, mining data, proposing new ideas and connecting experts and professionals from around the world which may share a common space in a particular successful project.

As for example the I-bot© of inwibe is an integrated chatbot for service and support purposes, that will use the smart contracts blockchained protocol of second generation for mining and getting knowledge useful for OI.

ZombieCoin presented a Bitcoin based mechanism to command and control botnets including flexible partitioning of the botnet, fine-grained control over the bots. (Wilson D. et. al., 2015) suggested a bitcoin based enhanced certificate format to improve Pretty Good Privacy services. Their prototype does not modify the original PGP protocol. Instead of sending the PGP certificate to the certificate server a transaction is made between the two addresses.

Finally, the category of innovation advisors might be partially covered by the softbots, as a sort of digital consultancy service, that might live in the blockchain. We mean that, knowing that in the future, (ownerless) companies will live in the blockchain ("Singularityhub", 2016) so that they will be implemented as distributed autonomous organizations and even might be ownerless, just for the sake of the good practices in OI and for the platform sake. In this scenario, we foresee that the bot-powered OI will have a place in OI and bots will be powered by the BT, enjoying and exploiting even further the capacities of OI.

6. **Final Comments**

This is a survey on OI for SME powered by online platforms and the potential application of BT. This article analyses and synthesizes the key findings in scouting current and future applications of BT to OI in key areas apart from the IP management or the OI for smart cities, notably digitization of the collaborative work and smooth cooperation across boundaries of companies by means of smart contracts, further transparency in (idea) contests, new means of funding, open data, and even bots development on the blockchain.

The main point is that BT seems naturally linked to distributed OI platforms and to online collaborative innovation. The benefits from applying BT to enhance OI networks are huge and most of them are still at an embryonic phase that are worth exploring for new stages of exciting innovation in the platformized dimension of both BT and OI where no good idea will be left behind.

As seen in this prospective survey, the BT is able to establish itself as a mainstream technology for OI ecosystems based on its current capabilities of full distribution at large that encourages openness and collaboration across the globe. Finally, it is prospected that BT will contribute with enough technical capabilities to be make OI considered a sustainable platform and reach mainstream adoption as it will lower adoption barriers with enhanced IP management, increased transparency, further knowledge and collaboration empowerment with smart contracts and open data, and new liquidity for funding innovation.

Acknowledgement

References

(Allen, 2017) Allen, D. (2017). Blockchain Innovation Commons. Papers.ssrn.com. Retrieved 18 October 2017, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2919170

(Bogers, Afuah, and Bastian, 2010) Bogers, M., Afuah, A., & Bastian, B. (2010). Users as Innovators: A Review, Critique, and Future Research Directions. Journal of Management, 36(4), 857-875. DOI: 10.1177/0149206309353944.

(Brunswicker, S. and Vanhaverbeke, W., 2015) Brunswicker, S., & Vanhaverbeke, W. (2015). Open Innovation in Small and Medium-Sized Enterprises (SMEs): External Knowledge Sourcing Strategies and Internal Organizational Facilitators. Journal of Small Business Management, 53(4), 1241–1263. http://doi.org/10.1111/jsbm.12120.

(Chesbrough and Bogers, 2014) Chesbrough, H., & Bogers, M. (2014). Explicating Open Innovation: Clarifying an Emerging Paradigm for Understanding Innovation Keywords. In H. Chesbrough, W. Vanhaverbeke, & J. West (Eds.), New Frontiers in Open Innovation (pp. 1–37). Oxford University Press. http://doi.org/10.1093/acprof.

(Davidson et al. 2016) Davidson, S., De Filippi, P., & Potts, J. (2016). Disrupting Governance: The New Institutional Economics of Distributed Ledger Technology. Papers.ssrn.com. Retrieved 17 October 2017, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2811995.

(de la Rosa et al., 2016) de la Rosa, J. L., Gibovic, D., Torres, V., Maicher, L., Miralles, F., El-Fakdi, A., & Bikfalvi, A. (2016). On Intellectual Property in Online Open Innovation for SME by means of Blockchain and Smart Contracts. 3rd Annual World Open Innovation Conf. WOIC 2016.

(de la Rosa et al., 2017) de la Rosa J. L, Gibovic D., Torres-Padrosa V. (2017) A Preliminary Work on Virtual Currencies for Open Innovation, IV International Conference on Social and Complementary Currencies, Barcelona, May 22-24, 2017.

(El-Fakdi and de la Rosa, 2016) El-Fakdi, A. and de la Rosa, J. L (2016). Open Innovation Platform: Adding Social Machines for Enlightening Discussions. Artificial Intelligence Research and Development, Frontiers in Artificial Intelligence Applications. Volume 288, pp 283 - 288. ISBN 978-1-61499-695-8 (print) | 978-1-61499-696-5 (online), IOS Press.

(Gawer and Cusumano, 2014) Gawer, A., and Cusumano, M. A. (2013). Industry. Platforms and Ecosystem Innovation. J Prod Innov Manag 31, no. 3 (September 4, 2013): 417–433.

(Glaser & Bezzenberger, 2015) Glaser, F., & Bezzenberger, L. (2015). Beyond Cryptocurrencies - A Taxonomy of Decentralized Consensus Systems. In European Conference on Information Systems (pp. 1–18). https://doi.org/10.18151/7217326.

(Johansen, 2016) Johansen, SK. (2017). A Comprehensive Literature Review on the Blockchain Technology as an Technological Enabler for Innovation, working paper https://www.researchgate.net/publication/312592741_A_Comprehensive_Literature_Review_on_the_Blockchain_Technology_as_an_Technological_Enabler_for_Innovation.

(Khan et al., 2017) Chris Khan, Antony Lewis, Emily Rutland, Clemens Wan, Kevin Rutter, Clark Thompson (2017), A Distributed-Ledger Consortium Model for Collaborative Innovation - IEEE Journals & Magazine, Volume: 50 Issue: 9, pages: 29-37, Retrieved 17 October 2017, from http://ieeexplore.ieee.org/abstract/document/8048650/

(Korpela et al., 2017) Korpela K., Hallikas J. and Dahlberg T. (2017). Digital Supply Chain. Transformation toward Blockchain Integration, Procs. of the 50th Hawaii International Conf. on System Sciences.

(Lember, 2017) Lember, V. (2017). The Increasing Role of Digital Technologies in Co-production. Available at:

https://www.researchgate.net/profile/Veiko_Lember/publication/319504628_The_Increasing_Role_of_Digital_Technologies_in_Co-production_and_Co-creation/links/59afd7240f7e9bf3c72922e1/The-Increasing-Role-of-Digital-Technologies-in-Co-production-and-Co-creation.pdf

(Nazare et al., 2016) Nazare, J., Duffy, K., & Schmidt, J. P. (2016). What we learned from designing an academic certificates system on the blockchain. New Frontiers in Open Innovation, Oxford: Oxford University Press, 2014, pp 29-49.

(Pazaitis et al., 2017) Pazaitis, A., De Filippi, P. and Kostakis, V. (2017). Blockchain and Value Systems in the Sharing Economy: The Illustrative Case of Backfeed. Working Papers in Technology Governance and Economic Dynamics, 73. Available at: http://technologygovernance.eu/files/main/2017012509590909.pdf

(Popov 2016) Popov S. (2016). The Tangle. Available at: https://iota.org/IOTA_Whitepaper.pdf

(Piller and West, 2014) Piller, F. and West, J. (2014) Firms, Users, and Innovation: An Interactive Model of Coupled Open Innovation, in Henry Chesbrough, Wim Vanhaverbeke and Joel West, eds., New Frontiers in Open Innovation, Oxford: Oxford University Press, 2014, pp 29-49. DOI: 10.1093/acprof:oso/9780199682461.003.0002

(Potts et al., 2017) Potts, J., Rennie, E., & Goldenfein, J. (2017). *A City Is a Data Pool: Blockchains and the Crypto-City*. *Papers.ssrn.com*. Retrieved 18 October 2017, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2982885.

(Scott et al., 2017) Scott, B., Loonam, J., & Kumar, V. (2017). Exploring the rise of blockchain technology: Towards distributed collaborative organizations. Strategic Change, 26(5), 423-428. doi:10.1002/jsc.2142.

(Sun et al., 2016) Sun, J., Yan, J., & Zhang, K. Z. (2016). Blockchain-based sharing services: What blockchain technology can contribute to smart cities. Financial Innovation, 2(1), 26.

(Tapscott, 2016) Tapscott D., Tapscott A. (2016). "Blockchain Revolution: How the Technology Behind Bitcoin is Changing Money, Business, and the World", Penguin Random House.

(Wilson D. et. al. 2015) Wilson, D., & Ateniese, G. (2015). From pretty good to great: Enhancing PGP using bitcoin and the blockchain. In International Conference on Network and System Security (pp. 368-375). Springer International Publishing.

(Williamson, 1983) Williamson, O.E. (1983). Markets and hierarchies' analysis and antitrust implications: A study in the economics of internal organization, Free Press, New York.

(Wörner et al., 2016) Wörner, D., Von Bomhard, T., Schreier, Y.-P., & Bilgeri, D. (2016). The Bitcoin Ecosystem: Disruption Beyond Financial Services? In ECIS 2016 Proceedings. https://www.alexandria.unisg.ch/publications/248647.

("Blockchain and Open Innovation", 2017) Blockchain and open innovation: What does the future hold? (2017). Retrieved 25 October 2017, from https://www.uktech.news/news/blockchain-and-open-innovation-what-does-the-future-hold-20161017

("Global Supply Chains", 2017) Global Supply Chains Are About to Get Better, Thanks to Blockchain (2017). Retrieved 25 October 2017, from https://hbr.org/2017/03/global-supply-chains-are-about-to-get-better-thanks-to-blockchain

("Blockchain Governance", 2017) Blockchain Governance Paradox (2017). Retrieved 25 October 2017, from https://ftalphaville.ft.com/2017/06/14/2190149/blockchains-governance-paradox/

("Notarization of IP documents", 2017) Notarization of IP documents with blockchains (2017). Retrieved 25 October 2017, from http://www.patentattorneys.ch/en/2017/02/15/bernstein/

("Blockchain Technology", 2017) Blockchain Technology Expected to Strongly Impact the IP Industry (2017). Retrieved 25 October 2017, from https://www.lexology.com/library/detail.aspx?g=a1461135-598b-4c3c-811c-73ac70c3f67b

("4G-Capital", 2017) http://www.4g-capital.com/

("Weifund", 2017) http://weifund.io/

("Smart Contracts", 2017) Smart Contracts: 12 Use Cases for Business & Beyond (2017). Retrieved 25 October 2017, from http://www.the-blockchain.com/docs/Smart%20Contracts%20-%2012%20Use%20Cases%20for%20Business%20and%20Beyond%20-%20Chamber%20of%20Digital%20Commerce.pdf

("IBM", 2015) Device democracy: Saving the future of the Internet of Things (2015). Retrieved 25 October, from http://www-935.ibm.com/services/us/gbs/thoughtleadership/internetofthings/

("Economist", 2015) The promise of the blockchain: The trust machine (2015). Retrieved 25 October, from, http://www.economist.com/news/leaders/21677198-technology-behind-bitcoin-could-transform-how-economy-works-trust-machine

("SpendMatters", 2015) Why Bitcoin's Blockchain Technology Could Revolutionize Supply Chain Transparency (2015). Retrieved 25 October, from, http://spendmatters.com/2015/11/09/why-bitcoins-blockchain-technology-could-revolutionize-supply-chain-transparency/

("Economist", 2016) The blockchain in finance: Hype springs eternal (2016). Retrieved 25 October, from, http://www.economist.com/news/finance-and-economics/21695068-distributed-ledgers-are-future-their-advent-will-be-slow-hype-springs

("Cryptoeconomics", 2017) Cryptoeconomics – The Opportunities and Challenges of Blockchain (2017). Retrieved 25 October 2017, from http://tabbforum.com/opinions/cryptoeconomics-the-opportunities-and-challenges-of-blockchain

("Blockchain solutions", 2017) Blockchain based solutions for intellectual property management (2017). Retrieved 25 October 2017, from https://medium.com/@foustry/blockchain-based-solutions-for-intellectual-property-management-2ba14b51d5f6

("Blockchain technology", 2017) Blockchain technology and IP (2017). Retrieved 25 October 2017, from, https://www.taylorwessing.com/download/article-blockchain-technology-and-ip.html

("10 ways", 2017) 10 ways Blockchain could be used in education (2017). Retrieved 25 October 2017, from, https://oeb-insights.com/10-ways-blockchain-could-be-used-in-education/

(Singularityhub 2016) http://singularityhub.com/2016/02/16/how-ownerless-firms-will-soon-live-on-the-blockchain

("Platform design whitepaper, 2016) http://platformdesigntoolkit.com/platform-design-whitepaper/ visited on October 30, 2017)

("Blockchain Matching Platforms", 2017) Blockchain Matching Platforms: An Innovative Way to Connect with Peers (2017). Retrieved October 2017, https://www.cryptocoinsnews.com/blockchain-matching-platforms-an-innovative-way-to-connect-with-peers/