The Generic Blockchain Ecosystem and its Strategic Implications

Completed Research

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Abstract

The emergence of blockchain technology, most known due to the hype around Bitcoin, has the potential to transform entire industries, such as banking, insurance, or the Internet of Things (IoT). Yet, parallel ecosystems like cryptocurrencies that substitute products and services of traditional financial institutions emerged. However, literature does not provide a structured overview of the blockchain ecosystem. By analyzing 479 blockchain companies reported in the Crunchbase database, this paper visualizes the current blockchain ecosystem using the e^3-value method consisting of eleven generic roles. Moreover, we identify three strategic implications where blockchain is fundamentally different from prior approaches: governance, trust, and openness. Scholars can apply the generic ecosystem for future research, while practitioners can use the model to identify possible disruptive actors or potential business opportunities.

Keywords

Blockchain, digital transformation, ecosystem, value network, e^3-value model.

Introduction

Blockchain, currently at the top of the Gartner hype cycle (Cearley et al. 2017), follows the blueprint process for a technology hype. Blockchain is known above all as the basis of the cryptocurrency Bitcoin (Nakamoto 2008). As of February 2018, more than 1,500 cryptocurrencies have a market capitalization in excess of $ 400 billion, with Bitcoin accounting for more than $ 150 billion with a more than eightfold rise over the last year (Coinmarketcap.com 2018). Some countries already accept cryptocurrencies as a means of payment. Hence, it is hardly surprising that many believe the technology has the potential to disrupt entire branches of the economy (Tapscott and Tapscott 2016).

While some understand it as technological innovation, some argue blockchain to be the technological basis for a new economy (Swan 2015). Drawing on the recent hype, Vitalik Buterin, founder of Ethereum, states, "whereas most technologies tend to automate workers on the periphery doing menial tasks, blockchains automate away the center. Instead of putting the taxi driver out of a job, blockchain puts Uber out of a job and lets the taxi drivers work with the consumer directly" (Tapscott and Tapscott 2016). Traditional banks, insurances, or the interaction of machines through the Internet of Things (IoT) can be replaced or automated through programmable contracts that are executed without human intervention or middleman, so-called smart contracts (Swan 2015; Tapscott and Tapscott 2016).

The case of cryptocurrency shows that innovative technology is continuously penetrating or substituting the business model of established organizations. One reason is that the market for digital technologies, such as blockchain is easily accessible and constantly innovating. Organizations that have the capacity to combine and deploy digital technologies create new business models that fundamentally transform the way

business is done (Lucas et al. 2013). Yet, existing studies solely focus on the business model of organizations or the transformation of the business model of established financial institutions (Puschmann 2017). To visualize the blockchain ecosystem, blockchain landscapes were developed (e.g., Mougayar 2015). However, none of the landscapes presented their coding process. Consequently, literature does not provide a structured inter-organizational overview of the emerging blockchain ecosystem (Puschmann 2017).

Towards this goal, and to trigger further research, this paper aims to answer the following research questions: *Which generic roles and value exchanges exist in the blockchain ecosystem? How does the generic blockchain ecosystem look like?* Therefore, we first use the e³-value method to model the blockchain ecosystem based on eleven generic roles we derived from analyzing 479 companies. We extracted the company data from the Crunchbase database, a comprehensive, socially curated database for established companies and startups.

The paper is organized as follows. First, we briefly present related work on blockchain. Second, we describe our research methodology. As third, we identify eleven generic roles and present the blockchain ecosystem. Next, we discuss the results, strategic implications and future research. The final section is the conclusion.

Related Work

Due to the early stage of development no general definition of blockchain technology has been established (Swan 2015). Condos et al. (2016) define a blockchain as an electronic ledger for digital records, events, or transactions managed by the participants of a distributed computer network. Previously, most trade repositories, e.g. for example, for lending or sale of securities, were not publicly available. The opening of transaction registers for all interested parties is an important innovation of the blockchain technology, so that all previous transactions can be viewed in the system (Harvard Business Review 2017). However, this does not necessarily indicate who carried out the transactions, e.g. in the case of Bitcoin, the users remain anonymous or pseudo-anonymous, since only the identification tag of the digital wallets is required for a transaction.

Furthermore, a blockchain is a distributed system without a central control point or authority (Glaser and Bezzenberger 2015; Tapscott and Tapscott 2016). Central control points or authorities are not necessary in a blockchain because the distributed network verifies the transactions being performed. This is considered a key innovation of the blockchain technology (Harvard Business Review 2017). If a transaction between two parties is to be made in the network, the nodes in the distributed network compete to solve a mathematical puzzle and also store that transaction in the trade repository (Nakamoto 2008). A transaction can then no longer be deleted from the trade repository or ever returned. The elimination of a central instance in the distributed network implies a radical shift to direct transactions between non-intermediaries or intermediary services (Tapscott and Tapscott 2016). The data structure of a blockchain corresponds to a database that groups entries into blocks that are linked in chronological order via a cryptographic signature (Walport 2015). The blocks contain a copy of the last transactions since the last block was added (Bogart and Rice 2015). The management system of a blockchain corresponds to a distributed consensus system. Since a blockchain has no central authority, there must always be consensus among the actors in the system about the valid state of the blockchain. For the verification of the blockchain different consensus mechanisms can be used, which are based on peer-to-peer mechanisms and encryption (Glaser and Bezzenberger 2015). Blockchain was originally created as an approach to cryptographic-based payment transactions to provide an alternative mechanism of trust between two transaction parties: Bitcoin (Nakamoto 2008). In classical transactions, the parties have to rely on a trusted third party, such as a bank. In the case of Bitcoin, the necessary trust is now completely substituted by the blockchain, as it allows for a collective trade repository operated by many decentralized registers (Nakamoto 2008). A consensus mechanism based on mathematical functions (in the case of bitcoin: hash functions) coordinates the network nodes and can validate and approve or reject the status of a transaction (Nakamoto 2008).

Frederik Voss, Vice President of Nasdaq, states "Blockchain is a technology that only works at its full potential in a network. You need to have a complete ecosystem on the blockchain for it to offer maximum value to all its participants" (Nasdaq 2016). However, literature does not provide a structured inter-organizational overview of the emerging blockchain ecosystem (Puschmann 2017). To visualize the blockchain ecosystem, some blockchain landscapes were developed for practitioners (e.g., Mougayar 2015). Mougayar (2015) clustered 268 companies that are involved in crypto-tech computing, decentralized

services, or cryptocurrencies into four major categories with over 20 sub-categories. However, the category development and the coding process is not published. Thus, we target to following a structured approach to identify the generic roles in the blockchain ecosystem and the value streams between them.

Research Approach

We conduct a three-step research approach based on Riasanow et al. (2017). To get an inter-organizational overview, we develop the generic ecosystem of the blockchain industry. We first identify the roles of the actors in the industry and the values streams between them. Second, we present the generic ecosystem based on the prior identified roles and value streams. Third, we validate the model with five semi-structured expert interviews.

For the first step, we decided to use Crunchbase data[1] in order to derive the roles in the ecosystem. Crunchbase possesses a comprehensive database for existing companies and startups (Marra et al. 2015) including a description of organizations' value propositions. Crunchbase contains startups at all funding stages, which enables researchers to capture new business model innovations in emerging markets (Marra et al. 2015; Perotti and Yu 2015). The information reported in the database consists of the company size class, its location, its primary role (firms, group, investor), its status (operating, acquired, IPO, or closed), its founding date, and the dates on which the record was created and updated.

We extracted all organizations listed on December 11, 2017. To collect all organizations of the blockchain industry, we filtered the Crunchbase category list by the search term "blockchain", which led to a sample size of 500 funded companies. This led us to capture established and emerging organizations, which are representative for the current blockchain industry. We excluded six companies, which have been "closed" or "acquired" so far, for example KapeIQ, a Blockchain-based intelligent fraud detection service. Furthermore, we had to exclude 15 organizations from our coding, as the listed website did not exist anymore, e.g., DigitalMR, a company that uses artificial intelligence for consumer insights. Hence, we shortened the data set by 21 companies. With the remaining 479 organizations we conducted in a first step a structured content analysis, including an inductive category development based on Mayring (2010). With this method, we identified a set of nine generic roles.

We established inter-coder reliability to ensure consistent coding. Two experienced raters independently coded the 479 organizations. All authors confirmed the final coding of each organization and discussed the coding discrepancies until we reached a consensus. For example, we coded Axoni as "blockchain infrastructure provider" based on its description *"New York-based provider of distributed-ledger technology for financial firms"*. We used the same approach for the identification of the value streams, but combined the Crunchbase information with secondary publicly available information from company websites, reports, press articles or annual reports. After both raters completed the coding, we used Krippendorff's (2004) Alpha to determine inter-coder reliability. The results indicated an Alpha of 0.87, reflecting an acceptable inter-coder reliability (Krippendorff 2004).

In the second step, we use the e^3-value method to visualize the ecosystem of the blockchain industry based on the identified generic roles and the value streams between the generic roles. The e^3-value method is a business modeling methodology to elicit, analyze, and evaluate business ideas from an ecosystem perspective. It is used to evaluate economic sustainability of ecosystem by modelling the exchange of things of economic value between actors (Gordijn and Akkermans 2003; Riasanow et al. 2017).

In the third step, we conducted five interviews with experts from the financial industry to validate the generic ecosystem. We used a semi-structured technique (Myers and Newman 2007) to interview a COO and co-founder of blockchain startup, a senior developer of a blockchain startup, two senior managers working in the blockchain lab of one of the big four accounting firms, and an independent blockchain consultant with a major in IS applications. The interviewees are either working in a leading strategic position or information technology related function, who have privileged access to information and knowledge on the subject (Bogner et al. 2009). This allowed us to draw from a broad knowledge and different insights from various companies. We conducted the interviews between December and March 2018. The interviews were recorded and transcribed afterwards took 48 minutes on average. To validate

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[1] The Crunchbase database is accessible via www.crunchbase.com. We used a premium account for data collection.

the generic roles and value streams, we discussed the roles and value streams of the proposed generic ecosystem with the experts. This step yielded another two generic roles: the blockchain community and the token-based community platform provider, ultimately leading to eleven generic roles.

Development of the Generic Blockchain Ecosystem

To model the generic blockchain ecosystem, we follow the approach of Riasanow et al. (2017). Hence, we first derive the roles of the actors in the ecosystem by drawing on data from 479 companies derived from the Crunchbase database. Actors, which offer similar services and products to the consumer are abstracted to one role based on the structured content analysis following Mayring (2010). One company can act in different roles by offering different services to other players. In table 1, we first present the generic roles of the blockchain ecosystem.

Role	Description	Example(s)
Consumer	The consumer requests on- and off-chain and hybrid applications as well as cloud mining services. In some contexts, a consumer is a *Prosumer*, by simultaneously using and creating a service, as it is the case when running an own node or creating an own token on the Ethereum blockchain. When participating in a token-based community platform, the consumer is a *Participant*, contributing knowledge and content with the intention of being rewarded by the auction mechanism. Since in many cases a consumer participates through investing in a blockchain or blockchain application, he can also be called an *Investor*. Besides that, consumers benefit from the analyses and statistics offered by ancillary service providers and is part of the public dialogue with blockchain alliances. A consumer pays for value adding activities with money or cryptocurrency.	
Blockchain Infrastructure Provider	Blockchain infrastructure provider supply users and developers with a set of infrastructure capabilities including the conceptual framework, the underlying decentralized ledger technology (DLT) and cryptocurrencies (Mougayar 2016; Swan 2015). Corresponding information as permission rules, block sizes etc. are defined here. They provide the foundational elements for any further blockchain service development or delivery utilized by platform or application providers. Further capabilities of blockchains are the P2P network, consensus algorithms, a virtual machine, historical records, and state balances (Mougayar 2016).	Ethereum, Bitcoin, BigChainDB, MultiChain, Corda, Hyperledger
Blockchain Platform Provider	Platform providers offer the technical basis in the form of software and services that are on top of the infrastructure. They build an environment to develop, run and test applications, and extend the functionality of infrastructure elements (Mougayar 2016). This includes smart contract languages and scripts, testing tools, sandbox environments, integrated development environments and rapid application development frameworks as well as other software capabilities on higher stack levels than blockchain protocols (Tapscott and Tapscott 2016). Through providing smart contracts with implemented token settings, voting systems as well as auction and reward mechanisms, blockchain platform providers offer the technical basis for token-based community platforms. Cloud-based development environments are offered as Blockchain as a Service (BaaS). Blockchain platform providers allocate APIs, including a transaction scripting language, a P2P nodes communication API, and a client API to check transactions on the network (Mougayar	Elemetric, Monax, Multichain, Setl.io, Etherparty, Smart Contract Solutions, ShapeShift, ChromaWay, RiddleAndCode, Neuroware,io, Tierion, BlockApps, IBM BlueMix

	2016). The software offered by technical platform provider is compatible with one or more types of blockchains.	
Blockchain Application Provider	Application providers offer applications that are linked to on-chain and off-chain services and technically differ as following. On-chain services as identity management, voting, tokenization, messaging, assets linkages and naming registration are provided by decentralized applications, called dapps (Mougayar 2016). The back-end of dapps is executed on blockchain nodes, whereas the front-end either runs on a third-party-server, a user owned software or a decentralized storage owner such as Inter-Planetary File Systems (IPFS). On the other hand, services such as reputation, storage, exchange services and payments gateways belong to off-chain services, where the value is moved outside of the blockchain. The back-end of such traditional applications is not executed on a blockchain but rather on cloud computing services like Amazon Web Services. Besides offering dapps and off-chain applications, application provider also mix up applications with an existing web application and create a so-called hybrid blockchain application. By taking advantages of the decentralized character of blockchain, those providers create P2P marketplaces for users by developing appropriate applications (Mougayar 2016). Areas of application are diverse and can possibly be found in every existing industry. A large proportion of studied application providers are wallet providers. A wallet stores the access to currency by saving the private keys that demonstrate ownership of a public key, which in turn can be used to access currency addresses. Currently, three distinct categories of wallets are available for storing currency: software-, hardware- or paper-based wallets (Dale 2018). The applications are hosted and operated by the application provider and are built on top of technical platforms and the appropriate blockchain infrastructure (Mougayar 2016). Thus, applications represent the end-user products, which are accessible via the internet. One of the main duties of the application provider is to ensure a smooth operation of the application through constant monitoring as well as resource and problem management. Accordingly, the service provider must be aware of the state of his system at any time (Böhm et al. 2010).	Databroker DAO, BlockScience, Storj.io, Power Ledger, Crowdz, Propy, OwlTing, Binded, FunFair, Scorum, TAO Network
Token-Based Community Platform Provider	A token-based community platform is built on internal token distribution reward systems for establishing and evaluating content (Steem 2017). It serves a dual purpose of being a digital token processing systems and a platform having a specific purpose, such as Steemit, a social media platform. Actors on such platforms do not compete over raw computing power, as miners do, but over incentives that in turn add value to the network. An example is Numerai, which proposes Numeraire, a cryptographic token executed on the Ethereum blockchain that can be used in an auction mechanism. As it is the purpose of token-systems, data scientists participating in Numerai projects reveal their knowledge of their models' abilities to generalize to new, unseen data for the purpose of maximizing winnings through the auction mechanism (Craib et al. 2017). Such platforms propose tokens appropriate to the blockchain they are executed on. In the case of Steemit, they are generated at a fixed rate of one block every three seconds. These tokens are represented as smart contracts, which in turn dictate the maximum number of coins mined the rules for distributing tokens and the initiation of sending and destroying tokens. In many cases, they are	Numerai, Steemit

	based on Ethereum's ERC-20 tokens, accompanied by certain built-in "Proof-of-Brain" properties, which is the token rewards algorithm that aligns incentives between application owners and community members. The reward pool is a pool of tokens dedicated to incentivizing content creation. It then distributes these tokens to various participants based on the defined rules.	
Miner / Mining Pool	Miners execute the decentralized computational process of confirming transactions trustfully in public blockchains (BitcoinMining 2018). Thus, they are responsible for adding transaction records to the ledger of past transactions. Miners use special soft- and hardware to solve the given mathematical problem and are issued with the appropriate cryptocurrency of the blockchain they did the mining for as a reward. Since in the case of Bitcoin the difficulty for mining increased, miners started to pool their resources together and share their hashing power while splitting the reward equally according to the amount of shares they contributed to solving a block (Blockchain.info 2018). This collaboration is called *Mining Pool*. Nevertheless, whether miners are involved in a blockchain or not depends on the type of blockchain that an application or platform is executed on and the appropriate trust and permission layer and consensus algorithm.	Antpool, Slush Pool, BTC.top, Bitfury
Mining Solution and Equipment Provider	Mining solution providers offer hardware and software that is required for executing the process of mining. This includes equipment sales, maintenance and repair services. Since normal processors or graphics cards do not withstand the required computing power anymore, miners use special hardware, which computes hashes with application-specific integrated circuits (ASICs) and appears to be noticeably faster (Schulz 2017; Swan 2015). Besides distributing mining hardware, they provide cloud-mining solutions for private individuals who are not interested in physically hosting machines. This service is called Mining as a Service (MaaS). Another service offered by mining solution providers is consulting in setting up and operating mining farms.	Giga Watt, Canaan, MinersGate Technology, Riot Blockchain, Bitmain Technologies Ltd., Genesis Mining
Blockchain Ancillary Service Provider	Provider of ancillary services for blockchain technology undertake a wide variety of tasks. This is for example the provision of assistance before, during and after the launch of a crowd sale, including securing funding and providing acceleration services such as connecting with experts to co-develop white papers or to comply with global regulations and legal and business administration. Ancillary service providers offer monitoring services with appropriate statistics and analysis. Moreover, they publish the latest blockchain and cryptocurrency news and developments, inform and educate people interested in blockchain and offer workshops and trainings for developers and managers (Mougayar 2015).	Sweetbridge, SettleMint Blockchain Academy, Byte Academy, BTC Media
Blockchain Alliances	Blockchain alliances are founded as associations for boosting the public dialogue between the different participants of the blockchain ecosystem. Those alliances can be collaborations between industry experts to explore the potential of DLT within their industry for the benefit of all stakeholders in the value chain. They try to fulfill the need for education and certification of industry professionals, as well as to solve legal issues, set up standards and establish a regulatory framework. Alliances bridge the gap between blockchain-focused organizations and national and international governmental agencies and regulatory authorities (WallstreetBlockchainAlliance 2017).	WSBA, Enterprise Ethereum Alliance, Hyperledger, R3, B3i, EWF

Blockchain Community	The blockchain community is a strong and crucial force in driving the blockchain technology further. Consisting of individuals with a great affinity with blockchain (e.g., open source developers or blockchain and crypto professionals), the community discusses whether a new currency, application, crowd sale, etc. is accepted or not. This step is crucial for the breakthrough and establishment on the general market.	Reddit, Slack, Blockchain Community IEEE, CryptoFriends, Commonlounge
Blockchain Consulting Services	When a company decides to leverage blockchain technology within their organization, they often request consulting companies for their expertise in blockchain-centric software, customized blockchain development, or prototyping. Additional services might a proof of concept, a cost benefit and risk evaluation to evaluate the business case, as well as the assessment of security issues regarding the implementation of such a technology. Particularly service providers might make use of consulting services. Infrastructure and mining service provider demand consulting services to solve technical and security problems, to evaluate service offerings.	DigitalX, BlockGemini Technology, e-BIT Inc., Blockchain Partners, Deloitte Consulting, Datarella GmbH

Table 1. Generic Roles of the Blockchain Ecosystem

Second, we used the e3-value method to propose a generic blockchain ecosystem, see Figure 1. It depicts the identified roles and the value streams between them. As our roles are on a more abstract level than business models, on role can refer to different business model types. Further, one company can act in different roles by offering different services to other players.

Drawing on the developed generic ecosystem, we identify three strategic implications in which emerging blockchain companies fundamentally differ from established companies: governance, trust, and openness.

Governance can be characterised by the allocation of decision rights, control and ownership (Tiwana 2010). In contrast, blockchain allows the creation of decentralised marketplaces that can be governed by a community. This empowers users to directly influence the direction of a project. For instance, the project District0x offers a creation platform that allows its users to design and set up new marketplaces, called districts. As users stake tokens to a project, they gain voting rights. These rights can not only be used to participate in the change of the design and the functionality of a district, but also to specify how the generated revenue of a marketplace is used or distributed (Lestan et al. 2017).

Trust lays the foundation of the willingness of users to participate in and execute transactions (Riasanow et al. 2015). With blockchain a single central authority as trust mediator becomes unnecessary (Beck et al. 2016; Tapscott and Tapscott 2016). As example, Provenance enables companies to track the paths of products within the supply chain, allowing verification of ownership, attributes and origin. Thereby, blockchain enables product journeys to be more transparent (Provenance 2018). An integration into the marketplace would allow consumers to avoid plagiarism and parallel imports. Through the integration of external reputation platforms, a global web of trust could be built that is founded on immutable and verified data stored on blockchains. Furthermore, participants with no available reputation data can improve their reputation score by staking tokens into their accounts that serve as additional security deposits in the case of a conflict (Liu and Fraser 2018).

Openness is associated with the degree of accessibility, and it can even involve relinquishing control over a platform (Boudreau 2010). In the context of blockchain organizations, openness is of particular importance, as many of these projects are open source. Today, many organizations grant access to their platforms by providing boundary resources in the form of documented APIs (Eaton et al. 2015). Blockchain goes beyond that. For example, Syscoin makes its core and API-server available as open-source (Wasyluk 2018). As a result, an open ecosystem is established that allows developers to create their own frontend applications or even participate in the core development.
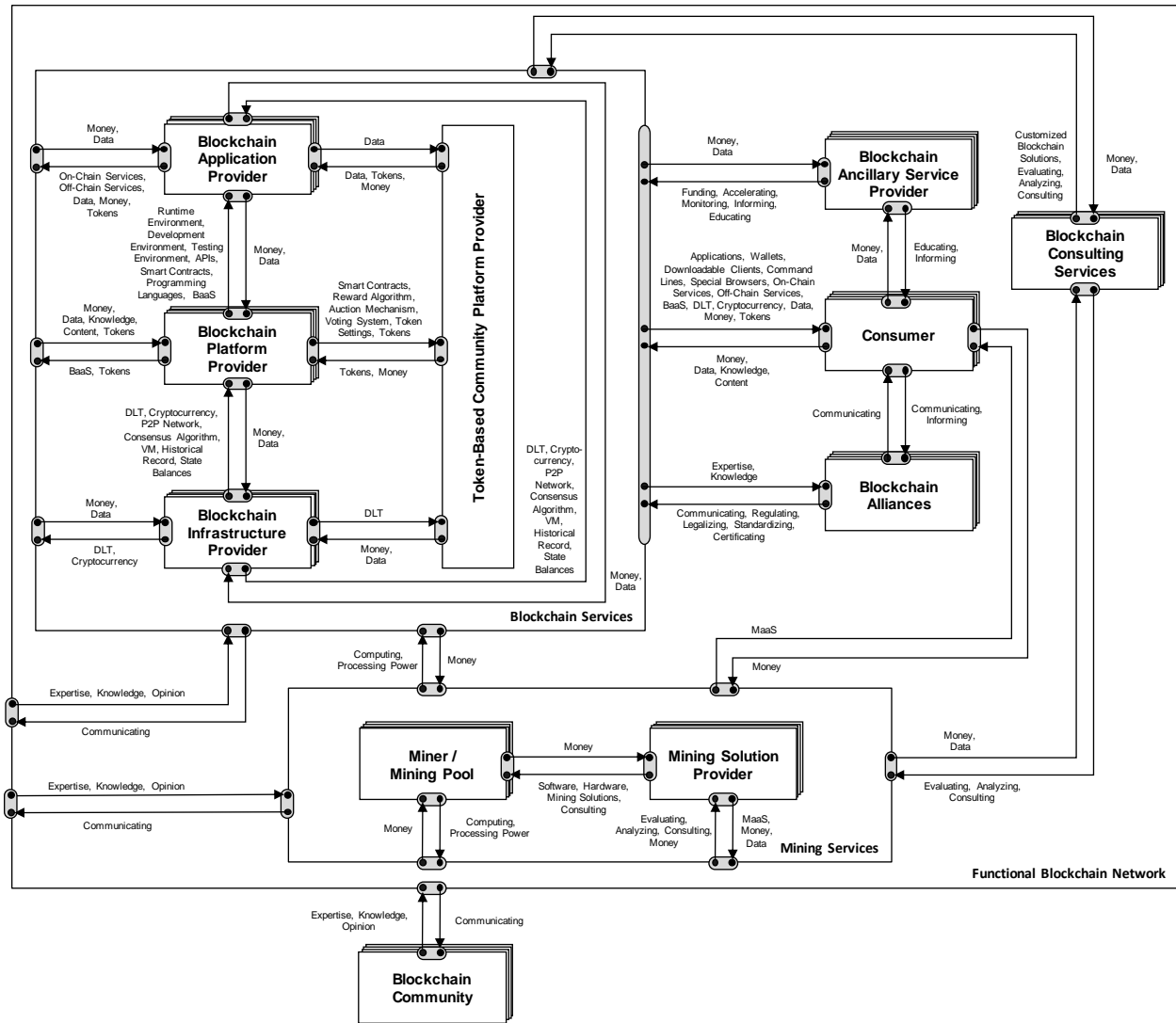
Figure 1. Generic Blockchain Ecosystem

Discussion

The model is limited by the information provided by the Crunchbase database and our coding of the generic roles. However, we reached an Alpha of 0.87, reflecting an acceptable inter-coder reliability for the coding of the generic roles. Drawing on the value streams between the roles, we relied on publicly available information, such as company websites, reports, press articles or annual reports. Further, we conducted five semi-structured interviews with blockchain experts to validate the proposed generic ecosystem.

Scholars can apply the developed generic ecosystem for further research, particularly for understanding digital transformation in the financial industry. We contribute to literature on blockchain, as existing studies solely focus on the transformation of the business model (Puschmann 2017). By developing the generic, inter-organizational, e³-value model of the blockchain ecosystem, we provide a macro-economic overview of an ecosystem that seeks to substitute the financial industry. There, we identified eleven generic roles. Based on the ecosystem, we identified three strategic implications in which blockchain fundamentally differs from prior approaches: governance, trust, and openness. On an ecosystem perspective, blockchain has the potential to substitute many of the existing products and services, e.g. in the case of payments or financing. However, plenty of the traditional financial institutions and regulatory authorities are increasingly experimenting with this innovative technology.

We suggest future research to determine the impact of blockchain on other ecosystems, such as the IoT. Blockchain could contribute to the interoperability of heterogeneous services and objects, which can be achieved through common standards and a platform (Mattila 2016). The unique identification of things or objects is of central relevance to the IoT. Blockchain-based identity management for items, services, and their transactions could break the concept.

Practitioners, e.g., from financial institutions can apply the model to identify potential threats to their current market position and potential opportunities to adapt to trends or shifts in consumer needs. According to Böhm et al. (2010) it is not necessarily important to know, which generic role might take the largest share within the ecosystem, but to develop a unique value proposition based on core competencies.

Conclusion

This paper presents the generic blockchain ecosystem, we identified by a structured content analysis of 479 blockchain organizations. The generic e³-value model shows the complexity of the blockchain ecosystem, consisting of eleven generic roles. Among them are miners, community roles and various application providers. However, many of the services are based on the cloud computing ecosystem (Böhm et al. 2010). To discuss three strategic implications in which blockchain differs fundamentally from prior organizations: governance, trust, and openness. Moreover, we encourage organizations to actively experiment with innovative technologies or to collaborate with emerging players in the blockchain ecosystem.

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