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The Tokenization of Everything: Towards a Framework for Understanding the Potentials of Tokenized Assets

Completed Research Paper

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Abstract

By enabling a new way to digitize transactions, distributed ledger technology allows to fundamentally change how value is digitally issued, transferred, and stored. Accordingly, «tokenization» refers to the concept of creating a singular identifier on a distributed ledger in terms of a token that may represent anything from financial assets, goods, to other valuable resources. Where tokenization may disrupt our economic system leading to more efficiency or democracy, it is required to gain insights and facilitate the development of use cases associated with this concept. To illustrate how firms can apply tokenization to innovate their businesses, we propose a framework of different token properties, drivers, and barriers for adoption based on literature and expert interviews and present eight archetypical cases derived from an analysis of 129 ventures. This work provides strategic guidance in a token economy and a starting point for future research of viable applications.

Keywords: Tokenization, Token Economy, Distributed Ledger Technology

Introduction

Without relying on mediation by trusted third parties, distributed ledger technology (DLT) provides a new technological paradigm in the operation of highly available, tamper-resistant distributed databases for transactions (Beck et al. 2017). Besides widely discussed implications for innovative information systems, the concept of «tokenization» has emerged in recent years by following DLT's basic abilities to enable a system for the management of asset ownership of unique digital representations (Hrga et al. 2020). In this context, tokenization refers to the process of creating a singular identifier on a distributed ledger in form of a token. A unique and persistent reference can be established to digitally represent anything that ranges from financial assets and goods to other valuable resources (Harwood-Jones 2019). It is assumed that the issuance, transfer, and storage of token on decentralized platforms reduce the drawbacks of intermediaries (e.g., single points of failures, lagging processing times). Especially the digital representation of bankable assets (e.g., stocks, bonds) has become a promising use case, where the Financial Times estimates that DLT-driven market infrastructures may save asset managers up to $2.7 billion per year just in the process of buying and selling funds (Mooney 2018).

Where many projects focus on the issuance of tokenized financial assets (Sazandrishvili 2020), it is also assumed that tokenization may serve as an enabler for new services and frictionless collaboration in a novel type of economy, a so-called token economy (Sunyaev et al. 2021). Accordingly, tokenization can be extended and utilized for many other purposes within a system and is not primarily limited to the transfer of ownership of tradeable objects. Unique tokens might be used as a means of tracking and tracing for a more transparent product lifecycle (e.g., food, pharmaceuticals) (Madhwal 2020). The access to services can be tokenized, letting the holder use a car sharing platform once a specific token is acquired. Organizations can issue a limited amount of tokens for licensing digital content or other digitized resources (Zhou et al. 2019). In each of these cases the role and reason for using tokenized assets can differ (e.g., improved transparency, increased liquidity) and extends the perspective on individual token design (e.g., native token, non-fungible token) (Oliveira et al. 2018). Although the technical feasibility of the concept has been broadly tested at prototype stage (e.g., transfer of bonds), expected adoption in established industries has not kept pace with the huge amounts of investments (Grilo and Zutshi 2020). While everything from art, real estate even oceans or stars may be tokenized, risks and legal aspects of use cases have to be considered (Sazandrishvili 2020). Decision makers are required to align their activities by identifying not only potentials but also weaknesses of a DLT-project (Naqvi and Hussain 2020). To the best of our knowledge, existing decision-aid tools (e.g., token standards) have fallen short to take these factors into account and lack strategic guidance for successful use case design and token-based business model development (Harwood-Jones 2019).

Especially for practitioners, the possibilities to create novel products and services seem endless and add complexity in assessing new business opportunities. For this concept to work, knowledge is required that defines what a token offers to represent, what tokenization enables, and which decentralized platform requirements have to be considered (Zachariadis et al. 2019). Previous research associated with tokenization focus mainly on two separated streams: Approaches to *describe a token* and general *applicability of tokenization*. The first topic deals with a range of different classifications to distinguish cryptoassets from one another. Some publications establish a common knowledge base for categorization and design (Freni et al. 2020; Oliveira et al. 2018) but neglect the study of broader implications. With regards to the second topic, there are only limited contributions that investigate value drivers or barriers. Mostly, they refer to industry-specific applications in banking (Sazandrishvili 2020) or supply chain management (Babich and Hilary 2020). It remains unclear how to address applicability between specific tokenized objects (e.g., financial assets, physical goods) in a particular scenario (e.g., increased liquidity, reduced costs). To cover the wide range of use cases offered by a token economy and identify the role of a token as part of an operating and business model, it is required to unify both research streams. By extending the understanding beyond descriptive token design, we address criteria for an assessment framework to support organizations in this decision-making and selection process through the following research question: *What are criteria for assessing asset tokenization use cases and which archetypical asset tokenization use cases exist?*

We applied a three-step research approach to develop a framework and to derive archetypes of this application area. At first, we carried out a literature review and analysis (Braun and Clarke 2006; Webster and Watson 2002) to establish an understanding about token-based solutions. Secondly, we conducted semi-structured interviews with 22 participants (e.g., C-level executives, product managers from Banking and FinTechs) following the recommendations by Ayres (2008) to refine the findings for our final framework. Lastly, we sampled a database of 129 firms in this field and derived eight empirically founded archetypes on basis of the identified criteria.

With our study, we contribute to practice as the framework allows a first assessment of use cases and, thus, facilitates decision making for the selection of viable applications. We contribute to research by synthesizing existing approaches and generating new means through empirical data. Therefore, our research serves as a foundation for new solutions and adoption towards a token economy. The remainder of this work is organized as follows. First, we introduce the domain background and current state of research. Second, we explain our research design applied in the development of the framework and derivation of archetypical use cases. Third, we present the identified criteria for assessment and generated archetypes. Finally, we discuss our findings, implications for both practice and research, as well as limitations, and present an outlook for future research.

Background

The Tokenization Concept

Many transactions involve trusted third parties as a necessity to authenticate a transfer of ownership (e.g., international bank transfers) between unknown participants. These operations are often associated with increased costs, time-consuming processes, and the exposure to a single point of failure. To overcome such challenges, DLT can be utilized to ensure the integrity of transactions in a decentral manner. Basically, it enables an append-only distributed database characterized by high tamper resistance in untrustworthy environments, known as byzantine fault tolerance (Kannengießer et al. 2020). Cryptocurrencies represent a known application, where its features allow a peer-to peer transfer of ownership without challenging the legitimacy of the transaction through a third party (Nakamoto 2008). According to new DLT frameworks (e.g., Ethereum), advanced features enabled a new form of crowdfunding in the past. So-called, initial coin offerings (ICO), introduced “tokens” to be sold in exchange for cryptocurrencies to investors seeking public investments for their company in return (Roth et al. 2019). As a known concept in non-DLT systems, tokens are utilized within closed environments such as casino chips, laundry credits or for IT access (Oliveira et al. 2018). Thus, DLT-based token further developed into an instrument to digitize anything that may represent an asset, utility or ownership due to their usefulness in their respective field. Pilkington (2015) highlights the purpose of tokens as ideal value containers for divisibility, ease-of-use, and facilitated trade. In this context, the concept of asset tokenization has gained growing attention. Research and practice defines the term and its surrounding environment in various, sometimes conflicting ways. Where Babich and Hilary (2020) mention tokenization to create ownership rights for trade facilitation across the supply chain, Zhou et al. (2019) addresses the concept to convert data for a secure handling in an IT-system. In fact, the terms ‘digital assets’ and ‘cryptoassets’ are also synonymously used to describe token that are mostly associated with an investment purpose (OECD 2020). Where an asset is primary defined as anything that has value to a certain stakeholder (Greer 1997), it is important to gain a deeper understanding of asset tokenization that goes beyond the mere representation of financial and monetary value.

According to the various meanings, tokenization can be initially described as the process of creating a token on a shared ledger in terms of a singular identifier that enables a unique and persistent reference. Dependent on the features of the underlying DLT, the token relies on a specific data structure and implemented logic to achieve a desired functionality (Roth et al. 2019). As everything may be represented by creating such reference, we define a token as a cryptographically secured digital representation of value or contractual rights (Distefano et al. 2020). A token may be then distinguished by serving as a bearer instrument (e.g., liability between issuer and owner), once a legal relationship is established and a specific bearer is assigned to that right (e.g., ownership rights embedded into a smart contract). By adding individual properties of an asset into a token, it can be designed to be unique, tradeable, scarce, and much more. From a practical perspective, a difference must be further drawn between tokenized assets that exist “off-chain” and “on-chain”. The tokenization of a “physical asset” that exists “off-chain” relies on an underlying object (e.g., digital twin of a car). Such systems differ from native record keeping in which a “native” token is built “on-chain”. It is only existent within the system and derives its value in and of themselves (e.g., Bitcoin) (OECD 2020).

Applicability of Tokenization

There is a substantial body of knowledge that mainly refers to grey literature, but only few scientific contributions investigate the distinct driver and barrier for adoption. Narayan and Tidström (2020) explore the usage of tokens in building a circular economy to facilitate coopetition. In this context, tokenization creates an effective incentive mechanism to generate ideas and scale up innovation between disconnected product platforms. Lotti (2019) investigates the features of tokenization for the art market and its potential for disintermediation. By rethinking the social relations and interactions in art production, art tokens may create new opportunities for digital design incentivized by so-called crypto economics. Beside these benefits in governance, the adoption of tokenization is primarily motivated by economic reasons. By overcoming the drawbacks related to costly intermediation, the concept improves the security of business processes and increases the usability in transaction handling.

Zhou et al. (2019) converts medical data into on-chain tokens to establish a safe and efficient data exchange. Babich and Hilary (2020) apply digital claim tokens in supply chain management for production, inventory, and financial controlling that enables a facilitated sharing, trading, and exchange among multiple stakeholders. Especially a reduced need for third parties is considered highly disruptive for the financial sector and other industries (e.g., intellectual property, collectibles) (Sazandrishvili 2020). Indicated by the surge of projects and initiatives, most references focus on digital representations and management of asset ownership using tokens for existing bankable assets. As a corollary of DLTs basic capabilities, the possibilities for automation (e.g., smart contracts), transparent record keeping, and trusted reconciliation between parties are widely discussed in the context of financial market infrastructures (Hartung et al. 2019). Shtybel (2019) explores the benefits of tokenised private securities for improved issuance, trading, and settlement. Also, the impact of tokenized assets on liquidity for otherwise untradable asset classes is highlighted (Harwood-Jones 2019). Although the opportunities for DLT and asset tokenization seem promising, often new obstacles before mass adoption may occur. While some publications state that technical immaturity leads to use cases stuck at prototyping phase (Hughes et al. 2019), other contributions assume that challenges in terms of governance, regulation, and operations need to be overcome to reach commercial adoption (Harwood-Jones 2019). Especially legal aspects and transition risks relating to the issuance of digital securities must be appropriately evaluated against nationally binding law (Savelyev 2018). Existing research on the applicability of tokenization mainly focuses on general potentials and challenges and is limited to a few selected applications with a strong emphasis on the financial sector. While various industries may benefit from this concept, it still remains unclear how to address these multifaceted use cases. Here, it would be appreciated to establish a common understanding and to provide a basis for strategic guidance in this highly innovative area.

Token Properties

Although the potentials of cryptocurrencies have been extensively discussed in literature, there is still a lack of consensus on what a token might represent (OECD 2020). To close this gap, a review has been conducted to highlight relevant token properties. Oliveira et al. (2018) proposes a token classification with four dimensions: purpose, governance, functional, technical groupings based on previous research and empirical data. Another categorization is presented by Euler (2018), where token are allocated along five groupings: purpose, utility, legal status, underlying value, and technical layer. According to these classifications, archetypes were further identified by mapping tokens against those parameters (Oliveira et al. 2018). A comprehensive approach of specific attributes and features is presented by Freni et al. (2020). With regards to a morphological framework, the shift from economics towards a token economy and the token's key role within these ecosystems is analyzed. A stronger industry focus is presented by integrating token characteristics into traditional finance (Ankenbrand et al. 2020). The taxonomy consists of selected attributes to classify tokens (e.g., claim structure, total supply, redemption). Interestingly, it can be stated that the perspective on token slowly shifts from cryptocurrency driven use cases (e.g., ICO) towards more comprehensive token standards to set the basis for enterprises with a more diverse and wide view of tokens for existing economic models (e.g., tokens for private DLTs). Beside academia, there are a couple of industry-oriented classifications that add regulatory and utility-driven aspects for a practical implementation of tokenization solutions. Mueller et al. (2018) distinguishes three major classes in terms of native utility, counterparty, or ownership token. The International Token Standardization Association (ITSA) establishes a common understanding on basis of a classification along the four dimensions purpose, industry, technological setup and legal claim (Ketz and Sandner 2019). Another initiative represents the InterWorkAlliance that drives standards for interoperability. By defining the most industry relevant token properties in predefined application areas (e.g., financial services, healthcare), a technical foundation for cross platforms is established to bridge the gap between different stakeholders (e.g., developers, business executives) based on similar technical features and token behaviours. Most of the frameworks reduce complexity for redundant dimensions and associated attributes. Strongly dependant on a business-, regulatory- or technically oriented perspective, a harmonization of the terminology and standardization of artifacts may help to overcome potential confusion and expand over time. However, previous research has fallen short to provide a framework that defines the unique business value of use cases in the context of respective token characteristics and to empirically derive wider implications of tokenization.

Research Method

Literature Review

To generate an initial set of criteria for tokenized objects and to define the applicability of tokenization as part of an operating and business model, we started the development of our framework by means of a structured literature review following Webster and Watson (2002). We used the scientific databases EBSCOhost, IEEEXplore, AISeL, Science Direct, ProQuest, and ACM Digital Library in September 2020 and defined the following search string ("Blockchain*" OR "Distributed Ledger*") AND ("Token*). To increase topicality, we included a title and abstract search with the terms ("Tokenization" OR "Tokenisation"). The search resulted in 214 documents. We identified the publications relevant to answer our research question and excluded irrelevant papers as well as duplicates. After the full-text screening, the remaining 23 documents represented the basis for a subsequent forward and backward search to enhance theoretical contributions with a practical perspective. At the end we selected 34 publications. To identify themes for a distinct assessment of use cases, we applied thematic analysis (Braun and Clarke 2006). According to the six phases (familiarization, initial code generation, search for themes, review themes, define and name themes, and report generation), we selected relevant (1) token attributes, functions, and properties; (2) drivers, potentials, and value propositions of tokenization as well as (3) challenges, limitations, and barriers for adoption. Where the themes represent preliminary dimensions of the framework, we refined the results in discussion rounds with researchers. We omitted highly technical features (i.e., burnability, expirability, issuance), adapted criteria for applicability (e.g., real-time processing, process automation) and grouped similar aspects for evaluation (e.g., facilitated access, democratization). Within this iteration, we derived 21 dimensions with a set of 76 sub-criteria.

Semi-structured Interviews

Based on the initial framework, we conducted two semi-structured interview rounds to complement our findings and to validate our results (cf. Table 1). All interviewees were either subject matter experts or C-level managers familiar with the concept of tokenization or participating in the development of such DLT-driven solutions. Despite a focus on the financial sector, we brought together interview partners from interdisciplinary backgrounds to widely represent the current state of the tokenization ecosystem.

Table 1. Interview Overview

Interview Round	Goal of the Interviews	ID	Function of the Interviewee	Affiliation	Company Size
1st Interview Round	Understanding of the problem domain, identification of value potentials and barriers of tokenization	B1	Head New Markets	Bank	Medium
		D1	Co-Head Clients	Digital Asset Bank	Medium
		D2	Head Token Platform	Digital Asset Bank	Medium
		L1	Lawyer & Founder	Legal & Regulatory Services	Medium
		L2	Swiss Senior Legal & Regulatory Expert	Legal & Regulatory Services	Large
		F1	Co-Founder und Chief Investment Officer	FinTech	Small
		P1	Head of Fintech	IT-Provider	Large
		P2	Manager Technology	IT-Provider	Large
		P3	Manager Tokenization Services	IT-Provider	Large
		D3	CEO / Head of Crypto Payments	Digital Asset Bank	Medium
		E1	Product Manager	Exchange	Large
2nd Interview Round	Reevaluation of prior results, refinement of the framework and identification of tokenization use cases	S1	Business Development	Start Up	Small
		D4	Chief Client Officer	Digital Asset Bank	Medium
		F2	Chief Executive Officer & Founder	FinTech	Small
		F3	Chief Executive Officer & Founder	FinTech	Small
		B2	Project Manger	Bank	Large
		R1	Researcher	Research	Medium
		F4	Chief Sales Officer	FinTech	Medium
		F5	Chief Executive Officer & Founder	FinTech	Small
		D5	Head of Business Unit	Digital Asset Bank	Medium
		F6	Chief Marketing Officer	FinTech	Medium
		D6	Board of Directors	Digital Asset Bank	Medium

At first, we aimed for a clear understanding towards the problem domain. The questions addressed the overall phenomenon designed to identify additional potentials and challenges of tokenization illustrated as a basic theme in the framework. We noticed that the experts highlighted similar aspects from our initial review (e.g., fractional ownership, legal issues). We adapted the structure of the interview guide and initiated a second interview round with the goal to directly validate the proposed criteria according to a solution artifact. The experts actively reflected the categories and discussed use cases from their domains. In total, we conducted 22 interviews and started the analysis of the results following Gioia et al. (2013). We established first and second level codes to identify confirmatory aspects towards our framework. Accordingly, we added new dimensions on token properties (e.g., token supply), aggregated sub-criteria on token representations (i.e., digital, physical, contract) and merged redundant aspects (e.g., technical complexity associated with oracle problems). This iteration resulted in the final framework illustrated in Table 2, where we conclude 12 dimensions with a set of 44 sub-criteria.

Deriving Archetypes

For the third phase, we applied the framework as an analytical tool (e.g., morphological box) to derive archetypical use cases on basis of a company analysis. This problem-solving technique is used for multi-dimensional questions, where an instantiation is assigned to its specific parameters in a grid box (Zwicky 1969). For the data collection, we conducted a screening in December 2020 for companies on crunchbase.org, chaineurope.org, and e-foresight.ch. The focus of our selection was on DLT and Blockchain based firms in German-speaking Europe (i.e., Germany, Austria, Switzerland, Liechtenstein) representing a viable ecosystem around tokenization. The initial database contained 183 company profiles as we considered additional sources (i.e., company website, whitepaper, press reports) to ensure data quality for the subsequent analysis. We included only firms that utilize tokenization as an integral part of their operating and business model (e.g., token issuance services, asset tokenizer). We excluded wallet providers, cryptocurrency exchanges, miners, or broader DLT-infrastructures (e.g., Ethereum) because their usage of tokens are not primarily driven by a tokenized representation associated with a specific product or service. Next, we assigned coding schemes to assess the companies according to the predefined criteria of the framework and omitted cases that resulted in insufficient information. We validated the instantiations in various iterations, where disputes were resolved in group discussions (Strauss 1987). The direct instantiations highlighted recurring combinations of criteria implying a tendency of companies with similar tokenization use cases. As a result, we identified eight archetypes (see Appendix) and demonstrated utility of the framework covering a final set of 129 firms.

Assessment Framework for the Tokenization of Assets

Given the identified token properties, value drivers, and barriers for tokenization, we present a comprehensive framework to be applied in the description and assessment of use cases associated with asset tokenization. Described below, the resulting framework consists of 12 dimension and 44 sub-criteria along the three overarching themes allowing for a distinct analysis, comparison, and discussion.

Table 2. Framework for the Assessment of Tokenization Use Cases

Industry Focus	Financial & Insurance Activities	Prof., Sc. & Technical Activities	Blockchain-Specific Application	Transport & Storage	Arts, Entertainment & Recreation	Wholesale & Retail Trade	Information & Commun.	Public Adm. & Defence
Tokenized Representation	e.g., Art	e.g., Gold	e.g., Votes	e.g., Shares	e.g., Membership			
Underlying Representation	Digital	Physical	Contract					
Function	Access to a Service	On-Chain Reward Potential	Off-Chain Cash Flow & Dividend	Store of Value	Collectibles	Means of Exchange	Voting Right	
Purpose	Payment Tokens	Utility Tokens	Asset Tokens					
Unit	Fractional	Whole	Singleton					
Tradability	Transferable	Non-Transferable						
Fungibility	Fungible	Non-Fungible						
Supply	Fixed	Unfixed						
Technical Setup	Ledger Native	Ledger Non-Native						
Driver of Tokenization	Democratization & Facilitated Access	Increased Liquidity	Disintermediation	Increased Transparency	Process Optimization	Digital Scarcity		
Barriers of Tokenization	Legacy Structures & Transition Risk	Data Privacy	Regulatory & Legal	Governance Issues	Oracle Problem			

Token Properties

- **Industry Classification:** a token can be described based on the industry of the use case. UK Standard Industry Classification (SIC) is applied (e.g., Financial and Insurance Activities, Professional, Scientific and Technical Activities) (Marshall et al. 2018).
- **Tokenized Representation:** specifies the reference, value or proxy of the tokenized representation in particular such as art, gold, credit loans, baseball bards, etc.
- **Underlying Representation:** indicates the superordinate category with regards to the underlying collateral or generic nature of the token-based asset: digital (e.g., bankable assets, cryptoassets), physical (e.g., real estate) or contract (e.g., usage right) (Oliveira et al. 2018).
- **Function:** the reason for holding tokenized assets is based on the function or target use of a token: access to a service, on-chain reward potential (e.g., staking, airdrops), off-chain cash flow (e.g., dividends), store of value (e.g., stablecoins, gold), collectibles with intrinsic value (e.g., CryptoKitties), means of exchange (e.g., currency), voting right (Marshall et al. 2018).
- **Purpose:** classifies the underlying economic purpose of a token into payment token (e.g., Bitcoin), utility token (e.g., Ether), and asset token (e.g., Crowdlitoken) (Mueller et al. 2018).
- **Unit:** indicates whether a token is sub-divisible into smaller fraction (fractional or partial, whole with no subdivision, singleton with a quantity of one) (InterWorkAlliance IWA 2020).
- **Transferability:** relates to the transferability of ownership to another party (e.g., sale of a registered security) (Oliveira et al. 2018).
- **Fungibility:** indicates whether a token can be interchanged. While a fungible token has interchangeable value with one another, a non-fungible token is unique and cannot be interchanged due to different values (Oliveira et al. 2018).
- **Total Supply:** describes to which limit a number of assets can be generated: fixed (e.g., capped), unfixed (e.g., based on predefined conditions, schedule-based supply or managed by authorized parties) (Ankenbrand et al. 2020).
- **Technical Setup**: describes on which layer (e.g., protocol-level) of the distributed ledger a token is applied: native (e.g., Bitcoin), non-native (e.g., ERC20) (Ketz and Sandner 2019).

Driver of Tokenization

We extend the perspective beyond token properties and consider applicability in terms of six distinct **drivers of tokenization** to identify the role of a token as part of an operating and business model. Each driver is to be selected, if one or more of the following aspects explicitly applies:

- **Democratization & Facilitated Access** refers to the degree of financial inclusion. While tokenization of real estate enables retail clients to participate in large scale real estate development projects and therefore is highly correlated to this factor, a token to trace the provenance of items (e.g., diamonds) is not.
- **Increased Liquidity:** through the release of untradeable or private assets (e.g., venture capital, real estate in certain market, collectibles such as wine, old-timers etc.) and 24/7 market access, tokenization helps to create liquidity and facilitates the trading and settlement (Harwood-Jones 2019; Shtybel 2019)
- **Disintermediation:** tokenization has the potential to reduce the need for trusted intermediaries. Peer-to-peer trading and atomic settlement are examples of disintermediation in financial markets (Shtybel 2019).
- **Increased Transparency:** tokenization increases transparency and traceability of token ownership (Shtybel 2019). Single-source-of-truth can improve efficiency, correctness and coordination requirements significantly.
- **Process Optimization:** typical examples of process optimization through tokenization are corporate action (e.g., automated dividend payments through smart contracts) (Shtybel 2019).
- **Digital Scarcity:** tokenization introduces the concept of scarcity or predictable supply to the digital domain, which contradicts the characteristics of digital medium such as mutability and copyability (Chen 2020; Lotti 2019; Macedo 2019)

Barrier of Tokenization

We present further five main **barriers of tokenization** describing identified challenges in adoption and implementation of token-based solutions. One or more of the following barriers may explicitly apply:

- **Legacy Structures & Transition Risk:** existing structures and legacy systems may represent a barrier when implementing use cases (e.g., core banking system, existing infrastructure).
- **Data Privacy:** depending on the business case the sensitivity to data privacy may vary and can even be in conflict with existing traditional security law (Shtybel 2019).
- **Regulatory & Legal:** uncertainties originating from legal, regulatory and compliance. Limited enforceability, lack of global standards and slow adaption of regulation and law represent examples of potential legal barriers for tokenization (Savelyev 2018).
- **Governance:** key aspects in token-enabled business models are new governance mechanisms. The extent of barriers might depend on the complexity of the underlying network, the number of involved partners in the ecosystem and applied incentive mechanism.
- **Oracle Problem:** gates between the digital and physical world pose challenges in terms of security, authenticity and trust. The more a business case relies on off-chain data, the higher its correlation to this factor. Barriers may vary the number of different sources, existence and design of technical interface, audit, and quality requirements.

Dependencies between Token Properties, Drivers, and Barriers of Tokenization

The analysis of 129 firms highlighted recurring combinations of criteria and allowed us to draw conclusions on various dependencies. For example, we found that bankable assets are often combined with fractionality to enable increased liquidity. To derive archetypes, we structured these dependencies according to their level of abstraction and referred to the tokenized representation at first to examine the interrelationships between properties, drivers, and barriers in the respective case. Our findings revealed that the tokenization of physical assets (e.g., real estate, artwork) is manly driven by the financial sector, logistics, and arts industry. While tokenized commodities were utilized for track and tracing, tokenized paintings were further applied for provenance and authenticity. However, high value assets (e.g., gold, watches) are mainly tokenized for specific investment purposes. This pattern is also highlighted by the majority of other products that already exist in a digitized form (e.g., bankable assets). Regarding shares and bonds, a fractional, tradable, and fungible token design is required. They fulfill the function to exchange and store value and enable off-chain or on chain reward potentials. Tokenized contracts (e.g., voting, usage rights) show strong dependency towards service and platform access for various industries. The ownership of such utility token does not only grant general access but also provides discounts and participation in decision-making processes. They are characterized by fungibility, flexible supply, and transferability between holders. Other utility token exist that provide individual asset ownership (e.g., digital twins, identities). Assigned to a unique bearer, they follow a capped token supply and a non-fungible design. Also for collectibles (e.g., luxury cars) a unique reference is established through non-fungibility, as transferability and fractionality is not desirable. Tokenized virtual items on basis of a capped supply (e.g., digital gaming cards) enable further ownership and possession for a limited series of objects. Where fungible and tradable token are mainly represented through non-native DLT-frameworks (e.g., ERC-20), non-fungible token may require extended functionality and application access and refer more often to proprietary DLT-systems.

Democratization and facilitated access is highly associated with the tokenization of physical assets, whereas the correlation with tokenized contracts is somewhat less pronounced. Some interrelations highlight the potentials to minimize investment amounts of non-bankable assets typically considered illiquid (e.g., watches, wine). But also tokenized equity and loans increase financial inclusion for a broader investor base through fractionality (e.g., peer-to-peer lending). Beside these benefits in product innovation, it is assumed that the financial sector is further driven by process optimization and increased transparency. This dependency refers specifically to automation of administrative tasks and a tamper resistant asset ownership of transactions. Interestingly, the disintermediation of existing structures is strongly pronounced for native digital currencies as a means of exchange (e.g., stablecoins). However, these aspects can be neglected for tokenized contracts. Where accessibility to services is a prerequisite, the use of tokens is driven by process innovation. This combination is also identified for life cycle tracking of physical objects. To provide provenance (e.g., artwork, diamonds), increased transparency is highly appreciated. To prevent replication of tokenized assets, digital scarcity is further introduced on basis of a fixed token supply. Accordingly, a non-fungible and singleton token design with less pronunciation on fractional ownership and increased liquidity is required.

By taking a closer look at the barriers, we need to distinguish between transformational and enabling capabilities of tokenization. Especially for existing bankable assets, a seamless integration into legacy system is often required and poses a transition risk for implementation. On the contrary, physical tradable assets show only low to no correlation towards compliant legacy systems. It is assumed that a functional market infrastructure is not established yet and that such use cases offer high potential for new products and services. Use cases for the transfer of asset ownership and tokenization of financial asset classes (e.g., shares, currencies) require further a regulatory basis. While common law often refers to known legal structures, the legislation for a dematerialization of a fully digitized asset ownership is often not established yet (e.g., legal assertion of smart contracts). Where token solely provide access to a service platform (e.g., tokenized goods in logistics) or serve as a basis for non-fungible collectibles (e.g., trading cards) a legal framework is not necessarily required. Some use cases show increased requirements for data privacy. Tokenized health data, for instance, may rely on restricted permission for monitoring sensible transactions. Additional complexity is added when new actors have to be coordinated or incentivized to join a decentral platform. A minimal viable ecosystem is often necessary that consist of additional stakeholders (e.g., asset tokenizer, custodian). With regards to physical representations (e.g., watches, container), a consistent data connection between the physical and digital world is appreciated. Especially for unique non-fungible token, this oracle problem has to be considered.

Archetypical Use Cases for Asset Tokenization

We present eight archetypical use cases covering the different manifestations for tokenization among the analyzed sample of firms (cf. Figure 1). They represent similar configurations of parameters to be understood as recurring applications in existing operating and business models (see Appendix).

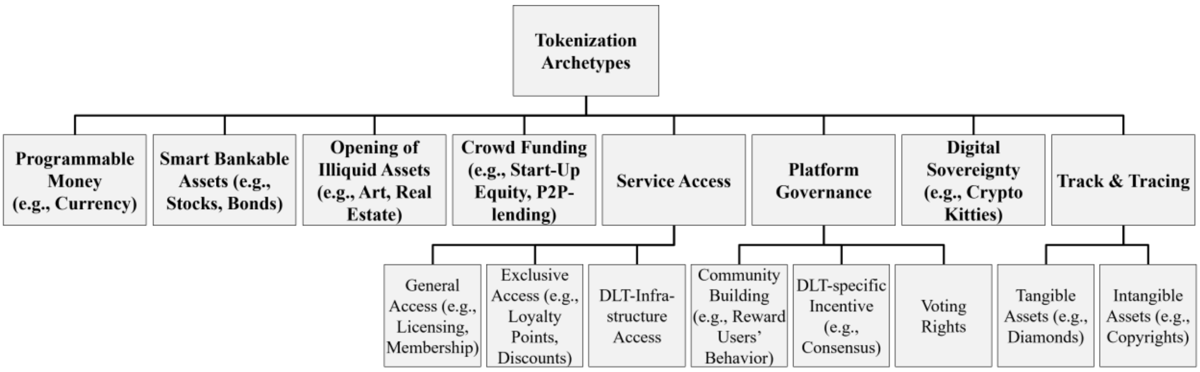

Figure 1. Asset Tokenization Archetypes

Primarily driven by the financial industry, **programmable money** represents applications associated with tokenized currency (e.g., stablecoins, central bank digital currencies) for an efficient means of exchange and store of value. By overcoming drawback of existing applications, payment tokens highly optimize processes and make it possible to trigger events and automate a multitude of services on automated decentralized platforms (e.g., micropayments). However, governance between stakeholders (e.g., central and commercial banks) and the adaptation of a legal framework, increase transition risks as centralized solutions already exists. **Smart bankable assets** are driven by similar aspects in terms of process optimization and investment rewards potentials. By implementing a financial contract logic, recurring cash flows and voting rights can be automated. Also market accessibility as well as the usage of tradable and fungible asset token increases transparency and liquidity. The integration into existing legacy systems and complexity of such market structures pose a risk, where legal and regulatory foundations are slowly established. Beside transformational aspects, the **opening of illiquid assets** focuses on the creation of token as a proxy for physical value. Due to the increased efficiency delivered by the digitalization process, representations of real estate or classic cars add additional accessibility by design. The fractionalized investment denominations of token may decrease market friction. Arranged at low amounts, access is provided to a much broader investors base to increase liquidity. However, the complex network of actors and required external data through oracles needs to be considered. Another, more specialized, form of democratization is represented by **crowd funding**. Emerged in form of ICOs, such applications are characterized by reduced transaction costs through elimination of external service providers. Where many associated business models were not economically viable before, tokens allow efficient, fractionized, real-time crowd investments ranging from private projects to participation in venture capital. A focus lies on fast and flexible tradability as basis for increased liquidity. However, obstacles remain for establishing such regulated market infrastructures and to incentivize the usage among stakeholders. Defined as **service access**, many use cases utilize tokens as an instrument for acquiring rights to a specific service. Implemented by various industries, tokenized licenses or memberships allow a facilitated and effective access to decentralized platforms. They are categorized according to the functions a token grants to the holder (i.e., general-, exclusive-, DLT-infrastructure access). Both fungibility and non-fungibility may be implemented to assign a unique private or public functionality. Unlike other cases, the tokens are not regulated at all. The services offered are solely depending on the provider and pose challenges for governance and implementation of external data sources. **Platform governance** represents a more abstract field of use cases for tokenizing incentive mechanisms as a means of coordination and cooperation. Embedded into a DLT protocol, tokens are issued as a reward to users for completing specific tasks or meeting a certain behavior (e.g., mining reward for transaction validation). Beside DLT-specific means of consensus, a token may also be demanded and valued on its own to further incentivize community building or voting. They are not primarily based on future monetarization but have social value by governing voting power and creating community sense. Democratization, process optimization, disintermediation, data privacy (e.g., pseudonymity, anonymity) and increased complexity are characteristic of such use cases. While DLT enables verifiable digital scarcity, we introduce **digital sovereignty** for applications that require unique representations and decentralized data access control for token holder in their own right (e.g., digital identities). Once implemented as a non-fungible token, the assets provide proof of authenticity and cannot be replicated by one governing entity. This democratization of interaction on decentralized platforms allows users to control in-game assets, for instance, independently from a single platform owner (e.g., CryptoKitties). Referring to the tokenization of unique physical assets or sensible data, data privacy and a secure link between the physical and the digital object have to be considered. At last, **track & tracing** is used to establish a tamper-proof-record of ownership among various stakeholders. Such use cases are often associated with logistical processes in many industries and allow organizations to utilize token for increased transparency along the lifecycle of tangible or intangible assets. Where tokenized consumer goods may take on fungible properties, non-fungible token are appreciated for high value items. Especially for provenance across supply chains, external data authenticity and integration into legacy systems must be considered. Several combinations between archetypes have been further identified. For example, use cases in supply chain finance that rely on both, track and tracing as wells as the opening of illiquid assets. As one archetype exhibits a main purpose, there might be additional purposes which are combinable and may extend token utility in a decentralized system.

Discussion

Given the increasing interest in asset tokenization, this work proposes a first qualitative framework that provides an understanding about the practicability of this application area by identifying relevant criteria for assessment, comparison, and documentation of use cases. To identify the role of tokenized representations as part of a broader business model, we extended the perspective beyond token properties and integrated selected aspects of applicability on basis of a literature review and expert interviews (i.e., drivers and barriers of tokenization). Our empirical data confirmed our initial assumptions that the same tokenized object can exhibit a multipurpose ability for different use cases. We further applied the framework in a structured comparison process based on a sample of companies associated with tokenization. Following our morphological approach, the different instantiations allowed us to further identify dependencies between the different dimensions and criteria to highlight similarities. Given the dataset, we propose eight archetypical use cases. Moreover, our study revealed that assessing the applicability of asset tokenization requires an interdisciplinary and multifaceted approach. The involved criteria uncover a range of various possibilities, strengths, and weaknesses on an abstract basis and represent a first set of formal descriptions for the design and development of uses cases and token-based business models. In assisting businesses to align their activities and assess potential trade-offs, applicability between the *drives* and *barriers* of a specific asset tokenization use case has to be illustrated in the first place. These two dimensions of the framework help to judge feasibility and to discern the pros and cons. Subsequently, the token property dimensions further specify the unique business value of a use case in the context of respective token characteristics and provide additional aspects from a business standpoint to clarify scenarios at the backdrop of token design. We regard the framework also as an initial approach for the operationalization of the tokenization concept. Although the development of a quantitative decision model is beyond the scope of this study, the identified dimensions may be weighted individually to improve an assessment. It could be shown that an additional perspective on applicability in terms of drivers and barriers is required to evaluate the role of tokens in a particular scenario. Designed to remain as simple as possible, we were further able to capture significant meaning by representing the current state of the tokenization ecosystem in terms of archetypical use cases. Finally, our results suggest that there is a huge potential offered by a token economy that is not limited to the tokenization of assets in the financial sector.

Implications

The presented findings contribute to practice in two ways. Firstly, the framework allows strategists and managers to support a comparison of use cases associated with asset tokenization helping to assess the potential in the context of different token designs, drivers, and barriers for adoption. By defining applicability according to the predefined criteria, the framework may be utilized as a decision-aid tool to develop and compare viable solutions for different tokenized objects and improve managerial practices for entering this highly innovative area. Secondly, the identified dependencies and archetypes highlight the usability of the framework and reduce complexity by providing an overview of major differences in existing token-based solutions. They provide strategic guidance in the design of tangible applications and illustrate how firms can apply this concept to innovate their businesses towards a token economy. Even though various classifications exist and are applied in practice, we observed that the tokenization domain is still heavily influenced by grey literature and that most frameworks are primarily geared towards cryptoassets (e.g., ITSA) without really examining new roles of tokens as part of an operating and business model. So far, there has been no overview about tokenization use cases that involves relevant factors for analysis (e.g., increased liquidity, governance issues). Accordingly, this study contributes to this gap through the synthesis of the research foci *token description* and *applicability of tokenization.* Our contributions to research are three-fold. First, we extend the existing knowledge base beyond token classifications by generating new empirical insights about existing use cases. Secondly, the archetypes serve as a cornerstone for the development of feasible solutions and may foster research on interdisciplinary applications in other industries. Thirdly, we support the multi-perspective discussion on the opportunities of a token economy. By combining the requirements of established industries with the disruptive innovations of its fast-moving open-source community, we may further establish a common understanding from a technological and economic perspective.

Limitation and future research

As the framework is initially based on scientific literature, we cannot generalize the presented findings without limitation. Some of the identified drivers and barriers stem from a very new phenomenon that highlight the need to enhance data collection using grey literature and more practical sources. Therefore, it cannot be claimed that the proposed framework is complete nor stops the need for further research at this intersection. Exhaustive and mutually exclusive principles associated with a structured approach to building a taxonomy were therefore neglected. Also limitations of the interview process have to be considered. The chosen experts may have found it difficult to verbalize feedback on the proposed framework. Especially interviewees with profound knowledge in banking and finance showed a stronger bias towards aspects associated with the tokenization of bankable assets in comparison to other industries. However, we considered this subjective interpretation by constantly reflecting our interim findings by the introduction of two broader discussion rounds. Due to the fast dynamics in this field, we cannot claim general transferability of the archetypes but rather indicate the status quo of a prevailing tokenization ecosystem. By design, there is a notable overlap of groupings. Validation is therefore pivotal to improve ambiguity and inconsistencies during the coding process. Nevertheless, the findings provide a first useful foundation with relevant distinctions and characteristics. In future research, efforts should be made by generating further insights using longitudinal data or case study approaches. Potentially, this will improve the understanding of token-based business model associated with tokenization and might lead to an extension of the framework with additional metrics and operationalizations (e.g., weighted sum model) . New companies may follow with entirely new services and products than the ones included in our dataset. With an emergence of new projects and players, it is not unlikely that the vast majority of assets will be digitized in the near future.

References

Ankenbrand, T., Bieri, D., Cortivo, R., Hoehener, J., and Hardjono, T. 2020. "Proposal for a Comprehensive (Crypto) Asset Taxonomy," in *2020 Crypto Valley Conference on Blockchain Technology (CVCBT)*, June, pp. 16–26.

Ayres, L. 2008. "Semi-Structured Interview," in *The SAGE Encyclopedia of Qualitative Research Methods*, L. Given (ed.), Thousand Oaks, CA, USA: SAGE Publications, Inc., pp. 810–811.

Babich, V., and Hilary, G. 2020. "OM Forum—Distributed Ledgers and Operations: What Operations Management Researchers Should Know About Blockchain Technology," *Manufacturing & Service Operations Management* (22:2), pp. 223–240.

Beck, R., Avital, M., Rossi, M., and Thatcher, J. B. 2017. "Blockchain Technology in Business and Information Systems Research," *Business & Information Systems Engineering* (59:6), pp. 381–384.

Braun, V., and Clarke, V. 2006. "Using Thematic Analysis in Psychology," *Qualitative Research in Psychology* (3:2), Routledge, pp. 77–101.

Chen, Y. 2020. "Information Integration in Libraries," *Library Hi Tech* (38:1), pp. 210–219.

Distefano, B., Pocher, N., and Zichichi, M. 2020. "MOATcoin: Exploring Challenges and Legal Implications of Smart Contracts through a Gamelike DApp Experiment," in *Proceedings of the 3rd Workshop on Cryptocurrencies and Blockchains for Distributed Systems*, CryBlock '20, Association for Computing Machinery, September 25, pp. 53–58.

Euler, T. 2018. "The Token Classification Framework: A Multi-Dimensional Tool for Understanding and Classifying Crypto Tokens." *Untitled INC*, January 18. (http://www.untitled-inc.com/the-token-classification-framework-a-multi-dimensional-tool-for-understanding-and-classifying-crypto-tokens/, accessed July 27, 2020).

Freni, P., Ferro, E., and Moncada, R. 2020. "Tokenization and Blockchain Tokens Classification: A Morphological Framework," in *2020 IEEE Symposium on Computers and Communications*, July, pp. 1–6.

Gioia, D. A., Corley, K., and Hamilton, A. L. 2013. "Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology," *Organizational Research Methods* (16:1), SAGE Publications Inc., pp. 15–31.

Greer, R. J. 1997. "What Is an Asset Class, Anyway?" *The Journal of Portfolio Management* (23:2), Institutional Investor Journals Umbrella, pp. 86–91.

Grilo, A., and Zutshi, A. 2020. "Preface for Special Issue on Blockchain and Tokenization for Industry and Services," *Computers & Industrial Engineering* (146), N.PAG-N.PAG.

Hartung, G., Rutter, K., and Stroemer, G. 2019. "A Solution for Managing High-Quality Liquid Assets: How Distributed Ledger Technology Can Benefit the Securities Lending Market," *Journal of Securities Operations & Custody*, p. 11.

Harwood-Jones, M. 2019. "Digital and Crypto-Assets: Tracking Global Adoption Rates and Impacts on Securities Services," *Journal of Securities Operations & Custody*, p. 10.

Hrga, A., Capuder, T., and Žarko, I. P. 2020. "Demystifying Distributed Ledger Technologies: Limits, Challenges, and Potentials in the Energy Sector," *IEEE Access* (8), pp. 126149–126163.

Hughes, L., Dwivedi, Y. K., Misra, S. K., Rana, N. P., Raghavan, V., and Akella, V. 2019. "Blockchain Research, Practice and Policy: Applications, Benefits, Limitations, Emerging Research Themes and Research Agenda," *International Journal of Information Management* (49), pp. 114–129.

InterWork Alliance IWA. 2020. “Token Taxonomy Framework Overview TTF,” *GitHub*, , May. (https://github.com/InterWorkAlliance/TokenTaxonomyFramework, accessed January 18, 2021).

Kannengießer, N., Lins, S., Dehling, T., and Sunyaev, A. 2020. “Trade-Offs between Distributed Ledger Technology Characteristics,” *ACM Computing Surveys* (53:2), pp. 1–37.

Ketz, C., and Sandner, P. 2019. “Market Standards for the Global Token Economy - International Token Standardization Association,” *Medium*, , July 16. (https://medium.com/@itsa_global/market-standards-for-the-global-token-economy-7d9f3d0cde37, accessed January 18, 2021).

Lotti, L. 2019. “The Art of Tokenization: Blockchain Affordances and the Invention of Future Milieus,” *Media Theory* (3:1), Rethinking Affordance, Media Theory, pp. 287–320.

Macedo, J. M. 2019. “A Taxonomy of Token Models and Valuation Methodologies,” *Medium*, , May 28. (https://medium.com/amazix/a-taxonomy-of-token-models-and-valuation-methodologies-7b6c0a1d02a9, accessed January 18, 2021).

Madhwal, Y. 2020. “Implementation of Tokenised Supply Chain Using Blockchain Technology,” in *2020 IEEE 21st International Symposium on “A World of Wireless, Mobile and Multimedia Networks” (WoWMoM)*, August, pp. 66–67.

Marshall, L., Repin, A., Tsavliris, C., and Humberstones, C. 2018. “CryptoCompare Cryptoasset Taxonomy,” CryptoCompare, October.

Mooney, A. 2018. *Blockchain ‘Could Save Asset Managers $2.7bn a Year.’* (https://www.ft.com/content/b6171016-171f-11e8-9e9c-25c814761640).

Mueller, L., Glarner, Linder, and Meyer. 2018. “BCP Framework for Assessment of Crypto Tokens - MME - Blockchain Crypto Property.”

Nakamoto, S. 2008. “Bitcoin: A Peer-to-Peer Electronic Cash System,” Original Whitepaper, Manubot.

Naqvi, N., and Hussain, M. 2020. “Evidence-Based Blockchain: Findings from a Global Study of Blockchain Projects and Start-up Companies,” *The Journal of The British Blockchain Association* (3), pp. 1–13.

Narayan, R., and Tidström, A. 2020. “Tokenizing Coopetition in a Blockchain for a Transition to Circular Economy,” *Journal of Cleaner Production* (263), p. 121437.

OECD. 2020. “The Tokenisation of Assets and Potential Implications for Financial Markets,” OECD Blockchain Policy Series, OECD.

Oliveira, L., Zavolokina, L., Bauer, I., and Schwabe, G. 2018. “To Token or Not to Token: Tools for Understanding Blockchain Tokens,” *ICIS 2018 Proceedings*

Pilkington, M. 2015. *Blockchain Technology: Principles and Applications*, Rochester, NY: Social Science Research Network.

Roth, J., Schär, F., and Schöpfer, A. 2019. “The Tokenization of Assets: Using Blockchains for Equity Crowdfunding,” *SSRN Electronic Journal*.

Savelyev, A. 2018. “Some Risks of Tokenization and Blockchainizaition of Private Law,” *Computer Law & Security Review* (34:4), pp. 863–869.

Sazandrishvili, G. 2020. “Asset Tokenization in Plain English,” *Journal of Corporate Accounting & Finance* (31:2), pp. 68–73.

Shtybel, U. 2019. “A New Era of Private Securities: Application of Blockchain in Private Capital Markets Infrastructure,” *Journal of Digital Banking* (4:2), pp. 152–160.

Strauss, A. L. 1987. *Qualitative Analysis for Social Scientists*, Cambridge: Cambridge University Press.

Sunyaev, A., Kannengießer, N., Beck, R., Treiblmaier, H., Lacity, M., Kranz, J., Fridgen, G., Spankowski, U., and Luckow, A. 2021. “Token Economy,” *Business & Information Systems Engineering*.

Webster, J., and Watson, R. T. 2002. “Analyzing the Past to Prepare for the Future: Writing a Literature Review,” *MIS Quarterly* (2:26).

Zachariadis, M., Hileman, G., and Scott, S. V. 2019. “Governance and Control in Distributed Ledgers: Understanding the Challenges Facing Blockchain Technology in Financial Services,” *Information and Organization* (29:2), pp. 105–117.

Zhou, T., Li, X., and Zhao, H. 2019. “Med-PPPHIS: Blockchain-Based Personal Healthcare Information System for National Physique Monitoring and Scientific Exercise Guiding,” *Journal of Medical Systems* (43:9), N.PAG-N.PAG.

Zwicky, F. 1969. *Discovery, invention, research through the morphological approach*, Macmillan.

Appendix: Tokenization Archetypes

Archetype Label	Industry Focus	Tokenized Representation	Underlying Representation	Function	Purpose	Unit	Tradability	Fungibility	Supply	Technical Setup	Driver of Tokenization	Barriers for Tokenization
Programmable Money	Financial & Insurance Activities	Currency	Digital	Means of Exchange	Payment Tokens	Fractional	Transferable	Fungible	Fixed	Ledger Native	Democratization & Faciliated Access	Legacy Structures & Transition Risk
		Money	Physical	Store of Value					Unfixed	Ledger Non-Native	Increased Liquidity	Regulatory & Legal
		…									Process Optimization	Governance Issues
Smart Bankable Assets	Financial & Insurance Activities	Stocks	Digital	On-Chain Reward Potential	Asset Tokens	Fractional	Transferable	Fungible	Unfixed	Ledger Non-Native	Democratization & Faciliated Access	Legacy Structures & Transition Risk
		Bonds		Off-Chain Cash Flow & Dividend							Increased Liquidity	Regulatory & Legal
		…		Voting Right							Increased Transparency	Governance Issues
				Store of Value							Process Optimization	
Opening of Illiquid Assets	Financial & Insurance Activities	Art	Physical	Off-Chain Cash Flow & Dividend	Asset Tokens	Fractional	Transferable	Fungible	Unfixed	Ledger Native	Democratization & Faciliated Access	Regulatory & Legal
	Transport & Storage	Real Estate		Store of Value						Ledger Non-Native	Increased Liquidity	Governance Issues
	Arts, Entertainment & Recreation	…									Disintermediation	Oracle Problem
Crowd Funding	Financial & Insurance Activities	Equity	Digital	Off-Chain Cash Flow & Dividend	Asset Tokens	Fractional	Transferable	Fungible	Unfixed	Ledger Native	Democratization & Faciliated Access	Legacy Structures & Transition Risk
		Debt	Contract	Store of Value						Ledger Non-Native	Increased Liquidity	Regulatory & Legal
		…		Voting Right							Disintermediation	Governance Issues
											Increased Transparency	
											Process optimization	
Service Access	Financial & Insurance Activities	Membership	Digital	Access to a Service	Utility Tokens	Fractional	Transferable	Fungible	Fixed	Ledger Native	Democratization & Faciliated Access	Data Privacy
	Prof., Sc. & Technical Activities	Discount	Contract			Whole		Non-Fungible	Unfixed	Ledger Non-Native	Increased Transparency	Governance Issues
	Blockchain-Specific Application	…				Singleton					Process Optimization	Oracle Problem
	Transport & Storage										Digital scarcity	
	Arts, Entertainment & Recreation											
	Wholesale & Retail Trade											
	Information & Commun.											
	Public Adm. & Defence											
Platform Governance	Arts, Entertainment & Recreation	Governance	Digital	Access to a Service	Utility Tokens	Fractional	Transferable	Fungible	Fixed	Ledger Native	Democratization & Faciliated Access	Data Privacy
	Blockchain-Specific Application	Incentive Mechanism	Contract	On-Chain Reward Potential		Whole			Unfixed	Ledger Non-Native	Disintermediation	Governance Issues
	Financial & Insurance Activities	Reward		Voting Right		Singleton					Process Optimization	
	Prof., Scientific & Technical Activities	…										
Digital Sovereignty	Arts, Entertainment & Recreation	Identity	Digital	Collectibles	Asset Tokens	Whole	Non-transferable	Non-Fungible	Fixed	Ledger Native	Democratization & Faciliated Access	Data Privacy
	Financial & Insurance Activities	Classic Cars	Contract	On-Chain Reward Potential	Utility Tokens	Singleton				Ledger Non-Native	Disintermediation	Oracle Problem
	Information & Commun.	Digital Cards	Physical	Off-Chain Cash Flow & Dividends							Digital scarcity	
	Transport & Storage	…		Store of Value								
Track & Tracing	Arts, Entertainment & Recreation	Artwork	Digital	Access to a Service	Asset Tokens	Whole	Non-transferable	Fungible	Fixed	Ledger Native	Increased Transparency	Data Privacy
	Financial & Insurance Activities	Diamonds	Physical	Store of Value	Utility Tokens	Singleton	Transferable	Non-Fungible	Unfixed	Ledger Non-Native	Process Optimization	Legacy Structures & Transition Risk
	Blockchain-Specific Application	Watches		Collectibles							Digital scarcity	Oracle Problem
	Transport & Storage	…										
	Wholesale & Retail Trade											

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