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A taxonomy for decentralized finance

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ABSTRACT

Decentralized Finance ('DeFi') has gained tremendous momentum over the past three years by using novel approaches to disintermediating financial institutions in the provision of financial services. However, empirical research in this field is still rare, and a more comprehensive understanding of the domain is a missing component in academic research. This paper develops a taxonomy based on a comprehensive literature analysis to systematically structure this emerging field. The taxonomy includes three perspectives (strategy, organization, technology) and seven dimensions (blockchain, value proposition, token type, business process, price mechanism, protocol type, integration type) as well as thirty-six characteristics. The application of the taxonomy to 278 DeFi start-ups reveals that most of the DeFi start-ups focus on Ethereum (36.3%) and have a focus on analytics and automation (52%), while, surprisingly only a few incorporate decentralized governance approaches (3.3%), provide decentralized exchanges (14%) or integrate off-chain data.

1. Introduction

For nearly two decades, the financial industry has been undergoing a fundamental digital transformation. This transformation has been called the 'fintech revolution'and has become apparent with the rise of innovative start-ups that offer digital financial services in the areas of payment, investments, financing, and insurance (Gomber, Kauffman, Parker, & Weber, 2018; Thakor, 2020). Fintech has seen a substantial growth over the last decade and comprised more than 26,000 start-up businesses globally in 2023 (Demandsage, 2023). One of the most recent fields of interest has been the blockchain technology. In 2022, blockchain start-ups received US$ 25.4 billion in venture capital funding, which is the second rank in total fintech funding after the payments domain with US$ 56.3 billion (KPMG, 2023). Although events like the FTX bankruptcy, or the TerraUSD troubles have led to lower trust in this new system, this funding also remained high in 2023 (US$ 4.4 billion in the first half of 2023) One reason for this is that institutional investors entered this space and formed a strong pillar.

The invention of the Bitcoin blockchain subsequently led to the development of other distributed ledger technologies (DLTs) like Cardano, Ethereum, Ripple, Solana, etc., which refer to distributed, open and trustless ledgers that allow users to define complex rules and conditions in scripts that are used for processes like the automatic execution of payments and thus go beyond simple financial transactions as this is the case with Bitcoin transactions (Amler et al., 2021). Some of these DLTs, such as Ethereum, even allow payments to depend on the execution of Turing-complete programs, so-called smart contracts (Buterin, 2014). Subsequently, a proliferation of traditionally centralized financial instruments and services are replicated and operated on DLT systems using such smart contracts (Amler et al., 2021). Financial instruments and services that are based on smart contracts are being referred to as 'Decentralized Finance' ('DeFi'), a concept which aims at providing financial services without any intermediaries (Financial Stability Board, 2019, p. 1). This is in contrast to existing fintech approaches, which are mainly based on centralized financial institutions and start-ups such as the payments provider Venmo, the robo-advisor Robinhood or the peer-to-peer (p2p) financing platform Lending Club (see Table 1). In contrast to a centralized financial system, where financial transactions are conducted by financial institutions as intermediaries, such decentralized models aim to provide solutions to at least five challenges of the current centralized financial system (Catalini & Gans, 2019):

(1) *Control:* In the US, for example, the four largest banks have a 44% share of insured deposits compared to 15% in 1984. The centralization phenomenon also applies to the BigTech sector (e.g., Amazon, Apple, Google, Meta) where most of the consumer

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Table 1
Examples for centralized and decentralized finance.

Financial processes model approach	Payments	Investments	Financing
Centralized Finance	Venmo	Robinhood	Lending Club
Decentralized Finance	Bitcoin	Yearn	AAve

and commercial credits are issued by these companies compared to fintech start-ups (Cornelli et al., 2020).

(2) *Access:* In 2021, around 1.4 billion people globally were still unbanked, and this business is very often unattractive to banks (World Bank, 2021).

(3) *Inefficiency:* A centralized financial system is in some ways inefficient. For example the remittance fee is 5–7% and the settlement time is T + 2 for securities transactions (see previous section).

(4) *Interoperability:* Most systems within and between financial systems are heterogeneous and are not interoperable with each other. An example is cross-border payments where different banks in different countries and time zones are involved.

(5) *Transparency:* Today's financial system is in many areas not transparent. For example, a consumer has only limited information about the financial health of his or her bank and in many cases has also no information about the processing of cross-border payment transactions.

With the vision of removing the intermediaries to render financial services in an openly accessible, permissionless, transparent and code-based system, DeFi is built on smart contracts and multiple DeFi solutions can be composed by interacting smart contracts, leading to even more flexible and powerful financial tools (Amler et al., 2021). With this flexibility, DeFi gained increasing relevance in the past two years. For example, in April 2021, Bitcoin's US$ 756 billion market capitalization exceeded the combined US$ 675 billion market capitalization of the world's top two highest valued banks JPMorgan Chase (US$372 billion) and Bank of America (US$ 303 billion). In addition, the market capitalization of the main DeFi blockchain Ethereum with around US$ 162 billion in December 2022 increased by a factor 2.4 within two years and the Total Value Locked (TVL) in DeFi applications grew from US$ 1 billion in June 2020 to more than US$ 31 billion in January 2024 (DeFi Llama, 2024). The TVL represents the sum of all assets deposited in DeFi applications earning rewards, interest, new coins and tokens, fixed income, etc. (NASDAQ, 2021).

However, because the DeFi concept is relatively new, only a few academic literature sources are available which makes DeFi still an unexplored field in academic research (Thakor, 2020). These few sources mainly focus either on isolated functional clusters (e.g., payments, investments, financing, etc.) (Amler et al., 2021; Jensen, Wachter, & Ross, 2021; Zhang, 2021; Kaal, 2020; Abdulhakeem & Hu, 2021; Werner et al., 2021) or consider conceptual frameworks for analizing DeFi in a broader context but lack a broader empirical evaluation (e.g., Abdulhakeem & Hu, 2021; Meyer, Welpe, & Sandner, 2021; Schär, 2021). Taken together, existing research is either very focused or not empirically validated, and due to the early development of these approaches, none of these sources provides a comprehensive overview of this emerging research field. Therefore, this research aims to develop a comprehensive framework of this new field based on both a comprehensive literature analysis to derive the state of the art and the building blocks of a taxonomy as well as the use of empirical data to evaluate its applicability. More specifically, this research attempts to answer the research question of "how can dimensions and characteristics of DeFi be classified in a comprehensive taxonomy?" To answer this question, this paper develops a taxonomy based on a systematic literature analysis and applies it to 278 start-up companies. The remainder of this paper is structured in seven sections. Section two discusses the theoretical background. Section three introduces the research methodology, literature analysis and data selection. Section four presents the results of the taxonomy development which is applied to the data of 278 start-up companies for the verification of the taxonomy that is constructed in section five. These results are then discussed in section six, while section seven concludes the major findings and highlights the future research areas.

2. Theoretical background

It is believed that the concept of DeFi was firstly introduced in 2014 when Vitalik Buterin published the Ethereum White Paper, which explores and envisions the future generation of smart contracts and decentralized autonomous organizations ("DAOs") (Buterin, 2014). However, the foundations of DeFi date back to the earlier developments of the Bitcoin blockchain, which was introduced in 2008 in a white paper by Satoshi Nakamoto (Nakamoto, 2008). In this paper, the concept of p2p transactions was used to demonstrate the potential of disintermediation in financial services by using blockchain technology. Blockchain in this context can be defined as: "(...) a type of distributed ledger, comprised of unchangeable, digitally recorded data in packages called blocks. These digitally recorded 'blocks' of data are stored in a linear chain. Each block in the chain contains data (e.g., Bitcoin transaction) and is cryptographically hashed. The blocks of hashed data draw upon the previous block in the chain, ensuring all data in the overall 'blockchain' has not been tampered with and remains unchanged." (BlockchainTechnologies.com 2018, para. 3). This definition refers to five core elements of blockchain technology (Gupta, 2017): (1) distributed database, (2) p2p transactions, (3) transparency with pseudonymity, (4) immutability of records and (5) computational logic, which can trigger automated transactions by smart contracts. An important element in the context of DeFi is a smart contract, which is defined as "(…) a computerized transaction protocol that executes the terms of a contract. The general objectives of [a] smart contract['s] design are to satisfy common contractual conditions (such as payment terms, liens, confidentiality, and even enforcement), minimize exceptions both malicious and accidental, and the need for trusted intermediaries. Related economic goals include lowering fraud loss, arbitrations and enforcement costs, and other transaction costs." (Szabo, 1996).

Since the launch of Ethereum in 2015, DeFi has been the key element in Ethereum's development, especially from 2020 on (which is also referred to as the "DeFi summer"). Since 2020, DeFi started to develop from single-chain Ethereum applications to cross-chain applications (Meyer et al., 2021), including improvements of early DeFi application limitations, such as in scalability, security, centralization, liquidity, and accessibility to information (Binance Academy, 2021). Although the DeFi applications have exploded since then, the definitions of DeFi are still unclear. A review of the existing literature definitions leads to the following three characteristics:

(1) *Disintermediation:* DeFi aims at the elimination or reduction in the role of one or more intermediaries (Financial Stability Board, 2019).

(2) *Open and decentralized applications:* DeFi refers to new types of open, decentralized financial applications (dApps) deployed on publicly accessible, permissionless blockchains (Jensen, Wachter, & Ross, 2021; Schär, 2021; Zhang, 2021).

(3) *Smart contract based:* DeFi is based on an open, permissionless, publicly accessible, composable, and interoperable protocol stack built on smart contract platforms (Amler et al., 2021; Schär, 2021; Werner et al., 2021).

However, research on the topic of smart contracts in financial services is still rare. Thakor (2020), for example, shows in a comprehensive analysis on the impact of fintech on the financial industry that "(…) research on this question is non-existent to sparse (…)". Up to now, most literature in the DeFi field provide academic reviews (Meyer et al.,

2021), while a few have also developed taxonomies for specific isolated areas, such as for specific functionalities or technical architectures (Amler et al., 2021; Jensen, Wachter, & Ross, 2021; Zhang, 2021; Kaal 2020; Abdulhakeem & Hu, 2021; Werner et al., 2021; Schär, 2021). For example, Meyer et al. (2021) develop a framework to analyze DeFi on a micro, *meso* and macro level. Schär (2021), on the other hand, proposes a conceptual framework for analyzing the multi-layered architecture of DeFi by differentiating between five layers, namely the settlement, asset, protocol, application, and aggregation layers and provides examples for each of the layers. And Jensen, Wachter, & Ross, 2021 explores a DeFi agent taxonomy by analysing the agent roles, incentives for participation and key risks. Furthermore, most literature (e.g., Abdulhakeem & Hu, 2021) refers to the Ethereum platform as a main source for DeFi applications and does not consider other blockchains. And, importantly, all of the aforementioned papers do not include a broader quantitative analysis based on real world examples. This paper aims to extend the existing knowledge by developing a DeFi taxonomy, which is based on a comprehensive literature analysis and, which is empirically mapped against 278 DeFi start-ups.

2.1. Research method

Taxonomies are usually applied to classify novel approaches or topic areas, thereby helping to structure emerging domains. They can be defined as "the theoretical study of classification, including its bases, principles, procedures and rules" (Simpson, 1961, p. 11). Different types of taxonomy methods, such as numerical taxonomies, quantitative classification, or empirical classification can be distinguished (Bailey, 1994). This paper applies the taxonomy development method from (Nickerson, Varshney, & Muntermann, 2013), because it is specifically tailored to the classification in technology-related studies that match with our DeFi-related datasets. In addition, it uses a unique interactive process, which helps to increase the overall validation and reliability of the taxonomy. The taxonomy of (Nickerson et al., 2013) consists of seven steps (see Fig. 1).

The *first step* determines the meta characteristics based on the purpose of the taxonomy. To obtain the relevant meta characteristics, a comprehensive and systematic literature analysis was conducted. The *second step* specifies the ending conditions for terminating the taxonomy development process. For this research, three ending conditions were defined: (1) at least one object has to be identified for each character in each dimension, (2) no additional dimension or characteristic was added in the last iteration, and (3) no characteristic or dimension was modified in the last iteration. This step was executed multiple times until the ending conditions were met.

For the steps 3 to 6, a deductive conceptual-to-empirical approach was first applied by analyzing literature comprehensively and deducing appropriate dimensions and characteristics. More specifically, *step 4* conceptualized the characteristics and dimensions of the objects, and *step 5* examined the objects for these characteristics and dimensions. Based on this, *step 6* created/revised the taxonomy by grouping characteristics into dimensions. In this research, steps 3–6 were repeated four times until it satisfied the three defined ending conditions. The taxonomy has evolved over these four iterations and has led to adaptions during this process. For example, initially, in the "business process" dimension, the characteristic derivatives was categorized as a single characteristic. However, the continued taxonomy development showed that this characteristic can be subsumed under the "investment" characteristic.

The taxonomy development ends when the ending conditions described previously are met in *step 7*. To verify the taxonomy, an empirical-to-conceptual approach was applied in a second step (by applying the steps 3–6 again) using the data from 278 relevant start-ups in the DeFi domain (see Appendix). Of course, the application of the empirical-to-conceptual approach also led to some modifications in the taxonomy that were not reflected in the literature-based-conceptual-to-empirical approach. The conceptual-to-empirical approach was first chosen, because characteristics and dimensions can typically be derived on the taxonomy developers' knowledge complemented by existing literature, in order to more precisely focus the research field if already some literature is available in this domain (Nickerson et al., 2013).

2.2. Literature analysis

To analyze the existing theory in more detail, a systematic literature analysis process was performed, which included five steps (Wolfswinkel

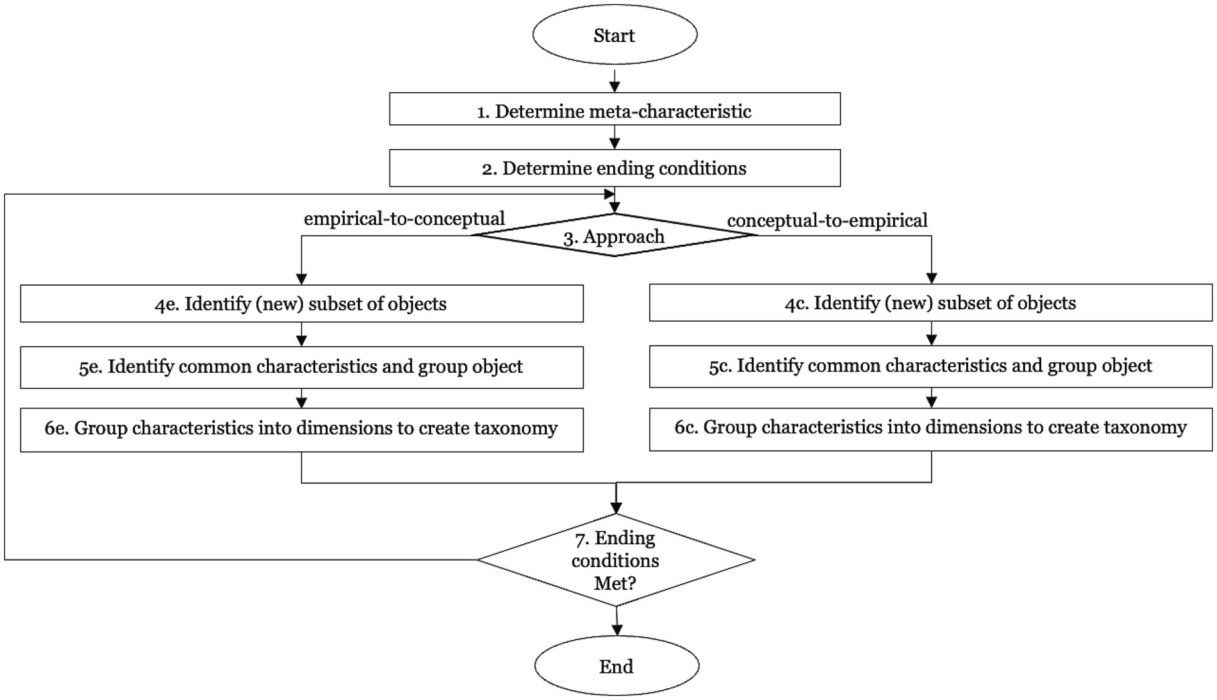

Fig. 1. Taxonomy development process according to (Nickerson et al., 2013).

et al. 2013): (1) definition of the scope of the analysis, (2) literature search, (3) selection of the final sample, (4) corpus analysis and (5) presentation of the findings.

In the *first step*, the relevant search terms were delineated and comprised: abstract: ("decentralized finance") and abstract: ("defi").

As part of the *second step,* the online databases Association for Information Systems (AIS) Electronic Library, Business Source Complete, ScienceDirec,t and Google Scholar were searched. With these four databases, a broad universe of academic literature can be covered identify existing knowledge. For the search itself, papers were excluded that provided work in progress papers from conference proceedings, panel introductions, papers that are not available in English, unavailable papers, teaching cases and pedagogical research papers. Each publication was downloaded and read through thoroughly. Only journal articles writen in English and cited at least once by other papers were selected to maintain the quality of the sample. In an additional step, a backward search was performed, which examined cited references, and a forward search, which identified articles that cited the original article after it had been published.

In the *third step*, the relevant papers for the analysis were chosen (see Table 2). The search terms delivered 839 results in the AIS Electronic Library, of which 8 results were determined to potentially be relevant for further inclusion into the research procedure. After analyzing their abstracts and introductions, 2 relevant papers were identified. The same methodology was applied to Business Source Complete (3454 papers), ScienceDirect (537 papers), and Google Scholar (41,600 papers). The total search sample comprised of 49,430 papers from which 149 papers were identified as potentially relevant for further analysis after reading through the papers' abstracts and keywords and after deleting doubles (see Table 2). This led to a final sample of 70 papers. In the literature search, all results were excluded in which (1) decentralized finance was not the core part, but the term was only mentioned, and (2) papers that could not be classified as research papers. Table 2 summarizes the results.

In the *fourth step*, each paper was classified according to descriptive elements, such as the title of the paper, author(s), publication outlet (journal or conference name), type of publication outlet (journal or conference), abstract, keyword, theories, methods, and definitions.

In the *fifth step*, the findings of the analysis are presented. All 70 papers are clustered in more detail in a next step (see Table 3). This led to the following findings:

First, one category of papers provides an overview and discussion on the development of the DeFi landscape. A lot of discussion focuses on the key technologies that enable the emergence of DeFi and the comparison of DeFi against the traditional financial system and fintech solutions. Key risks relating the existing DeFi solutions and the challenges of regulating DeFi are also extensively analyzed and reviewed in this category of papers.

Second, most research has been conducted in the field of proposing a new protocol under one DeFi subcategory. For example, in the paper titled "XCLAIM: Trustless, Interoperable, Cryptocurrency-Backed Assets" (Zamyatin et al., 2019), the author proposes a generic framework for achieving trustless and efficient cross-chain exchanges using cryptocurrency-backed assets. Instead of shedding light on an ecosystem-level understanding, these category of papers provide useful information when a specific DeFi application or a specific DeFi category is selected for an attribute assessment.

Third, another category of papers focuses on developing DeFi taxonomies by using qualitative approaches. One example is the paper "An Introduction to Decentralized Finance (DeFi)" (Jensen, Wachter, & Ross, 2021), where the authors provide an overview of agents, incentives, and risks by examining the key market categories and use-cases for DeFi applications today and identifying four key risk groups for potential stakeholders contemplating the advantages of DeFi applications.

Table 2
Summary of the literature analysis.

Databases	Search terms
	"Decentralized finance" OR "defi"
AIS Electronic Library	2 (8; 839)
Business Source Complete	7 (19; 3, 454)
ScienceDirect	8 (33; 3, 537)
Google Scholar	53 (89; 41,600)
Total sample	70 (149; 49, 430)

2.3. Start-up data

For the verification of the taxonomy, a collection of 278 start-ups was used. This analysis uses start-ups as an empirical base of analysis in contrast to incumbent institutions, since radical innovations are more frequently introduced by new market entrants rather than by the incumbents (Weiblen and Chesbrough, 2015). This is in line with the findings of most studies in the field of DeFi, which show that disruptive innovations mainly come from start-ups, rather than from financial institutions that merely partner or invest in those firms. The vast amount of potentially relevant start-ups was identified in the databases DeFi Pulse, DeBank and DeFi Llama in combination with the respective DeFi solutions, for instance, the list of leading DeFi projects on www.solana.com for the Solana DeFi solutions. Only start-ups, which satisfy all three of the following criteria were selected: ((a) top ten ranked blockchains) only DeFi start-ups built on Bitcoin, Ethereum, Terra, BSC, Avalanche, Fantom, Solana, Tron, Cardano and Cronos are included as these blockchains are ranked among the top ten blockchains with regard to their TVL (DeFi Llama, 2024); ((b) TVL of DeFi) the DeFi start-up exceeds a TVL of US$ 10 million to include only relevant firms with substantial funding. However, this rule is exempt for DeFi applications, which adopts and accepts non-fungible tokens (NFTs) as these NFT-approaches are latest launched with TVL being accumulating respectively; and ((c) the DeFi start-up is operational) only start-ups, which are operational are included in the sample by examining whether the start-up websites are in service. Of course, the selection criteria might not fully capture the characteristics of the entire DeFi start-up landscape. However, the sample size already considers 93.5% of the top 9 blockchains and includes 6.5% of other blockchain DeFi start-ups outside the top 9. With this, the probability is relatively small to miss important developments.

3. Results of the taxonomy development

3.1. Conceptual-to-empirical approach

According to (Nickerson et al., 2013), a taxonomy comprises a set of perspectives, dimensions, and characteristics. As DeFi is an enabler of networked ecosystems (Schär, 2021), research on such networked ecosystems typically distinguishes the three perspectives strategy, organization, and systems that are typical for ecosystems (Abe, 2005). Each of these perspectives consists of several dimensions, each dimension with two or more characteristics. The factor of each cluster is identified by specified attributes that are mutually exclusive and collectively exhaustive. The literature sources that were identified in the literature analysis are used to design the taxonomy. These include the following elements: strategy, organization and technology (perspectives) as well as blockchain, value proposition, business process, price mechanism, protocol type and integration type (dimension). The taxonomy also mentions whether the dimension is exclusive (E) or non-exclusive (N). The exclusiveness of a dimension indicates that exactly one characteristic can be identified within a certain dimension. In contrast, a non-exclusive dimension allows the identification of multiple characteristics for each identified dimension. Based on this, the following perspectives, dimensions, and characteristics could be derived from the literature analysis, which are summarized in Table 4:

Table 3
Results of the literature analysis.

Topic groups	Research methods	Identified research
Overview and discussion on the DeFi ecosystem	Literature analysis	(Rajasekaran, Azees, & Al-Turjman, 2022; Reno et al. 2021; Rueegger & Machado, 2020; Schär, 2021; Schirrmacher et al. 2021; Shekhawat, Sharma, & Saxena, 2021; Smith, 2021; Sridhar, Mootha, & Subramanian, 2020; Stepanova & Eriņš, 2021; Tefagh et al. 2020; Tien et al. 2020; Trivedi, Mehta, & Sharma, 2021; Wang et al., 2021)
	Case study	(Rajasekaran, Azees, & Al-Turjman, 2022; Rueegger & Machado, 2020; Smith, 2021; Sridhar, Mootha, & Subramanian, 2020; Stepanova & Eriņš, 2021; Tefagh et al., 2020; Tien et al., 2020; Wang et al., 2021)
	Comparative study	(Sridhar, Mootha, & Subramanian, 2020)
Classification of DeFi	Literature analysis	(Wang et al., 2021; Wang et al. 2020; Wang et al., 2020; Werner et al., 2021; Wharton Business School and World Economic Forum, 2021; Wu, Liu, Zhao, & Zheng, 2021; Yang et al. 2019; Yousaf, Nekhili, & Gubareva, 2022)
	Case study	(Wharton & World Economic Forum, 2021; Wu, Liu, Zhao, & Zheng, 2021)
	Comparative study	(Werner et al., 2021; Wharton & World Economic Forum, 2021)
	Model development	(Wang et al., 2021; Werner et al., 2021; Yousaf, Nekhili, & Gubareva, 2022)
Examination on the building blocks and infrastructure-level operations relating to DeFi development (to be continued)	Literature analysis	(Zamyatin et al., 2019; Zetzsche, Arner, & Buckley, 2020; Zhang, 2021; Zhou, Qin, Torres, Le, & Gervais, 2021; Zutshi et al. 2021; Abdulhakeem & Hu, 2021; Amler et al., 2021; Aspris, Foley, Svec, & Wang, 2021; Bartoletti et al. 2021; Bartoletti et al. 2022; Borkowski et al., 2019)
	Case study	(Borkowski et al., 2019; Zetzsche, Arner, & Buckley, 2020)
	Comparative study	(Abdulhakeem & Hu, 2021; Bartoletti et al., 2021; Bartoletti et al., 2022)
	Model development	(Abdulhakeem & Hu, 2021; Amler et al., 2021; Zamyatin et al., 2019; Zetzsche, Arner, & Buckley, 2020; Zhang, 2021; Zhou, Qin, Torres, Le, & Gervais, 2021; Zutshi et al., 2021)
	Technical study	(Amler et al., 2021; Aspris, Foley, Svec, & Wang, 2021; Bartoletti et al., 2021; Bartoletti et al., 2022; Zhou, Qin, Torres, Le, & Gervais, 2021);

Topic groups	Research methods	Identified research
Deep dive on the subcategories of DeFi applications	Literature analysis	(Buterin, 2014; Chen & Bellavitis, 2020; Cherecwich, 2021; Cong, Li, & Wang, 2021; Cousaert, Xu, & Matsui, 2021; Daian et al., 2019; Domingo & Mathew, 2020; Egelund-Müller, Elsman, Henglein, & Ross, 2017; Eskandari et al. 2020; George & Lesaege, 2019; Grant, Popescu, Stăuceanu, & Voinea, 2020; Guerar, Merlo, Migliardi, Palmieri, & Verderame, 2020; Halden, Cali, Dynge, Stekli, & Bai, 2021; Han et al. 2019; Harz et al. 2019; Herlihy, 2018; Jensen, Wachter, & Ross, 2021; Jung, Tilly, Gehani, & Ge, 2019; Kim, 2021; Kumar et al. 2020; Lei et al., 2019; Li et al. 2019; Merwe, 2021; Mikhalev & Mandrusova, 2021; Nakamoto, 2008; Ojog, 2021; Okoye & Clark, 2019; Pop et al., 2020; Popescu, 2020; Qin et al. 2021)
	Case study	(Egelund-Müller, Elsman, Henglein, & Ross, 2017; Fusion Foundation, 2017; Gudgeon et al. 2020; Guggenberger et al. 2021; Han et al., 2019; Herlihy, 2018; Jung, Tilly, Gehani, & Ge, 2019; Li et al., 2019; Merwe, 2021; Pop et al., 2020; Popescu, 2020; Qin et al., 2021)
	Comparative study	(Cherecwich, 2021; Domingo & Mathew, 2020; Gudgeon et al., 2020; Guggenberger et al., 2021;); Li et al., 2019; Merwe, 2021; Merwe, 2021; Mikhalev & Mandrusova, 2021)
	Model development	(Buterin, 2014; Chen & Bellavitis, 2020; Cong et al., 2021; Cousaert et al., 2021; Daian et al., 2019; Fusion Foundation, 2017; George & Lesaege, 2019; Guerar, Merlo, Migliardi, Palmieri, & Verderame, 2020; Guerar, Verderame, Merlo, & Migliardi, 2019; Halden, Cali, Dynge, Stekli, & Bai, 2021; Harz et al., 2019; Jensen, Wachter, & Ross, 2021; Jung, Tilly, Gehani, & Ge, 2019; Nakamoto, 2008)
	Technical study	(Buterin, 2014; Chen & Bellavitis, 2020; Cherecwich, 2021; Cousaert et al., 2021; Daian et al., 2019; Domingo & Mathew, 2020; Eskandari et al., 2020; George & Lesaege, 2019; Grant, Popescu, Stăuceanu, & Voinea, 2020; Gudgeon et al., 2020; Guerar, Verderame, Merlo, & Migliardi, 2019; Guggenberger et al., 2021; Herlihy, 2018; Jensen, Wachter, & Ross, 2021; Kim, 2021; Lei et al., 2019; Merwe, 2021; Meyer et al., 2021; Ojog, 2021; Okoye & Clark, 2019; Qin et al., 2021)

Strategy: The strategic perspective focuses on the different blockchains around which a specific DeFi solution is centred. As mentioned before, this research is focused on the top 10 blockchains, from which Bitcoin, Ethereum, Terra, BSC, Avanlanche, Cronos, Cardano, Solana, Polkadot, Arbitrum, Fantom, Oasis, and Velas were identified as relevant within the sample.

The second relevant dimension within the strategy perspective is the value proposition, which refers to the different ways of benefits that different DeFi solutions can provide. Here, six value propositions are distinguished. The use of a "decentralized data infrastructure" refers to the storing of a record of transaction data on a blockchain instead of a centralized platform. The simplest form of this, can be a consortium of collaborating organizations in a value chain agreeing to host multiple nodes on a permissioned blockchain, which provides benefits such as transparency or reduced transaction costs. "Membership management" on the other hand refers to blockchain based forms of identification, authentication, data privacy, etc., which allows applications to be designed p2p without losing the benefits of data privacy and security. The third characteristic is "analytics and automation". For example, smart contracts that are linked to digital stock exchanges can automate the processing of ownership change of digital assets and thus speed up processes and reduce counterparty risk. The fourth characteristic "crypto economic models" addresses the incentivization of validators of transactions and thus rewarding staking for various forms of consensus mechanisms like proof-of-work or proof-of-stake. Fifth, the characteristic "decentralized governance" refers to how decision making is performed. As many of the blockchains are managed by an open source community, they are built on the principles of decentralization and distributed governance. Instead of being funded by a few investors, these blockchains are crowdfunded by every token holder, which has the

Table 4
DeFi taxonomy.

Perspective	Dimension	Characteristics						E/N
Strategy	Blockchain	Ethereum (DeFi Llama, 2022) Tron (DeFi Llama, 2022)	Terra (DeFi Llama, 2022) Fantom (DeFi Llama, 2022)	BSC (DeFi Llama, 2022) Cronos (DeFi Llama, 2022)	Avanlanche (DeFi Llama, 2022) Cardano (DeFi Llama, 2022)	Solana (DeFi Llama, 2022) Others (DeFi Llama, 2022)		E
	Value Proposition	Decentralized Data Infrastructure (Zutshi et al., 2021; Schär, 2021)	Membership Management (Zutshi et al., 2021; Schär, 2021)	Analytics & Automation (Zutshi et al., 2021; Schär, 2021)	Crypto-economic Model (Zutshi et al., 2021; Schär, 2021)	Decentralized Governance (Zutshi et al., 2021; Schär, 2021)	Aggregation (Schär, 2021)	N
	Token Type	Fungible tokens (Cong et al., 2021; Domingo & Mathew, 2020; Schirrmacher et al., 2021)			Non-fungible Tokens (Cong et al., 2021; Domingo & Mathew, 2020; Schirrmacher et al., 2021)			N
Organization	Business Process	Payments (Domingo & Mathew, 2020; Jensen, Wachter, & Ross, 2021; Schär, 2021; Werner et al., 2021)	Financing (Domingo & Mathew, 2020; Jensen, Wachter, & Ross, 2021; Schär, 2021; Werner et al., 2021)	Investments (Domingo & Mathew, 2020; Jensen, Wachter, & Ross, 2021; Schär, 2021; Werner et al., 2021)	Insurance (Domingo & Mathew, 2020; Jensen, Wachter, & Ross, 2021; Schär, 2021; Werner et al., 2021)	Trading (Domingo & Mathew, 2020; Jensen, Wachter, & Ross, 2021; Schär, 2021; Werner et al., 2021)		E
	Price Mechanism	Automated (Schär, 2021)	P2P Negotiation (Schär, 2021)	Proposed by Maker (Schär, 2021)	Off-chain Order books (Schär, 2021)	On-chain Order Books (Schär, 2021)		E
	Protocol Type	Reserve Aggregation (Schär, 2021)	Constant Function Market Maker (Schär, 2021)		Peer-to-Peer (Schär, 2021)	Decentralized Order Book Exchanges (Schär, 2021)		E
Technology	Integration Type	Single-chain (Meyer et al., 2021)	Cross-chain (Meyer et al., 2021)		On-chain (Schär, 2021; Liu et al. 2021; George & Lesaege, 2019; Kumar et al., 2020)	Off-chain (George & Lesaege, 2019; Kumar et al., 2020; Liu et al., 2021; Schär, 2021)		N

benefit of distributing governance and incentivization. That is why these initiatives often rely on community voting and community participation for the management of DeFi applications. The sixth characteristic "aggregation" means the connection of several DeFi applications to perform complex processes among various DeFi blockchains.

Finally, the type of token (fungible, non-fungible) that is used in a specific DeFi scenario is a third dimension within this perspective. A non-fungible token (NFT) is a non-exchangeable digital asset, such as a photo, song or video, whose ownership is authenticated and stored on a blockchain, and which can be collected, sold and traded on various online platforms. On the other hand, a "fungible good" is one that is interchangeable: a gallon of gas at one gas station is equal to a gallon of gas at another gas station.

Organization: The organizational perspective focuses on business processes which a DeFi solution attempts to address. Here, the characteristics of payment, financing, investments, insurance and trading are distinguished. For example, in payments, stablecoins provide a mechanism to solve the major issue of crypto assets: stabilizing their volatility. For this, different types of stablecoins emerged, which can be fiat collateralized (USD Coin), commodity collateralized (e..g, Digix Gold), crypto collateralized (e.g., DAI) or non- collateralized (e.g., Ampleforth). In investments, financial instruments such as option marketplaces, perpetual contracts or synthetic assets have emerged. A synthetic asset is a tokenized derivative that mimics the value of another asset using data oracles (e.g., Synthetix). In financing, two different approaches have emerged in the DeFi space. One is the issuance of loans that are over-collateralized and thus secured with crypto assets. An example is MakerDAO. This DeFi application was launched in 2015 and integrates loans with a stablecoin called DAI. To receive a DAI loan through MakerDAO, users need to deposit an Ethereum-based crypto asset as collateral (e.g., ETH, ZRX, OMG, etc.). The deposit ratio of ETH to DAI is 150% and the exchange rate of ETH to DAI credit tokens is 66% which means that for 3 ETH one can lend 2 DAI. Payment fee ranging from 0.5% up to almost 20% must be paid. The MKR token holders who govern the platform (these are the MakerDAO minters) approve the transaction. They also control the platform by deciding upon the inclusion of additional collateral, the stability fee, the annual interest rate, and the collateral ratio. The MKR token holders also act as the buyers of last resort for the DAI lenders. This indicates that if the collateral ETH stored in MakerDAO is less than the required amount, MKR is created and traded in an auction to raise the additional capital required. In terms of insurance, DeFi applications allow users to insure events like hacks, attacks on DeFi protocols, smart contract failures, or stablecoin price crashes. Users can file claims for these events and receive a compensation from a decentralized pool of coverage providers and earn yield over the capital they have locked from the premiums they paid. The verification process can either be human (e.g., Nexus Mutual) or automatic (e.g., Risk Harbor). Finally, in trading, perpetual contracts are derivative contracts that allow traders to invest long- and short-term for an asset without an expiration date (e.g., dYdX), while option marketplaces create an option contract and facilitate buying and selling (e.g., Opyn).

Another relevant dimension is the price discovery mechanism, for which automated p2p negotiation, proposed by maker, off-chain and on-chain order books can be distinguished. These price discovery mechanisms are processes where DeFi solutions are used to match counterparties with regard to their willingness to sell or purchase a given asset for a certain price within a decentralized network. One of such price mechanisms is an automated one, where transactions are executed automatically based on smart contracts once the pre-programmed contract terms are fulfilled. In contrast, a p2p negotiation mechanism involves a potential buyer and seller in the negotiation process about the price and other price-related transaction conditions. The third characteristic "proposed by maker" means that the transaction initiator will propose a price range for a counterparty on which the counterparty can bid. Fourth, "on-chain order book" refers to a price discovery mechanism where every order is stored within a smart contract for deal-matching. And finally in the case of "off-chain order book" several decentralized exchange protocols rely on off-chain order books and only

use the blockchain as a settlement layer. Off-chain order books are hosted and updated by centralized third parties, often referred to as "relayers".

Technology: The technology perspective differentiates the different protocol and integration types. The dimension "protocol type" refers to how a specific transaction process is programmed for the execution by a DeFi application. Here, four different characteristics can be distinguished. First, "reserve aggregation" protocols have centralized control mechanisms, such as maximum prices or a minimum number of liquidity providers (e.g., Kyber Network). A "constant function market maker" on the other hand is a liquidity pool that holds (at least) two crypto assets in reserve and allows anyone to deposit tokens of one type and thereby to withdraw tokens of the other type. The peer-to-peer protocol, which is also known as the "over-the-counter protocol", mostly relies on a two-step approach where participants can query the network for counterparties who would like to trade a given pair of crypto assets and then negotiate the exchange rate bilaterally. Finally, the "decentralized order book exchange" collects all buy and sell orders in the order book, where potential transactions are matched before they are being executed.

The integration type defines whether DeFi solutions are implemented on a single chain (e.g., Etherum) or as cross-chain applications across several blockchains. Also, some DeFi applications facilitate on-chain transactions, and the application is independent of any chain networks. Another category of DeFi applications are "off-chain" integrated ones where so-called "oracles" (e.g., Chainlink) integrate data on a blockchain (on-chain) with off-chain data. An example would be the tracking of external price information of digital assets, which are processes on a certain blockchain (on-chain).

Table 4 summarizes the perspectives, dimensions, and characteristics of the DeFi taxonomy.

3.2. Empirical-to-conceptual approach

In order to validate the taxonomy, the start-ups are mapped with the perspectives, dimensions and characteristics. This demonstrates the applicability of the taxonomy and its usefulness (Nickerson et al., 2013). Table 5 summarizes the results of the start-up mapping, which reveals the following findings:

Strategy: To comprehend the distribution of DeFi applications, the sample has been clustered according to the blockchains where a DeFi service was first built and launched. Here, Ethereum is the leading blockchain, with 36% of all analyzed DeFi applications, followed by BSC (16%), Solana (12%) and Fantom (10%). Nonetheless, it should be noted that there are competing platforms that are either forkings of Ethereum (e.g., BSC is a hard fork of Go Ethereum), or parallel ones (e.g., Polygon is a separate Ethereum-based blockchain with an operating mechanism highly similar to Ethereum), or even newly designed ones (e.g., Solana is designed with the consensus mechanism proof-of-history, which improves the performance in terms of transaction volume per second relative to Ethereum). Compared to their value proposition, DeFi start-ups primarily focus on analytics & automation (52%) followed by aggregation (23%). While only few start-ups aim at decentralized data infrastructure (12%), membership management (2%), crypto-economic models (8%) or decentralized governance (3%). Recently, however, more and more DeFi applications started to adopt a decentralized governance structure to include community involvement and voting features under the power frame of decentralized governance. An example is Alchemix Finance, which is the pioneering lending platform for self-repaying loans with a feature of community decentralized governance. Finally, the sample is also clustered according to the type of tokens adopted on the platform. Currently, non-fungible tokens ("NFT") are accepted and transacted in around 6% of the selected DeFi applications of the sample. However, it should be noted that NFTs only started to gain popularity from the market in 2021 when around 1200 trademark applications for NFTs were received by the U.S. Patent and Trademark Office (only 3 were received in 2020), indicating a huge upward potential on the adoption rate of NFTs in the future.

Organization: To understand the DeFi landscape from an organizational perspective, the selected DeFi start-ups are classified according to the type of business process they support. 38% concentrate on investments (e.g., automated asset management, portfolio management, yield aggregator and crypto asset indices), followed by 35% which are focusing on trading services (e.g., exchanges, automated market makers, market predictors), 23% on financing, 3% on payment services and 2% on insurance. Furthermore, more than 90% of the start-ups adopt automated price discovery mechanisms. This is consistent with the understanding that smart contract is the building block for DeFi services, which promote permissionless, automatic transactions. The rest of the price-mechanisms still display a feature toward traditional off-line transactions on centralized exchanges or marketplaces. Such mechanisms have been adopted when centralized services are transitioning toward the mode of decentralized operation.

Technology: The third perspective relates to the technology and technical design, including the protocol type and the integration type. Regarding the protocol type, nearly 63% are deemed to employ p2p protocols and this is consistent with the vision of DeFi, which facilitates p2p transactions. However, some rely on reserve aggregation (15.5%), decentralized order book exchanges (14%), or constant function market

Table 5
Summary of start-up evaluation.

Perspective	Dimension	Characteristics						E/N
Strategy	Blockchain	Ethereum (36.3%)	Terra (7.6%)	BSC (16.2%)	Avanlanche (6.8%)	Solana (11.5%)		E
		Tron (1.8%)	Fantom (10.4%)	Cronos (1.8%)	Cardano (1.1%)	Others (6.5%)		
	Value Proposition	Decentralized Data Infrastructure (11.6%)	Membership Management (1.7%)	Analytics & Automation (52.0%)	Crypto-economic Model (8.0%)	Decentralized Governance (3.3%)	Aggregation (23.4%)	N
	Token Type		Fungible tokens (94.2%)			Non-fungible Tokens (5.8%)		N
Organization	Business Process	Payments (3.2%)	Financing (22.7%)	Investments (37.8%)	Insurance (1.8%)	Trading (34.5%)		E
	Price Mechanism	Automated (91.4%)	P2P Negotiation (0%)	Proposed by Maker (1.1%)	Off-chain Order books (0.7%)	On-chain Order Books (6.8%)		E
Technology	Protocol Type	Reserve Aggregation (15.5%)	Constant Function Market Maker (7.6%)		Peer-to-Peer (62.9%)	Decentralized Order Book Exchanges (14.0%)		E
	Integration Type	Single-chain (56.8%)	Cross-chain (43.2%)		On-chain (95.3%)	Off-chain (4.7%)		N

Cumulated relative frequencies can be different from 100% if a dimension is non-exclusive.

maker (7.5%). In terms of the integration type, 57% of the start-ups operate on one single chain, while almost half of them are even interoperable across chains (43%). As discussed earlier, this pattern could be reversed in the future given the pressing need for interoperability in a diverse ecosystem where multiple chains co-exist. Only less than 4.7% of the start-ups were recognized as off-chain applications (e.g., oracles), while 95.3% were implemented as purely on-chain applications.

While the taxonomy shows relative frequencies of the characteristics among the start-ups, the dependencies between the three dimensions are another important area to identify potential patterns. For this, a Pearson's chi-squared test is used (Agresti, 2007). When the test shows the independence between two perspectives, there is no significant relationship between the two perspectives. Table 6 shows the contingency tables and Pearson's chi-square's test of independence between the three, perspectives' strategy, organization, and technology, with its dimensions ($n = 278$ for each sub-table). The analysis reveals that business processes are related to value propositions, protocol types and integration types (on-chain/off-chain). However, a correlation between business processes and token types/price mechanisms could not be confirmed.

4. Discussion

The analysis of the literature and the start-ups indicates that the topic is currently still emerging. Most of the literature is from the past two years, which clearly shows that the maturity is still low. Although blockchain technology emerged as early as 2008 with the Bitcoin blockchain, its application for real life examples in the context of financial services is still low and has only recently increased over the past few years. Especially, the area of DeFi has gained much interest, as it promises to provide financial services without intermediaries. However, as shown, research in this field is still rare and a comprehensive understanding of DeFi is a missing component. The taxonomy developed in this paper shall shed light on the classification of these approaches.

Table 6
Summary of pearson's Chi-squared test.

Business process value proposition	Pay-ments	Finan-cing	Invest-ments	Insur-ance	Trad-ing	Total
Decentralized Data Infrastructure	6	6	19		16	47
Membership Management			2	3	1	6
Analytics & Automation	1	49	39	2	49	140
Crypto-economic Model	2	2	5		8	17
Decentralized Governance		2	4		5	11
Aggregation		4	36		17	57
Total	9	63	105	5	96	278
Pearson's chi-squared test of independence $X^2 = 138$; p-value $= 0$	Result: confirmed					

Business process token type	Pay-ments	Finan-cing	Invest-ments	Insur-ance	Trad-ing	Total
Non-fungible Tokens	1	1	4		10	16
Fungible Tokens	8	62	101	5	86	262
Total	9	63	105	5	96	278
Pearson's chi-squared test of independence $X^2 = 7$; p-value $= 0.12$	Result: not confirmed					

Business process price mechanism	Pay-ments	Finan-cing	Invest-ments	Insur-ance	Trad-ing	Total
Off-chain order books		1			1	2
On-chain order books	1	3	5		10	19
Proposed by Maker		2	1			3
Smart Contract	8	57	99	5	85	254
Total	9	63	105	5	96	278
Pearson's chi-squared test of independence $X^2 = 9$; p-value $= 0.69$	Result: not confirmed					

Business process protocol type	Pay-ments	Finan-cing	Invest-ments	Insur-ance	Trad-ing	Total
CFMM Protocol					21	21
Decentralized Order Book Exchanges			2		37	39
Peer-to-peer Protocol	8	55	84	4	24	175
Reserve Aggregation Protocol	1	8	19	1	14	43
Total	9	63	105	5	96	278
Pearson's chi-squared test of independence $X^2 = 138$; p-value $= 0.0$	Result: confirmed					

Business process integration type I	Pay-ments	Finan-cing	Invest-ments	Insur-ance	Trad-ing	Total
Cross-chain	4	23	51	4	38	120
single-chain	5	40	54	1	58	158
Total	9	63	105	5	96	278
Pearson's chi-squared test of independence $X^2 = 6$; p-value $= 0.23$	Result: not confirmed					

Business process integration type II	Pay-ments	Finan-cing	Invest-ments	Insur-ance	Trad-ing	Total
Off-chain			1		12	13
On-chain	9	63	104	5	84	265
Total	9	63	105	5	96	278
Pearson's chi-squared test of independence $X^2 = 20$; p-value $= 0.0$	Result: confirmed					

The main contribution is a theory based and empirically validated taxonomy, which closes the research gap of a comprehensive model outlining the dimensions and characteristics of DeFi. The results of this research led to at least three findings, which have theoretical, business, and regulatory implications.

First, from a theoretical perspective, this research complements existing research by providing a comprehensive taxonomy for DeFi. The taxonomy with its three perspectives, seven dimensions, and thirty-six characteristics outlines the relevant criteria to analyze this emerging and growing sector in more detail. In addition, it validates the increasing importance of a more sophisticated future DeFi infrastructure, which emphasizes the development of non-Ethereum blockchain networks and the interoperability across different blockchains. Although Ethereum-based DeFi start-ups make up 36.3% of all DeFi start-ups in the sample, alternative blockchain networks such as BSC, Fantom and Solana contain large numbers of DeFi start-ups with significant TVLs across the full range of use cases. Especially Solana and its own DeFi ecosystem has been growing very fast since 2020, due to the faster and cheaper transaction processing capabilities on Solana compared to the performance of Ethereum. Surprisingly, only 3.3% of all DeFi solutions follow a decentralized governance approach, although DAOs are said to be a core element of such approaches (Buterin, 2014). Instead, many blockchains follow a more centralized approach, where governance is in the hand of a few individuals or groups (Ziegler & Welpe, 2022).

Second, from a business perspective, the taxonomy shows potential areas for novel configuration forms of future value propositions and business models in this emerging field. Entrepreneurs and investors could spot several developing trends from this taxonomy. For instance, the latest DeFi start-ups models tend to include the value proposition of decentralized governance on top of analytics and automation or crypto-economics models, featuring the voting right and community-led characteristics in their product design. This could be an area of opportunities for relevant stakeholders. In addition, today only 4% of the start-ups from the sample provide cross-chain services, which shows that cross-chain interoperability is still a niche (e.g., cross-chain value transfer services like Wormhole and Stargate) and might emerge as another trend in the near future. Finally, the analysis reveals that business processes are related to value propositions, protocol types and integration types (on-chain/off-chain), while a correlation between business processes and token type/price mechanisms could not be confirmed. This demonstrates that technology-related aspects (protocol types and integration types) and strategic aspects (value propositions) have a great impact on the design of business processes in payments, investments, financing, insurance, and trading.

Third, from a regulatory perspective, this research outlines a conceptual and empirical framework that can be used to design regulatory measures. Risk management is intensively discussed in existing literature on DeFi, which identifies key risk areas, analyzes the major types of fraudulent and rule-violating behaviors originated from existing DeFi applications, and proposes counter measures. However, what is missing from the present research is the measurable impact. An example is the removal of Ponzi schemes in the category of financing DeFi applications. Such an understanding may offer value to policy-makers to forecast the feasibility of DeFi-related regulatory policies and to optimize the balance between costs and benefits before implementing new policies.

5. Conclusion

This research develops and evaluates a taxonomy for the emerging field of DeFi, which provides a conceptual and empirical framework to comprehend this rapidly emerging domain. The results obtained from the analysis of relevant literature and start-ups show that this novel field is still premature. It answers this paper's research question of:"How can dimensions and characteristics of DeFi be classified in a comprehensive taxonomy?"

Although DeFi has gained increased interest over the past year, it still holds some risks which prevent a greater dissemination. For example, the risk of impermanent loss is still high for many DeFi solutions, which increases the cost of new tokens. The major obstacle in this respect is over-collateralization, which leads to lower capital efficiency. The taxonomy shows that the latest DeFi approaches use the value proposition of decentralized governance, including voting rights and community-led characteristics as a part of their design. Such mechanisms could improve the high risks with additional governance features. In addition, cross-chain interoperability could also reduce risks, since today only 4% of the DeFi solutions contain this functionality. Summarized, the findings of this research reveal at least five areas for future research.

First, the taxonomy classifies the emerging domain of Defi and shows patterns of the existing start-up landscape in this new domain. These may serve as a starting point to more precisely understand potentials for future configurations to design new infrastructures and businesses based on DeFi. Currently, this whole sector is only developed by individuals or groups mostly from outside the incumbent financial system.

Second, only a few studies focus on how DeFi substitutes/complements the existing financial system. Furthermore, only limited research investigates potential interfaces between traditional financial institutions and DeFi. One core question is how DeFi and the incumbent financial system might be connected. This involves not only technology-based questions, but also organizational and strategic issues. For example, how can DeFi applications be used to leverage the potentials but exclude the risks of the DeFi pitfalls, which we have observed recently.

Third, most start-ups are only just entering this domain and only limited data is currently available. If these services are used by more customers in the future, research about customer behavior and the impact on the existing financial system can be derived. This requires other research methods than the one used in this paper. Up to now, most applications can only be observed in isolated use cases, and a more comprehensive understanding based on larger data sets is still missing.

Fourth, the role of regulators and policy makers to shape this new field is not fully explored yet, as most of the approaches are still very young. However, regulation might be an important field in the future, as DeFi makes it hard to assign responsibilities to certain intermediaries, since DeFi was built without them. How can a regulatory system be designed that has evolved as a stakeholder-centric system and not an activity-based one?

Fifth, although this study extends existing research, it also holds some limitations. This taxonomy only provides a static DeFi ecosystem overview, instead of a dynamic approach such as a real-time simulation, which includes periodic updates to reflect the rapidly evolving DeFi space. Longitudinal studies may complement the existing data set and support such a dynamic view. Software tools, which support the continuous development of the taxonomy might support this.

CRediT authorship contribution statement

Thomas Puschmann: Conceptualization, Methodology, Writing – original draft, Writing – review & editing, Supervision, Project administration, Resources. **Marine Huang-Sui:** Investigation, Data curation, Formal analysis, Visualization, Writing – original draft.

Data availability

Data will be made available on request.

Appendix A. List of start-ups

No	Start-up	No	Start-up	No	Start-up	No	Start-up	No	Start-up	No	Start-up
1	Benqi	2	Impermax	3	Gro	4	Mercurial Finance	5	Ellipsis Finance	6	Coinwind
7	Trader Joe	8	Liquity	9	Maple Finance	10	Port Finance	11	Tranchess	12	Annex
13	Maximiser	14	Ramp DeFi	15	Premia Finance	16	Parrrot Protocol	17	Solo Top	18	Valas Finance
19	Axial	20	Mover	21	Integral	22	InvictusDAO	23	Acryptos	24	DDDX
25	Echidna Finance	26	MCDEX	27	Hegic	28	Socean	29	Synapse	30	Liqee
31	Snowball	32	Bancor	33	Compound	34	Raydium	35	BiSwap	36	ForTube
37	Pangolin	38	Abracadabra	39	Charged Particles	40	Solend	41	Alpaca Finance	42	BakerySwap
43	Blizz Finance	44	Aave	45	Metronome	46	Serum	47	Babyswap	48	Stargate
49	Nereus Finance	50	Opyn	51	Flexa	52	Marinade Finance	53	Minswap	54	Position Exchange
55	Wonderland	56	Sablier	57	Vesper	58	Aldrin	59	SundaeSwap	60	pNetwork
61	Yield Yak	62	Element Finance	63	Uniswap	64	Apricot Finance	65	WingRiders	66	PancakeSwap
67	Vector Finance	68	Maker	69	dForce	70	Astroport	71	dYdX	72	Hector Finance
73	DeFrost	74	InsurAce	75	Alpha Homora	76	Nexus Protocol	77	Swapr	78	DeversiFi
79	Yeti Finance	80	Idex	81	PerlinX	82	Angel Protocol	83	Sushiswap	84	Mooniswap
85	KyberSwap	86	WePiggy	87	dHEDGE	88	ApolloDAO	89	YuzuSwap	90	Crypto Volatility Index
91	Iron Bank	92	Injective Protocol	93	Mashrooms Finance	94	Anchor	95	PieDAO	96	Wasabix Finance
97	Platypus Finance	98	Reflexer	99	Centrifuge	100	Soluna	101	xToken	102	Warp Finance
103	StakeDao	104	BiFi	105	BarnBridge	106	Spectrum Protocol	107	Notional	108	Dodo
109	GMX	110	Set Protocol	111	Rari Capital	112	Risk Harbor	113	Idle Finance	114	Ribbon Finance
115	Lightening Network	116	B.Protocol	117	mStable	118	Kujira	119	CREAM Finance	120	Beta Finance
121	Venus	122	Curve	123	Pendle	124	Pylon Protocol	125	Nexus Mutual	126	Loopring
127	cBridge	128	Gnosis	129	Comb Finance	130	Edge Protocol	131	Truefi	132	Strike
133	Belt Finance	134	Enzyme	135	QiDAO	136	Mars Protocol	137	Tokenlon	138	yAxis
139	Autofarm	140	xDai	141	Reaper Farm	142	White Whale	143	InstaDApp	144	Genshiro
145	Bunny	146	Nsure	147	Solidex	148	Terraswap	149	bZx	150	Yoshi Exchange
151	KnightSwap Finance	152	Balancer	153	Market	154	PRISM Protocol	155	DeFi Saver	156	PaintSwap
157	JetFuel Finance	158	Frax Finance	159	Grim Finance	160	Mirror	161	Alchemix Finance	162	Deus Finance
163	Guard(Helmet)	164	Wing Finance	165	Solidly	166	INK Protocol	167	Quickswap	168	SpookySwap
169	Deri Protocol	170	Yearn Finance	171	WigoSwap	172	Lido	173	Tornado Cash	174	Jpool
175	Orion Protocol	176	Augur	177	Sturdy	178	Loop Finance	179	FountainProtocol	180	Friktion
181	Planet	182	Cyclone	183	Liquid Driver	184	Aperture Finance	185	Mango Markets	186	Larix
187	TEN Finance	188	OnX Finance	189	MiniPanther DAO	190	Stader	191	Synthetify	192	01
193	Rabbit Finance	194	Olympus	195	Tarot	196	JustStables	197	Sunny	198	Jet
199	Moonpot	200	Yield Protocol	201	SpiritSwap	202	JustLend	203	Katana	204	Drift
205	Mars Ecosystem	206	Composable	207	Robo-Vault	208	SocialSwap	209	Oxygen	210	Crema Finance
211	Beefy Finance	212	Ubeswap	213	ProtoFi	214	SUN.io	215	Almond	216	ValleySwap
217	Waterfall DeFi	218	Clipper	219	Geist Finance	220	SUNSwap	221	Francium	222	Internal
223	ApeSwap	224	Saddle	225	Excalibur	226	VVS Finance	227	Hubble	228	TWAP
229	MoonFarm	230	Bella Flex Savings	231	Spartacus	232	MM Finance	233	Saber	234	Winklink
235	Linear Finance	236	O3 Swap	237	Tetu	238	MM Optimizer	239	Atrix	240	Pyth
241	Atlantis Loans	242	Harvest Finance	243	Fantohm	244	Tectonic	245	UXD	246	Flux
247	OCP Finance	248	Inverse Finance	249	Beethoven X	250	DarkCrypto	251	Orca	252	DIA
253	Pacoca	254	Synthetix	255	Scream	256	Band	257	Tulip Protocol	258	UMA
259	MDEX	260	Reserve	261	Hundred Finance	262	Chainlink	263	Quarry	264	Ubinetic
265	JPEG'd	266	X2Y2	267	0xDAO	268	Harbinger	269	OpenSea	270	Nil DAO
271	SuperFarm	272	Universe.XYZ	273	LatteSwap	274	LooksRare	275	Rarible	276	Tiny World
277	GuildFi	278	Alchemist Crucible								

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