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RESEARCH PAPER

Breaking the chains of traditional finance: A taxonomy of decentralized finance business models

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Abstract

Recently, the looming bankruptcy of Credit Suisse, which ultimately led to its merger with UBS, has intensified the discussion surrounding the need for more transparent and democratic financial markets. Decentralized finance (DeFi) represents a departure from traditional financial intermediation by leveraging blockchain technology and smart contracts. Despite its growing importance, limited research has been conducted on the business models of DeFi services. This study aims to address this gap by examining the business models of various DeFi services, identifying key drivers of innovation, differentiation, and value creation. Using a rigorous taxonomy development framework, we identify 12 dimensions and 47 characteristics that operationalize business models in DeFi. Our findings contribute to a better understanding of the transformation of financial services through blockchain technology and provide valuable insights for DeFi entrepreneurs, investors, and policymakers.

Keywords Decentralized finance · Blockchain · Business model · Taxonomy · Web3

JEL classification G15 · G23 · O32 · O33

Introduction

For decades, trust in traditional financial intermediaries, such as banks and key institutions, has been gradually eroding. The financial crisis of 2008 was a stark manifestation of this declining confidence, with many perceiving these entities as having aggravated the crisis through high-risk investments and questionable practices (Sapienza & Zingales, 2012). This erosion of trust was not a fleeting episode; events in the following years, such as the near-collapse of Credit Suisse (Packiry, 2023) and the Wirecard debacle (Teichmann et al., 2023), further deepened the public's mistrust in the financial realm. In a telling indicator, the Edelman Trust Barometer (2021) boldly highlighted this sentiment, reporting a significant trust deficit in the financial services sector across 20 of the 27 countries assessed. By 2022, with accumulating challenges underscored by a pervasive skepticism of central financial entities, the sector's landscape looked bleak (Edelman Trust Barometer, 2022). This enduring disenchantment, underscored by concerns about opacity, inefficiency, and potential corrupt practices in traditional finance, intensified the search for alternatives. This paved the way for the emergence of decentralized finance (DeFi) as an alternative to traditional financial systems (Lockl & Stoetzer, 2021).

DeFi is a new type of financial system operating on public blockchains, offering financial products and services without the need for intermediaries or country-specific restrictions. DeFi is powered by smart contracts, which are self-executing digital contracts that facilitate agreements between buyers and sellers through direct

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implementation in program code (Gramlich et al., 2023; Meyer et al., 2022). The growth and success of DeFi services, which had a global market capitalization of over $50 billion as of April 2023 (CoinMarketCap, 2023), can be attributed to the desire for decentralization, democratization, and open access to financial services (Chen & Bellavitis, 2020). Organizations typically adopt established institutional logics, which are sets of beliefs and assumptions about how organizations ought to operate (Faik et al., 2020; Mignerat & Rivard, 2009; Vaskelainen & Münzel, 2017). In the financial industry, the traditional institutional logic emphasizes the role of intermediary financial institutions in fostering trust, stability, and regulatory compliance (Zetzsche et al., 2020). However, DeFi represents a departure from this logic, as it seeks to eliminate intermediaries and instead place trust in code and peer-to-peer interactions. At the same time, DeFi represents an evolution of this logic, as it adapts to technological advancements and new approaches in achieving the goals of trust, stability, and regulatory compliance (Meyer et al., 2022).

Given the importance of institutional logics in shaping organizational practices and behaviors (Faik et al., 2020; Mignerat & Rivard, 2009; Vaskelainen & Münzel, 2017), it is crucial to understand how DeFi services operationalize the desire for decentralization and open access to financial services. Previous research in the information systems (IS) literature has emphasized the utility of business models in understanding how organizations create, deliver, and capture value under specific market conditions (Anton et al., 2021; Beinke et al., 2018; Möller et al., 2019). Business models can help enhance the understanding of the discourse between innovation and value creation and provide an industry overview (Teece, 2010), assisting organizations in better understanding their market positioning (Baden-Fuller & Mangematin, 2015). With a surge in the prominence of DeFi, a thorough exploration into the structure and nuances of DeFi service business models becomes essential. Yet, to date, limited research has ventured into dissecting the dimensions and characteristics of business models specific to the DeFi realm. Most of the recent literature on DeFi has focused on technological and market aspects, such as revenue streams (Xu & Xu, 2022), blockchains (Chong et al., 2019), decentralization (Chen & Bellavitis, 2020), regulation (Zetzsche et al., 2020), or liquidity provision (Fan et al., 2022).

Therefore, this study aims to address this gap by examining the ways in which DeFi services internalize and manifest the principles of decentralization and technology harmony within their complex business architectures. By probing a spectrum of DeFi services, our objective is to highlight the pivotal elements propelling innovation, differentiation, and enhancing value in this nascent arena. Specifically, we ask the following research question:

What are the dimensions and characteristics that operationalize business models in DeFi, and what are the common types of business models that shape the field?

To achieve this, we utilized a rigorous framework for taxonomy development that combines empirical and conceptual classification approaches, adapted from Nickerson et al. (2013). Our analysis suggests that DeFi business models are characterized by 12 dimensions and 47 characteristics and demonstrate a range of innovative approaches to changing institutional logics beyond the traditional financial intermediation. Additionally, a significant contribution of our research is the delineation of distinct business model archetypes using clustering, which provides a deeper understanding of prevalent DeFi business models. Together, the taxonomy and identified archetypes offer DeFi entrepreneurs, investors, and policymakers a comprehensive view of the DeFi landscape, critical for astute decision-making. The remainder of this study is structured as follows: Firstly, we provide a broad theoretical background on DeFi and business model research. Secondly, we describe our research method, which includes the development of a rigorous taxonomy and an evaluation based on the application of 76 established business models and 10 expert interviews. Subsequently, we present the taxonomy and evaluation results and discuss the main contributions of our study, as well as its limitations. Finally, we conclude by summarizing our key findings and outlining potential avenues for future research.

Theoretical background

Decentralized finance

Blockchain technology, a decentralized digital ledger that securely records and verifies transactions across a distributed network, is often described as the backbone of modern digital currency systems. The decentralized nature of the technology ensures that no single entity has control over the entire blockchain, and that all transactions are transparent to all participants in the network (Beck et al., 2018). Beyond serving as the foundation for cryptocurrencies, the blockchain's inherent security, transparency, and decentralized attributes have rendered it central for the DeFi sector. By reducing the need for centralized intermediaries, blockchain technology has enabled financial systems to operate with greater efficiency, transparency, and inclusivity (Lockl & Stoetzer, 2021; Moncada et al., 2021). The cryptocurrency ecosystem has undergone significant development in recent years, leading to a new paradigm in the financial sector,

characterized by a shift towards decentralized financial services (Lockl & Stoetzer, 2021). Gramlich et al. (2022) assert that DeFi is a catalyst for a new financial ecosystem that provides the infrastructure for other ecosystems. One of the unique features of DeFi is the ability to replicate standardized financial service products in the form of decentralized applications (dApps), as well as the opportunity to create new and innovative financial services (Moncada et al., 2021). Smart contracts, a core component of dApps, are self-executing computer programs that automatically enforce and execute the terms of a contract between (often unknown) parties (Beck et al., 2016; Buterin, 2014). These contracts are encoded with the conditions, rules, and penalties of a traditional contract and operate on a blockchain network, enabling a secure and tamper-proof execution of the agreement. Once the specified conditions are met, the smart contract automatically executes the terms of the contract without the need for intermediaries or manual intervention. Smart contracts facilitate the exchange of digital assets and the execution of transactions in a trustless and transparent manner.

Therefore, DeFi presents unprecedented opportunities for value creation (Eikmanns et al., 2021). Its global, efficient, and decentralized nature enables convenient access to financial, investment, and insurance services (Katona, 2021). Due to the high degree of combinability of DeFi protocols and services, they are often referred to as Lego building blocks in the literature (Amler et al., 2021; Eikmanns et al., 2021; Katona, 2021; Schär, 2021).

Schär's (2021) DeFi stack model illustrates the multilayered, hierarchical architecture of DeFi. The settlement layer consists of the underlying blockchain (e.g., Ethereum) and the associated protocol asset (e.g., Ether), which stores ownership information and guarantees the conformity of state changes with the rules. The blockchain functions as a settlement and conflict resolution layer (Schär, 2021). The open-source code used to establish trust among participants creates a need for constant innovation to remain competitive (Schär, 2021). Despite numerous tests and audits, potential risks exist, such as the exploitation of vulnerabilities (Gramlich et al., 2022). For example, pseudonymized data stored on the blockchain can enable tracing back to individuals, raising privacy concerns (Chen & Bellavitis, 2020; Gramlich et al., 2022). These technical challenges and regulatory issues must be addressed to drive DeFi innovation and support the emergence of new business models (Chen & Bellavitis, 2020). Previous research on DeFi business model innovations has been limited in scope, often focusing on isolated sections or partial aspects while neglecting the bigger picture. This approach has led to a fragmented understanding of the DeFi landscape and the factors contributing to the success of DeFi business models. To gain a more comprehensive understanding, it is necessary to take a more thorough and integrated approach that examines the key elements. Gramlich et al. (2022) have identified six main categories of DeFi applications, namely stablecoins, decentralized exchanges (DEX), lending and borrowing, derivatives, insurance, and asset management. DEX utilize smart contracts to tackle trust issues inherent in centralized exchanges by allowing users to retain control over their private keys. Tokens can be exchanged as needed, and a fee is charged for this service, which is divided between the DEX protocol and liquidity providers (Xu & Xu, 2022). Automated market maker algorithms are typically employed to determine the precise asset price based on the ratio of assets in the liquidity pool for seamless order execution (Gramlich et al., 2022; Makarov & Schoar, 2022).

In addition, automated market makers enable the lending and borrowing of cryptocurrencies, with crypto assets locked in a smart contract, and the variable interest rate, based on supply and demand of the respective assets. The lending and borrowing protocol receives part of the interest rate paid (Xu & Xu, 2022). To prevent loan defaults and guarantee liquidity, a sufficient amount of collateral must be deposited for borrowing, as the creditworthiness of the borrower cannot be easily determined due to the pseudonymous nature of DeFi (Gramlich et al., 2022; Jensen et al., 2021; Schär, 2021).

Derivatives can also be mapped on the blockchain and used to hedge or leverage underlying crypto assets (Gramlich et al., 2022; Nelaturu et al., 2022). Insurance is another DeFi domain gaining momentum, with oracles used to hedge risks such as smart contract hacks and insures real and virtual goods (Gramlich et al., 2022; Guggenberger et al., 2021). Several asset management tools combine different DeFi services to provide users with convenient access to different DeFi protocols (Gramlich et al., 2022), allowing users to diversify their crypto portfolios and manage investment risks (Schär, 2021; Schellinger, 2020). Yield farming services can be used for asset management, investing in different DeFi protocols depending on strategic design, and algorithmically reallocating investments under certain circumstances.

Business model research

The significance of business models has gained substantial attention in both academic research and practical applications in recent years (Al-Debei & Avison, 2010; Budler et al., 2021; Kraus et al., 2020). Despite this, a generally accepted definition of "business model" is yet to be established (Al-Debei & Avison, 2010). This is partly due to the interdisciplinary nature of the concept, the presence of

multiple perspectives, conceptual ambiguity, and the inherent flexibility and customization of business models, which add to the complexity of defining the term (Massa et al., 2017; Veit et al., 2014). Digital technologies and automation are influencing and changing the way companies operate, from production to marketing to the business model itself. The business model is undergoing iterative evolution and innovation, influenced by digital advancements and competitive pressures (König et al., 2019, Trischler & Li Ying, 2022). The falling barriers to competition due to digitalization, for example, due to the availability of highly scalable cloud services, are increasing competitive pressure in various markets. Therefore, it makes sense to diversify the company's success and to evaluate and implement multiple (digital) business models. Kohtamäki et al., (2019, p.390) argue in the same vein, stating that "being locked into a single business model, no matter how profitable, can create deep-rooted rigidity." The authors conclude that continuous business model innovation is necessary. One of the starting points is the observation and investigation of competitors' business models.

Business models act as a link between a company's strategic objectives and its operational processes, helping to answer critical questions related to strategy, operations, and technology (Al-Debei & Avison, 2010) and facilitate discussions about value creation, performance, and competitive advantage (Zott et al., 2011). Osterwalder et al. (2005) emphasize the importance of business models as the foundation upon which a company's operations are built. Every company (implicitly) adheres to a particular business model that delineates the frameworks and processes for creating, delivering, and capturing value (Teece, 2010). Simply relying on innovative technologies is not sufficient to ensure a company's commercial viability and success (Teece, 2010). Instead, it is essential to fully develop and understand a business model to guarantee successful market entry and adaptation to the ever-evolving complexities of the business environment (Al-Debei & Avison, 2010; Teece, 2010). Through an exhaustive review of the literature, Massa et al. (2017) identified three primary interpretive approaches to the meaning and function of business models: (1) the way companies operate, (2) how employees perceive their operations, and (3) a formal conceptualization that encompasses both (1) and (2) (Massa et al., 2017).

In this paper, we adopt the third interpretive approach, which aligns with earlier publications in the realm of business model taxonomies (Anton et al., 2021; Tönnissen et al., 2020; Weking et al., 2020a, 2020b). This approach enables us to focus on the formal conceptual depiction of an organization's functioning, which encompasses how the organization creates, delivers, and captures value. Previous research at the intersection of blockchain technology and business models has utilized taxonomies as an effective analytical tool, as demonstrated by Beinke et al. (2018), Tönnissen et al. (2020), and Weking et al. (2020b). Some research approaches have focused on investigating the broader impact of blockchain technology on business models (Weking et al., 2020b), while others have specifically explored token-based ecosystems (Tönnissen et al., 2020) or analyzed blockchain startups in the financial sector (Beinke et al., 2018). Furthermore, some studies specifically investigate blockchain-based platforms, such as the research carried out by Lage et al. (2022). Despite the growing interest in decentralized financial services, no previous research has explicitly analyzed DeFi business models. Therefore, we follow Beinke's et al. (2018) call to analyze companies or providers and gain insights into the impact of blockchain technology on value creation in the financial sector. A summary of the most relevant papers described here is shown in Table 1.

While existing studies have provided a foundation for understanding the influence of blockchain technology on business models, there is still a need to examine the DeFi space specifically. The rapid evolution of DeFi business models and its potential to disrupt traditional financial systems make DeFi business models a crucial area of business interest. By exploring a variety of companies and providers in the DeFi ecosystem, researchers can gain valuable insights into how blockchain technology is shaping value creation in this emerging sector. These insights can contribute to a better understanding of the overall impact of blockchain technology on the financial industry and guide future developments in the DeFi ecosystem.

Research method

Taxonomy

Business model taxonomies are valuable tools for organizing, analyzing, and understanding the complexities of different business models. To create a comprehensive and effective taxonomy, we use the methodology developed by Nickerson et al. (2013), which combines both inductive (empirical-conceptual) and deductive approaches (conceptual-empirical). Furthermore, the taxonomy should comprise n dimensions, D_i ($i = 1, \ldots, n$), each containing k_i ($k_i \geq 2$) mutually exclusive and collectively exhaustive characteristics. Due to the diverse and complex nature of DeFi business models, the requirement for mutually exclusive characteristics in each dimension could not be met. To maintain a concise and robust taxonomy, we follow the approach of Gimpel et al. (2018) and allow multiple selections of characteristics in certain dimensions. In addition, we follow the design science research guidelines established by Hevner

Table 1 Related studies

Authors	Dimensions	Short summary
Beinke et al. (2018)	• Value proposition • Delivery channel • Market segment • Revenue stream • Product offering	The authors analyzed the business models of 63 financial start-ups using blockchain technology. They found that start-ups are primarily taking existing business models (e.g., credit cards) and transforming them through the use of blockchain technology. They have identified seven key focus areas, ranging from direct financial applications such as trading platforms, corporate payment solutions, and cryptocurrency credit cards. They also include infrastructure providers, such as wallet services, as well as customized applications designed to meet the needs of both businesses and consumers.
Tönnissen et al. (2020)	• Customer segment • Types of centralized business models • Associate • Market types • Stage of business ecosystem • Level of control • Collaboration • Increase network effects • Network effect • Token incentive • Token purpose/type	The authors analyzed the business models of 195 startups in token-based ecosystems. In their analysis, the authors identified three archetypes: the pioneer (vision) model, the expansion model, and the authority model. They found that the chicken-and-egg problem (especially in the latter two archetypes) also applies to blockchain-based systems and that many ecosystems face the challenge of attracting enough users and providers to their ecosystem.
Weking et al. (2020b)	• Value classification • Customer target • Underlying asset • Key partner • Key channel • Customizability • DAO-affiliation • Blockchain classification • Additional technology • Revenue stream	The researchers developed a taxonomy of blockchain business models by studying 99 blockchain ventures. Building on the taxonomy, the article conducted a cluster analysis and derive five archetypal business model patterns that illustrate how blockchain technology is changing existing models and creating new ones. The first pattern, named "Blockchain for Business Integration," involves companies using a standardized, shared database to enhance interoperability, collaboration, and data exchange within value chains. The second pattern, "Blockchain as Multi-Sided Platform," leverages peer-to-peer transactions to overcome limitations on what can be offered and by whom. This approach utilizes blockchain(s) to function as multi-sided markets. The third pattern, "Blockchain for Security," builds on blockchains' cryptographic capabilities, e.g., enabling solutions which clarify ownership. The fourth pattern "Blockchain Technology as Offering," offers application programming interfaces to developers, thus providing them with access to blockchain infrastructure. Finally, the fifth pattern is "Blockchain for Monetary Value Transfer," which contains business model which utilize cryptocurrencies to transfer monetary values.
Amshoff et al. (2015)	• Customer segments • Value proposition • Products and services • Marketing channels • Customer relationships • Revenue model • Key activities • Key resources • Organizational form • Key partners • Investment costs • Operations costs	The authors argue, that disruptive technologies fundamentally alter the way how value is created and captured, those creating new markets (segments). This is a double-edged sword: great opportunities through the use of new (digital) technologies, but also risks, including high investment costs. Developing a strategy for these new markets or market segments is a difficult task due to the high level of uncertainty. As a solution, the authors describe business model patterns that can be interpreted as proven business model elements, providing insights into business strategy. They conclude that business model patterns are a valuable approach to representing the business logic of new, unknown markets and, in turn, provide an approach to new business models.

et al. (2004) to ensure that our taxonomy development process is rigorous. The taxonomy development process is illustrated in Fig. 1.

At the beginning of the taxonomy development, meta-characteristics and end conditions are established to guide the iterative process (Nickerson et al., 2013). Based on our research objective, we define our meta-characteristic as the identification of distinctive properties of DeFi business models. In this paper, the objective and subjective end conditions proposed by Nickerson et al. (2013) are used (cf. Supplement A). We start with a conceptual-empirical approach (deduction), in which the dimensions of the taxonomy are created without taking into account the objects to be classified. This approach is chosen because we aim to identify

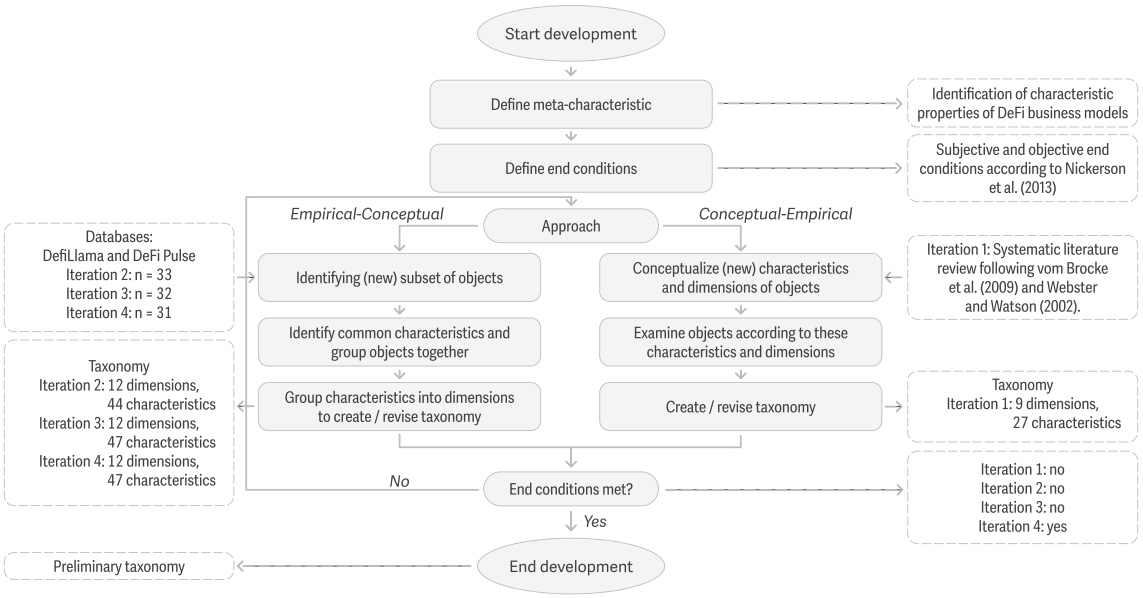

Fig. 1 Taxonomy development process

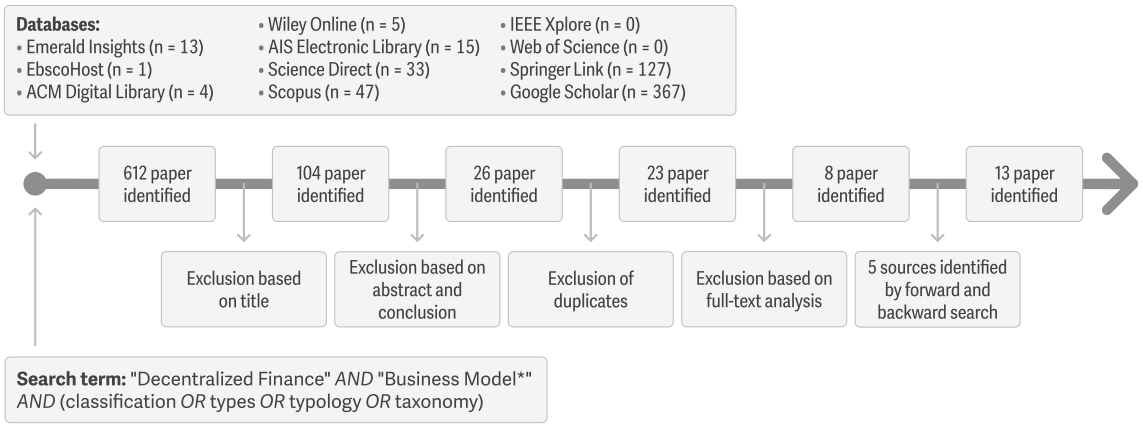

Fig. 2 Process of systematic literature review

the concepts that already exist in related research (Möller et al., 2019). To identify relevant literature, we conducted a systematic literature review following the guidelines by vom Brocke et al. (2009) and the concept-centric analysis approach described by Webster and Watson (2002). We scan the databases Emerald Insights, EBSCOhost, ACM Digital Library, Wiley Online, AIS Electronic Library, Science Direct, Scopus, IEEE Xplore, Web of Science, Springer Link, and Google Scholar, using the search term:

> *"Decentralized Finance" AND "Business Model*" AND (classification OR types OR typology OR taxonomy).*

Our search of the various databases yielded a total of 612 papers. Using an iterative process of relevance check, we evaluated each article's title, abstract, and full-text analysis to ensure they met our inclusion criteria. We excluded publications that focused on unrelated topics or technical aspects of DeFi and removed any duplicates. Specifically, we included articles in the English language that addressed business model aspects (dimensions and characteristics) and relevant technologies in the DeFi domain, such as blockchain and smart contracts. After applying our criteria, we were left with eight articles. To expand our search, we also conducted forward and backward searches, which yielded an additional five relevant publications. Thirteen relevant papers were selected as the basis for the first iteration of taxonomy development (for a more detailed report of the process, cf. Figure 2).

Table 2 Concept matrix

Sources	Dimensions								
	Key activity	Customer segment	Customer value	Stack layer	Blockchain	External data	Delivery channel	Governance	Revenue
Anoop and Goldston (2022)	x			x			x	x	x
Brühl (2021)	x				x		x		
Chen and Bellavitis (2020)	x								
Eikmanns et al. (2021)	x		x	x			x	x	
Jensen et al. (2021)	x		x				x	x	x
Katona (2021)	x	x		x	x	x	x	x	x
Meyer et al. (2022)	x					x		x	
Moncada et al. (2021)	x	x	x		x				
Nelaturu et al. (2022)	x					x		x	
Qin et al. (2021)	x					x			
Schär (2021)	x			x	x				
Werner et al. (2021)	x		x					x	x
Xu and Xu (2022)	x								x
$\sum$	13	2	4	4	4	4	5	7	5

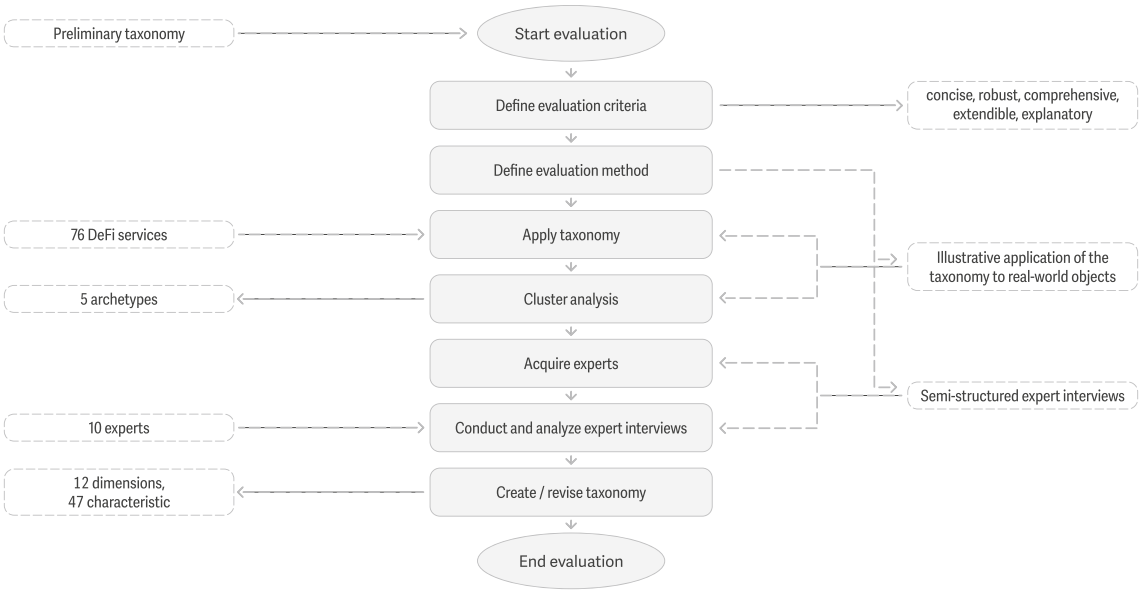

Fig. 3 Taxonomy evaluation process

The literature review results are presented in the concept matrix in Table 2. The initial dimensions and characteristics of the taxonomy were derived from this concept-centric approach, while the empirical-conceptual approach (induction) was used to enrich the existing concepts with empirical data, an approach that is similar to related research (Anton et al., 2021; Möller et al., 2019). To identify existing DeFi business models, we used the DefiLlama[1] database. These databases provide a comprehensive overview of DeFi services for practice and research (Grassi et al., 2022; Şoiman et al., 2022). After removing duplicates, we identified 1924 listed protocols. Nickerson et al. (2013) suggest relying on a systematically selected subset when dealing with large datasets.

We relied on the total value locked (TVL) indicator which is a measure of market size, growth, and market success of DeFi services (Maouchi et al., 2022; Şoiman et al., 2022). A high TVL of a protocol implies an established business model. A total of 100 protocols with the highest TVL were initially examined in three iterations. However, due to incomplete or inconsistent information, it was not possible to comprehensively analyze the business model of 24 DeFi services. Therefore, they were excluded from further consideration, leaving a subset of 76 DeFi services for analysis. Relevant information about the business models was derived from primary and secondary sources, including whitepapers, documentation, websites, and media reports. The analysis of white papers and documentations contributes comprehensively to the evaluation of blockchain-based products and services as these papers explain the features, technical implementation, and market outlook (Gramlich et al., 2023; Liu et al., 2021). To ensure data quality, data from multiple sources were triangulated, and the validity of the process was confirmed through evaluations by three independent researchers. During these evaluations, certain controversial issues emerged. For instance, there were challenges in differentiating specific business model aspects, incorporating unique technical implementations described in white papers into our taxonomy, and deciding on the utility of secondary sources when primary documents were ambiguous or lacking detail. In the face of such disagreements, our research team engaged in thorough discussions to achieve consensus, ensuring the robustness of our final taxonomy.

Evaluation

Evaluation and validation of the resulting artifact is a crucial step in the development of the taxonomy (Nickerson et al., 2013; Szopinski et al., 2019). We have employed two predominant methods for this purpose. Initially, we gauge the taxonomy's suitability by applying it to specific business models, a common evaluation practice in taxonomy research (Szopinski et al., 2019). Subsequently, expert interviews with seasoned users from both academic and practical domains validated the taxonomy's meaningfulness and relevance (Nickerson et al., 2013; Peffers et al., 2012). A visual depiction of this evaluation can be found in Fig. 3.

Our use of the clustering method primarily serves as an evaluative instrument. By categorizing DeFi business models

[1] https://defillama.com (accessed 13.08.2022).

Table 3 Overview of interview partners

ID	Category	Position and function	DeFi experience	Duration
E1	Research and Practice	Deputy Head of a research center and Co-Founder of a DeFi-Consulting Start-Up	1.5 years	40 min
E2	Practice	Managing Director of a Blockchain and DeFi-Consulting Start-Up	4 years	29 min
E3	Research	Research Assistant	2 years	31 min
E4	Practice	Blockchain Consultant	2 years	24 min
E5	Practice	Co-Founder of a DeFi service	3 years	20 min
E6	Practice	IT Project and Partnership Manager regarding NFT and Interoperability	1.5 years	18 min
E7	Practice	Management Consultant with a focus on digital assets and blockchain and Lecturer in the field of DeFi	2 years	23 min
E8	Research	Research Assistant	4 years	55 min
E9	Practice	Blockchain and Web3 Architect	2 years	32 min
E10	Practice	Blockchain Developer	2 years	32 min

based on their shared characteristics as derived from the taxonomy, our objective is to validate its practicality and scope in depicting real-world scenarios. The emergence of distinct clusters, or "archetypes," reinforces the taxonomy's capability to accurately classify diverse DeFi business models, further reinforcing its credibility and facilitating subsequent refinements. Beyond mere evaluation, the identification of these business model archetypes via clustering is, in itself, a valuable contribution. This offers a granular insight into the dominant DeFi business models prevalent today. These archetypes, thus, provide stakeholders with an expansive understanding of the DeFi market, a valuable asset for informed decision-making. To operationalize this, three researchers individually categorized DeFi services using our taxonomy. Intercoder reliability was ascertained using Fleiss' kappa, with a value of 0.69 suggesting a "good" agreement level (Fleiss, 1971; Landis & Koch, 1977). The subsequent cluster analysis grouped business models based on commonalities (Möller et al., 2019). It is crucial for a successful cluster analysis to ensure uniformity within clusters and distinctiveness among them (Tönnissen et al., 2020). Recognizing common patterns among DeFi business models, we identified primary patterns, i.e., archetypes. These reflect a more abstract representation of the analyzed DeFi services (Anton et al., 2021; Eickhoff et al., 2017; Gimpel et al., 2018), facilitating a clearer comparison of their shared characteristics and distinct features (Beinke et al., 2018). The methodological underpinning for archetype identification incorporated a two-step cluster analysis, leveraging Ward's (1963) Minimum Variance method, followed by the k-mode clustering algorithm by Huang (1998) to segregate based on likeness.

The primary objective of conducting semi-structured interviews is to evaluate the preliminary taxonomy based on its comprehensibility, completeness, and usefulness (Szopinski et al., 2019). The outcomes of the interviews were used to revise the taxonomy iteratively and reveal unconsidered aspects. It is important to select interviewees who have concrete academic or practical experience in the field of DeFi. Moreover, having extensive knowledge of business models is a crucial factor in selecting suitable experts (Kamprath & Halecker, 2012). A total of ten expert interviews were conducted; an overview of their positions and the duration of the interviews are shown in Table 3. The use of interview guidelines ensures the comparability of the results (Gläser & Laudel, 2010). The interview guideline can be found in Supplement B. The interview guideline consists of ten leading questions and corresponding follow-up questions and is based on the subjective end conditions according to Nickerson et al. (2013). After transcription, we conducted a qualitative content analysis (Mayring, 2015), by analyzing the interviews with a mixed-coding strategy (Bandara et al., 2015). Initially, we used a deductive coding scheme based on the predefined interview guidelines. Later, we refined the coding structure using an inductive coding approach to capture emerging patterns in the interview statements and achieve a more detailed level of coding. Any discrepancies in the coding of the individual researchers were discussed among all authors and resolved through a final coding structure.

Results

To establish a conceptual starting point for the development of the DeFi business model taxonomy, we adopted the widely recognized V4 framework by Al-Debei and Avison (2010). This industry-independent framework has been employed in previous academic works on business model taxonomies (Anton et al., 2021; Möller et al., 2019) to establish meta-dimensions and is used in this study to further develop the taxonomy.

	Dimension	Characteristics							E/N*
Value Proposition	Key Activity	Decentralized Exchange	Lending and Borrowing	Complex Financial Products	Asset Management	Stablecoin	Infrastructure Services	Niche Services	N (Aggregated Services)
	Customer Segment	Exclusive B2B Focused		B2B and B2C		B2B, B2C and C2C			E
	Customer Value	Yield	Convenience	Trading	Interoperability	Yield and Liquidity	Value Storage		E
Value Architecture	Stack Layer	Protocol Layer		Application Layer		Aggregation Layer			E
	Blockchain	Ethereum		Solana		Other Blockchain			N (Multiple Blockchains)
	Oracle	Oracle Usage			No Oracle Usage				E
	Security	Audit		Audit and Bug Bounty		No Information			E
Value Network	Delivery Channel	API/SDK		(Web) App		(Web) App and API/SDK			E
	Governance	Decentralized Governance		Partial Decentralized Governance		Centralized Governance			E
	Key Partner	Liquidity Provider		DeFi Service Provider		Liquidity Provider and DeFi Service Provider			E
Value Finance	Revenue	Fees		Fees and Interest		Price Spreads		No Revenue	E
	Revenue Distribution	Operational Expenses		Rewards		Rewards and Operational Expenses		Rewards and Price Stability	Rewards, Price Stability and Operational Expenses	E

Fig. 4 Final taxonomy (*E = mutual exclusive; N = not mutual exclusive)

In Fig. 4, the final taxonomy is presented in the form of an intuitively understandable morphological box (Ritchey, 1998), consisting of four meta-dimensions, twelve dimensions, and 47 characteristics, which we explain below.

The meta-dimension *value proposition* encompasses information about products and services, describing the added value for target customer groups (Al-Debei & Avison, 2010; Osterwalder et al., 2005). Consequently, the dimensions *key activity*, *customer segment*, and *customer value* are subordinated to this meta-dimension.

The *key activity* dimension captures the operational focus of a DeFi service. The *decentralized exchange* characteristic includes providers whose focus is on trading and determining the price of (native) tokens (Jensen et al., 2021; Schär, 2021). Through the simple and fast exchange of different tokens, users can participate in rising or falling prices of digital assets (Moncada et al., 2021). Execution prices can be determined using automated market makers or classic order books (Meyer et al., 2022; Werner et al., 2021). Moreover, users can earn interest by lending assets, while borrowed collateralized assets can be used for other investments (Schär, 2021; Xu & Xu, 2022). These are covered by the *lending and borrowing* characteristics, respectively. The *complex financial products* characteristic includes DeFi services that offer services related to derivatives (e.g., options, futures, synthetic contracts), prediction markets, and tokenization (Jensen et al., 2021; Katona, 2021). *Asset management* services simplify investing in various assets, utilizing yield aggregators, or cryptocurrency indices for portfolio diversification (Jensen et al., 2021; Schär, 2021). These protocols follow different investment strategies such as staking, lending, or liquidity providing (Schär, 2021; Xu & Xu, 2022). *Stablecoin* services focus on providers who issue stablecoins and operate payment systems (Katona, 2021; Moncada et al., 2021). In general, DeFi services tend to offer more complex use cases than simple payment transactions (Grassi et al., 2022). Providers that offer more technical support services to their users are assigned to the *infrastructure services* characteristic. An example within this characteristic is cross-chain router protocols which enable token exchanges between different blockchains. The characteristic *niche services* include DeFi services that do not fit into any of the other characteristics of the key activity dimension, such as launchpads or insurances. Providers that offer different services, such as lending, yield farming, or trading (non-fungible) tokens, are assigned to the characteristic *aggregated services* due to the combinations of multiple services.

The *customer segment* dimension categorizes each provider's target customer group into three segments: Exclusive Business-to-Business (B2B) focused, Business-to-Business and Business-to-Consumer (B2B and B2C), as well as Business-to-Business, Business-to-Consumer, and Consumer-to-Consumer (B2B, B2C, and C2C). Providers in the *exclusive B2B-focused* segment offer services to other DeFi service providers and companies, while those in the *B2B and B2C* segment offer services to private

consumers, businesses, and other DeFi providers (Katona, 2021; Moncada et al., 2021). The *B2B*, *B2C*, *and C2C* segment includes business models such as decentralized trading platforms that enable the trading of tokens between consumers.

The *customer value* dimension plays a crucial role in outlining the primary reason why users rely on a particular DeFi service. The *yield* characteristic includes protocols whose primary objective is to maximize the customer's return on investment (Jensen et al., 2021; Werner et al., 2021). In addition, some DeFi services focus on increasing *convenience*, for example, by integrating multiple DeFi protocols and simplifying access to them via a single platform (Moncada et al., 2021). To provide a more nuanced understanding of customer value, the *trading* characteristic has been added to describe DeFi services that primarily focus on facilitating trading activities. Popescu (2020) emphasizes the importance of fostering *interoperability* between different blockchains for DeFi services. Consequently, DeFi services such as Bridges have been developed. The *yield and liquidity* characteristic includes protocols, which enables users to obtain liquidity for further financial transactions or provide liquidity to the protocol to generate returns. Stablecoin providers issue cryptocurrencies with a stable value, which can be used to hedge against volatility or to diversify a portfolio. They can also be used as a *value storage*.

The *value architecture* meta-dimension refers to the efficient utilization of technological and organizational infrastructure to meet customer needs (Al-Debei & Avison, 2010). This meta-dimension includes four dimensions: *stack layer*, *blockchain*, *oracle*, and *security*.

The *stack layer* dimension characterizes the hierarchical, multi-layer architecture of DeFi. The *protocol layer* includes DeFi protocols that define standards for applications such as decentralized exchanges or lending and borrowing services (Anoop & Goldston, 2022; Schär, 2021). The *application layer* characteristic describes DeFi services built on top of individual protocols within the protocol layer, simplifying user access to DeFi services (Anoop & Goldston, 2022; Schär, 2021). The *aggregation layer* characteristic includes DeFi services that bundle several applications and protocols together to provide users with easy access to multiple DeFi services in a seamless manner. These services have high composition capability and enable complex use cases, such as yield farming and liquidity mining, to be accessed through a single platform (Anoop & Goldston, 2022; Katona, 2021; Schär, 2021).

The *blockchain* dimension describes the settlement infrastructure underlying the respective DeFi services. DeFi services built on the Ethereum blockchain are classified under the *Ethereum* characteristic, as Ethereum is the most widely used blockchain for DeFi services (Brühl, 2021; Katona, 2021; Schär, 2021). Based on the analysis of the sample, the *Solana* blockchain is the second most popular choice. The majority of the sample is built on these two blockchains. To maintain the conciseness of the taxonomy, DeFi services that are not based on Ethereum or Solana are subsumed under the *other blockchain* characteristic. Furthermore, some DeFi services operate on *multiple blockchains*.

The *oracle* dimension determines whether data can flow from the outside world into the self-contained blockchain ecosystem. Oracles enable the import of external data into a blockchain network and can also be used to establish interoperability between different blockchains, facilitating data exchange between them (Meyer et al., 2022; Nelaturu et al., 2022). This leads to the dichotomous characteristics of *oracle usage* and *no oracle usage*.

The *security* dimension describes the measures taken to provide a service that is as secure and trustworthy as possible. DeFi services assigned to the *audit* characteristic have been audited by at least one external auditor. The *audit and bug bounty* characteristic includes corresponding DeFi services that have both been externally audited for security vulnerabilities and offer an additional monetary incentive in the form of bug bounty programs for uncovering potential vulnerabilities. For a few services, *no information* could be found.

The *value network* meta-dimension is crucial for understanding the relationships and interactions between an organization and its stakeholders (Al-Debei & Avison, 2010). This meta-dimension consists of three dimensions: *delivery channel*, *governance*, and *key partners*.

The *delivery channel* dimension pertains to how DeFi services can be managed and accessed. DeFi services offering access via *API/SDK* provide access to their service via Application Programming Interface (API) or Software Development Kit (SDK). In contrast, *(web) apps* offer user-friendly access via a (web-based) front-end (Brühl, 2021; Jensen et al., 2021; Katona, 2021). Services providing a combination of those access options are subsumed under the characteristic *(web) app and API/SDK*.

The *governance* dimension addresses the extent to which decisions are made regarding new features or changes to the protocol (Jensen et al., 2021; Werner et al., 2021). DeFi services that issue governance tokens, allowing users to vote on all decisions regarding changes to the protocol, are assigned to the *decentralized governance* characteristic (Anoop & Goldston, 2022; Jensen et al., 2021; Nelaturu et al., 2022). DeFi services with *partial decentralized governance* structures represent business models where governance token holders have limited co-determination rights (Deshmukh et al., 2021). In DeFi business models with *centralized governance*

structures, operators alone have the right to make changes to the service, and users have no say (Deshmukh et al., 2021).

The *key partner* dimension describes the essential partners or stakeholders that enable the DeFi business model to function effectively. The *liquidity provider* characteristic encompasses DeFi services that depend on deposited liquidity to conduct their business activities. Decentralized exchanges, for example, require sufficient liquidity to facilitate exchange transactions, and incentives are often provided to encourage liquidity provision. Additionally, stablecoins must be backed by adequate collateral to ensure their stability, and lending and borrowing providers can only grant loans if sufficient collateral is deposited. Some business models utilize the services of other *DeFi service providers* while adding their own innovations. Many DeFi service providers rely on *liquidity providers and DeFi service providers* as key partners to facilitate their operations.

The *value finance* meta-dimension examines an organization's revenue and cost structures (Al-Debei & Avison, 2010). This meta-dimension includes the dimensions of *revenue* and *revenue distribution*.

The *revenue* dimension captures the various ways that DeFi services generate revenue. Providers can charge variable or fixed *fees* for the use of their services (Anoop & Goldston, 2022; Xu & Xu, 2022). The characteristic *fees and interest* describes business models that both charge fees and earn interest payments. While it was not possible to identify providers that generate income solely from interest payments, some business models rely on *price spreads*, which can be achieved through the use of market-maker mechanisms. Additionally, some providers offer their services for free and generate *no revenue*.

The *revenue distribution* dimension examines how fees collected are allocated. *Operational expenses*, such as research, development, and security, are one way that fees are used. *Rewards* are also a common use of fees, especially for staking or providing liquidity services. Some providers allocate fees exclusively to r*ewards and operational expenses*, while others allocate fees exclusively to *rewards and price stability.* In the latter case, the fees are used to stabilize the price of tokens issued by buying them back and burning them, which can serve as an inflation hedge. Other protocols use fees for *rewards*, *price stability*, *and operational expenses.*

Evaluation

Application of the taxonomy

In the beginning of the evaluation process, we used the developed taxonomy to classify 76 DeFi business models according to their dimensions and characteristics to validate the taxonomy's applicability. We were able to assign each DeFi service one characteristic per dimension, which demonstrates the applicability of the taxonomy. The categorical dataset serves as the foundation for conducting further analyses. The first step in the two-stage cluster analysis involved binary coding of the categorical dataset, followed by the application of the hierarchical clustering technique, utilizing interval squared Euclidean distance in SPSS (version 26). Furthermore, the categorical dataset served as the basis for the non-hierarchical clustering procedure using the k-mode algorithm (Huang, 1998), which was implemented in Python.

The initial clustering results showed that four DeFi services belonging to the characteristic "niche services" in the dimension "key activity" as well as the dimensions "blockchain" and "security" were distorting the silhouette scores. Thus, we excluded the distorted elements from further consideration to obtain more accurate results in line with previous clustering approaches (Anton et al., 2021; Möller et al., 2019; Punj & Stewart, 1983; Rousseeuw, 1987). In order to determine the appropriate number of clusters, we employed both the elbow method and the hierarchical clustering analysis. The average silhouette score and the coefficients of the assignment overview from the hierarchical cluster analysis suggested that a cluster number of five would be appropriate. Furthermore, a cluster number of five was found to be subjectively interpretable to differentiate between different business models. The five identified clusters represent archetypes that demonstrate commonalities and differences among DeFi services analyzed (Beinke et al., 2018). We present the derived archetypes together with a brief description and the size

Table 4 Overview of archetypes, cluster sizes, and representative DeFi services

No	Archetype	Cluster size	Examples
1	One-Stop-Shops	17	• PancakeSwap • Trader Joe • BiSwap
2	Lending & Borrowing	10	• Aave • Compound • Solend
3	Yield Optimization	16	• Beefy • Yearn Finance • Alpaca Finance
4	Ecosystem Driver	13	• MakerDAO • Multichain • Poly Network
5	Decentralized Exchange	16	• Uniswap • Curve • KLAYswap

of the hierarchically formed clusters and give examples of corresponding DeFi services (cf. Table 4). In Fig. 5, we illustrate the characteristics of each archetype in terms of their features per dimension based on the hierarchical clustering analysis.

Archetype 1—One-Stop-Shops

Business models falling under this archetype are user-centric platforms that strategically aggregate various applications, protocols, and information to offer them to the users as a convenient tool. This aggregation, coupled with a user-friendly interface, makes it easier for masses to enter the DeFi universe. Some one-stop-shops also offer services like Farm-as-a-Service or Vesting-as-a-Service targeting business users. Providers of this archetype have different revenue streams, such as general user fees, performance fees, interest from lending and borrowing, or income from price spreads. The generated revenues are partially paid out as rewards to liquidity providers and partly retained as reserves to stabilize the price of issued tokens. Most business models of this archetype have central governance structures (cf. Figure 5).

Archetype 2—Lending & Borrowing

The lending and borrowing archetype represents business models that facilitate transparent liquidity markets for secured lending and borrowing of crypto-tokens. These platforms enable investors to earn interest by lending tokens, while borrowers can access new investment opportunities (e.g., arbitrage trading) without selling their lent assets, by providing collateral. Liquidity providers are compensated with interest payments from borrowers, and in case of liquidation, liquidators receive penalty fees from the borrower. This archetype has both centralized and decentralized governance structures and uses price oracles to determine the exact price of assets. They offer convenient access for users through (web) applications and programming interfaces (cf. Figure 5).

Archetype 3—Yield Optimization

The yield optimization archetype is focused on generating the highest possible returns through various investment strategies. These businesses provide simple and intuitive access to complex investment opportunities through (web) applications, which are automated to be efficient and attractive to private investors with sparse technical understanding, businesses, and other DeFi service providers. They offer liquidity mining, (liquid) staking, and automated market-making projects or combine them in an automated way to generate maximum returns. Many of these business models have both centralized and decentralized governance structures and may charge management or performance fees, which are used to further develop the products offered.

Archetype 4—Ecosystem Driver

The ecosystem driver archetype comprises business models that aim to build and drive the infrastructure for a decentralized financial ecosystem. These models strive to increase interoperability between blockchains and create stable value payment instruments for the volatile DeFi market. Their target group includes both end users and other DeFi services who integrate bridge and router functions into their dApps, enhancing accessibility and convenience for users. Interoperability services and stablecoin providers rely on sufficient liquidity to conduct their business. These business models have mostly decentralized governance structures, which enable governance token holders to participate in changes to various protocol parameters (cf. Figure 5).

Archetype 5—Decentralized Exchange

The decentralized exchange archetype comprises business models that focus on token trading and pricing, generating revenue through fees and price spreads. Liquidity providers and stakers of protocol tokens participate in the fees charged for trading. Access to the service is provided through (web) applications and programmable interfaces. The governance structures are mostly decentralized, although not all protocols allow governance token holders to propose and vote on changes. In addition, some services offer higher returns or bonuses to increase customer loyalty if users lend their tokens to the protocol on a long-term basis. Many DeFi services in this archetype build on established protocols such as Uniswap and add innovative features to attract additional customer segments.

Fig. 5 Characteristics of the archetypes

Meta-Dimension	Dimension	Characteristics	Sampling Distribution	One-Stop-Shops	Lending & Borrowing	Yield Optimization	Ecosystem Driver	Decentralized Exchange
Value Proposition	Key Activity	Decentralized Exchange	19,7%	0,0%	0,0%	0,0%	0,0%	93,8%
		Lending and Borrowing	14,5%	0,0%	100,0%	0,0%	7,7%	0,0%
		Complex Financial Products	2,6%	0,0%	0,0%	12,5%	0,0%	0,0%
		Asset Management	18,4%	0,0%	0,0%	87,5%	0,0%	0,0%
		Stablecoin	5,3%	0,0%	0,0%	0,0%	30,8%	0,0%
		Aggregated Services	23,7%	100,0%	0,0%	0,0%	0,0%	6,3%
		Infrastructure Service	10,5%	0,0%	0,0%	0,0%	61,5%	0,0%
		Niche Services	5,3%					
	Customer Segment	Exclusive B2B Focused	5,6%	0,0%	0,0%	0,0%	30,8%	0,0%
		B2B and B2C	52,8%	29,4%	80,0%	100,0%	69,2%	0,0%
		B2B, B2C and C2C	41,7%	70,6%	20,0%	0,0%	0,0%	100,0%
	Customer Value	Yield	23,6%	0,0%	0,0%	100,0%	0,0%	6,3%
		Convenience	25,0%	100,0%	0,0%	0,0%	0,0%	6,3%
		Trading	19,4%	0,0%	0,0%	0,0%	0,0%	87,5%
		Interoperability	11,1%	0,0%	0,0%	0,0%	61,5%	0,0%
		Yield and Liquidity	15,3%	0,0%	100,0%	0,0%	7,7%	0,0%
		Value Storage	5,6%	0,0%	0,0%	0,0%	30,8%	0,0%
Value Architecture	Stack Layer	Protocol Layer	8,3%	0,0%	0,0%	0,0%	38,5%	6,3%
		Application Layer	75,0%	29,4%	100,0%	100,0%	61,5%	93,8%
		Aggregation Layer	16,7%	70,6%	0,0%	0,0%	0,0%	0,0%
	Blockchain	Ethereum	27,8%					
		Solana	8,3%					
		Other Blockchain	31,9%					
		Multiple Blockchains	31,9%					
	Oracle	Oracle Usage	52,8%	41,2%	90,0%	50,0%	46,2%	50,0%
		No Oracle Usage	47,2%	58,8%	10,0%	50,0%	53,8%	50,0%
	Security	Audit	20,8%					
		Audit and Bug Bounty	75,0%					
		No Information	4,2%					
Value Network	Delivery Channel	API/SDK	8,3%	0,0%	0,0%	0,0%	38,5%	6,3%
		(Web) App	23,6%	35,3%	30,0%	25,0%	15,4%	12,5%
		(Web) App and API/SDK	68,1%	64,7%	70,0%	75,0%	46,2%	81,3%
	Governance	Decentralized Governance	54,2%	35,3%	70,0%	56,3%	84,6%	37,5%
		Partial Decentralized Governance	26,4%	23,5%	0,0%	18,8%	15,4%	62,5%
		Centralized Governance	19,4%	41,2%	30,0%	25,0%	0,0%	0,0%
	Key Partner	Liquidity Provider	48,6%	11,8%	80,0%	37,5%	46,2%	81,3%
		DeFi Service Provider	8,3%	17,6%	0,0%	18,8%	0,0%	0,0%
		Liquidity Provider and DeFi Service Provider	43,1%	70,6%	20,0%	43,8%	53,8%	18,8%
Value Finance	Revenue	Fees	69,4%	70,6%	0,0%	87,5%	69,2%	93,8%
		Fees and Interest	22,2%	17,6%	100,0%	6,3%	15,4%	0,0%
		Price Spreads	4,2%	11,8%	0,0%	0,0%	0,0%	6,3%
		No Revenue	4,2%	0,0%	0,0%	6,3%	15,4%	0,0%
	Revenue Distribution	Operational Expenses	4,2%	11,8%	0,0%	6,3%	0,0%	0,0%
		Rewards	29,2%	23,5%	40,0%	6,3%	46,2%	37,5%
		Rewards and Operational Expenses	44,4%	29,4%	60,0%	81,3%	23,1%	31,3%
		Rewards and Price Stability	11,1%	11,8%	0,0%	6,3%	15,4%	18,8%
		Rewards, Price Stability and Operational Expenses	11,1%	23,5%	0,0%	0,0%	15,4%	12,5%

Expert interviews

To further validate the taxonomy and the derived archetypes, ten semi-structured expert interviews were conducted. The interviews aimed to evaluate the usefulness and quality of the taxonomy and the archetypes by future users from research and practice (Hevner et al., 2004; Oberländer et al., 2019; Peffers et al., 2012; Szopinski et al., 2019). Additionally, the interviews served to check whether the subjective end conditions suggested by Nickerson et al. (2013) were sufficiently fulfilled. To assess whether the taxonomy is *comprehensive*, we asked the interviewees to classify the business model of a DeFi service of their choice into our developed taxonomy and to assign an archetype to the selected business model. They were able to classify the DeFi services in detail, indicating that the taxonomy is *comprehensive*. In addition, the experts highlighted the large database on which the taxonomy is based (E8) and stated that the taxonomy can describe DeFi services well (E2). However, the *robustness* of the taxonomy is evident as the experts were able to identify the dimensions and characteristics that characterize the different archetypes. Nevertheless, the experts also noted that not all dimensions allow explicit conclusions to be drawn about the respective archetypes. For instance, the governance dimension (E5, E6, and E10) and the blockchain dimension (E2, E5, and E6) do not necessarily allow conclusions to be drawn about specific archetypes. The *conciseness* of the taxonomy was evaluated by asking the experts about the number of dimensions and

characteristics. They mostly agreed that the taxonomy does not need additional dimensions and characteristics, rather it was characterized as "[…] mature […]" (E7) and "[…] well segmented […]" (E4). These statements underline the information density and value of the taxonomy. Overall, it is confirmed that the derived taxonomy is very well suited for analyzing DeFi business model compositions in a comprehensive and structured way. All relevant dimensions and characteristics to describe DeFi business models are included in the taxonomy, "[…] especially much more than what one would spontaneously come up with" (E10). This statement illustrates the usefulness of the taxonomy, as it can even serve as a guide for experts to consider the most relevant aspects of a DeFi business model. Only E1 states that the number of dimensions is in the upper range but still does not seem overwhelming or unwieldy, but rather necessary due to the complexity of the DeFi ecosystem. Furthermore, the *extendibility* of the taxonomy has been validated. The experts agree that the extensibility of the taxonomy is crucial for its long-term relevance and usefulness. As DeFi is a fast-evolving field, with new use cases and technologies emerging constantly, the taxonomy should be extended with new dimensions and characteristics to stay up-to-date (E4, E5, E7, and E9). E5 suggests an annual extension of the taxonomy to keep up with the pace of change in the DeFi ecosystem. As an example, E5 points out that revenue distribution has become more relevant in the past year, underscoring the need for continuous updates to the taxonomy. Despite being *comprehensive* and *explanatory*, the experts also note that the taxonomy's one characteristic per dimension approach does not always capture the full complexity of DeFi business models (E1, E3, E7, E8, and E9). However, they acknowledge that this is a necessary trade-off to maintain the conciseness and usability of the taxonomy.

Suggested changes arising from the interviews are presented in Supplement C. The authors carefully considered each suggestion, particularly with regard to the conciseness and comprehensiveness of the taxonomy. However, improvement suggestions 2, 5, 7, and 9 were not included in the taxonomy because they were each expressed by only one expert and did not change the information value of the individual dimensions and characteristics. Improvement suggestion 4 was also not included in the taxonomy. The majority of the subset of DeFi services considered are executed on the Ethereum blockchain, on multiple blockchains, or on the Solana blockchain. Other blockchains, such as the Binance Smart Chain (three out of 76) or Cronos (two out of 76), are only used by a very small fraction of the DeFi services considered. In order to maintain a robust and concise taxonomy, these blockchains are subsumed under the characteristic *Other Blockchains*. Overall, the rejected improvement proposals would only dilute the conciseness of the taxonomy.

Discussion

Theoretical implications

The emergence of DeFi as an alternative to traditional financial systems promises to disrupt the traditional institutional logic that emphasizes the role of intermediary financial institutions in promoting trust, stability, and compliance (Zetzsche et al., 2020). Consequently, there is a pressing need to understand the dimensions and characteristics of DeFi business models to identify the key drivers of innovation, differentiation, and value creation within the industry (Gramlich et al., 2023). Despite recent scholarly attention to the technological and market aspects of DeFi (Chen & Bellavitis, 2020; Chong et al., 2019; Fan et al., 2022; Xu & Xu, 2022), there remains a noticeable gap in the literature regarding the business models of DeFi services. Hence, this study aims to bridge this gap by systematically examining the dimensions and characteristics of DeFi business models and identifying how these models facilitate the novel institutional logic that is being propagated in the financial services industry. According to the classification framework presented by Schoormann et al. (2023), our taxonomy adheres to the "identification of real-world instances" production pattern. This approach enables a comprehensive understanding of the primary features of existing business models through an in-depth empirical analysis (Schoormann et al., 2023). We employ the rigorous methodology proposed by Nickerson et al. (2013) to develop and evaluate a comprehensive taxonomy of 12 dimensions and 47 characteristics. This taxonomy delineates the evolving market landscape and the application of novel institutional logics within the financial sector.

The innovative institutional paradigm in DeFi boasts transparency, accountability, and private financial autonomy (Qin et al., 2021; Zetzsche et al., 2020). However, our findings show that this promise is presently only partially being kept. For example, one-stop-shops archetype offers a user-friendly platform that aggregates various DeFi services and protocols to make it easier for users to access and manage their assets. These platforms generate revenues through user fees, performance fees, interest from lending and borrowing, and income from price spreads. The generated revenues are partially paid out as rewards to liquidity providers and partly used to cover operating costs. However, most of these business models have centralized governance structures, which means that they do not fully adhere to the decentralized ethos of DeFi. One concrete example of centralized governance is BENQI,[2] which offers services such as lending

[2] https://benqi.fi.

and borrowing, as well as liquid staking. While the protocol has a decentralized decision-making process for proposing and voting on changes to the system, it still relies on a centralized foundation to oversee the overall development and maintenance of the protocol. Furthermore, the lack of regulation in the DeFi ecosystem raises concerns about the security of assets being managed by these business models. Despite claims of transparency and accountability, there have been instances of hacks and exploits that have led to the loss of funds for users.[3] Thus, while DeFi presents an exciting opportunity for greater user control and participation in a new financial system, more research on regulation, security measures, and transparency are necessary to fully realize the potential of this institutional logic.

Expanding on the theme of technological advances, and moving into the discourse on technology-enabled (digital) business models (see Table 1), the unearthed archetypes mirror the DeFi service business model trends, elucidating the encompassing business stratagems (Amshoff et al., 2015). This exploration provides first empirical insights into the DeFi market's blueprint and prevalent business models. For example, it is striking that very few DeFi services operate at the protocol level but primarily at the application or aggregation level. Drawing parallels with Weking et al. (2020b), who identified five archetypal blockchain-related business model patterns, our DeFi service assessments predominantly align with the fourth ("Blockchain Technology as Offering") and the fifth pattern ("Blockchain for Monetary Value Transfer"). Thus, our results echo Weking et al.'s (2020b) findings, tailored for DeFi services.

In contrast to Beinke et al. (2018), who analysed blockchain-based business models within the financial startup sector in general, our analysis reveals distinct variations in the DeFi services when compared to the business models they identified. While DeFi models often draw from traditional structures, their evolution is evident in the increased intricacy, embracing (partially) automated lending and borrowing, complex financial products, and asset management. There has been a significant increase in the maturity of applications and services, likely driven by increased competitive pressure, a growing user base, and improved technology. It is also noticeable that most DeFi services are based on decentralized, or at least partially decentralized, governance and are aimed at both private and business customers. Both can be seen as approaches to reach the broadest possible user base: Participation in governance, for example, can motivate developers and customers alike to continuously develop, promote, and shape DeFi services according to their needs. Broad outreach to different customer groups increases the number of potential customers. Both can serve as measures to counteract the "chicken-and-egg problem" of blockchain-based ecosystems (Tönnissen et al., 2020).

Drawing everything together, our operational framework for DeFi within the financial realm stands as a guiding light for developing novel business models, as simply introducing innovative financial technologies may not necessarily lead to economic benefits. Understanding how these technologies can be integrated profitably into the existing system is essential (Chesbrough, 2010). The proposed taxonomy can serve as a starting point for future research efforts and can help highlight the variety of different business models in this area. It can also be used as a concept matrix for literature analysis and a valuable guide for scholars across diverse disciplines intending to develop taxonomies in related fields of research (Schoormann et al., 2023). Moreover, it is crafted to not only demystify the present but also to unravel the prospective evolutionary trajectories of both traditional and DeFi business models. In this light, our taxonomy serves dual roles—it is an analytical framework and a comparative tool. It enables a nuanced dissection of existing models while setting the stage for explorative studies that juxtapose the dynamics of traditional financial mechanisms against the burgeoning DeFi models. Furthermore, we contribute to the taxonomy research by providing a blueprint for a comprehensive development and evaluation process, as many taxonomy papers in IS research neglect the evaluation aspect (Oberländer et al., 2019).

Implications for practice

This study holds significant relevance for both the academic realm and the industry, shining a spotlight on the burgeoning field of DeFi. The resulting artifacts contribute to a better understanding of DeFi business models by differentiating their core components. DeFi opens up new horizons for companies, offering them the potential to explore novel markets and avenues for value creation through emerging forms of digital financial services. Our research provides a comprehensive framework for businesses and decision-makers, guiding them in navigating the complexities of DeFi applications and opportunities. This includes understanding the nuances of DeFi business models.

The identification of five distinct archetypes within DeFi business models offers a holistic view of the essential components and recurring patterns observed in DeFi projects. They can leverage our taxonomy and its underlying patterns to assess the feasibility of implementing their own DeFi projects, taking into account both potential opportunities and obstacles. Such an approach facilitates the consideration of relevant project characteristics and allows for a comparative analysis against competitors or benchmark clusters within the DeFi ecosystem (Anton et al., 2021).

[3] Overview of DeFi Hacks: https://defillama.com/hacks.

Our study equips practitioners with tools to adapt and innovate their business models, focusing on specific user segments and uncovering untapped "economic niches" within the DeFi ecosystem (Beinke et al., 2018). The taxonomy and archetypes aid in identifying and analyzing competitors and market segmentation. Businesses can deeply reflect on their models based on competitive analysis, leading to strategic realignments or the adoption of new features. The majority of DeFi services predominantly depend on fee-based revenue models. Investigating alternative approaches, such as subscription models, could enable market differentiation and innovation. The taxonomy also supports user-centered service adjustments and expansions, contributing to innovation management.

Comprehensive analyses of DeFi business models can inform investment decisions regarding strategic portfolio diversification. Such a taxonomy is invaluable for regulators and policymakers to understand and regulate the complex domain of DeFi based on a scientifically and empirically founded classification. It can also be used to gamify the domain of DeFi for the interested public and contribute to financial and technological education by reducing complexity.

Limitations

It is important to consider the weaknesses of this study in the context of its strengths. The development of a taxonomy is subjective and can vary depending on the research focus and individual perspectives (Anton et al., 2021; Beinke et al., 2018; Eickhoff et al., 2017). However, we took steps to ensure the objectivity of our study by conducting the coding process with multiple researchers and validating the steps via intercoder reliability. Furthermore, our taxonomy was developed and evaluated systematically to capture the essential nature of the domain, rather than based on all possible research papers and DeFi services.

The evaluation has shown that the criterion of mutual exclusiveness, as preferred by Nickerson et al. (2013), does not apply to all dimensions of our taxonomy. There is a necessary reason for this: The complexity and variability of DeFi services in the Key Activity and Blockchain dimensions is extremely high. We illustrate this using the example of the key activity: There are seven different key activities, which can be combined with each other. The combination of the seven key activities results (theoretically) in up to 120 possible combinations, which would contribute to the taxonomy losing clarity and reducing its usefulness. These dimensions are marked as "not mutual exclusive" in Fig. 4 (Beinke et al., 2023; Gimpel et al., 2018). In this way, we create transparency and improve the applicability of the taxonomy in practice. Listing various combinations of services in one dimension might not only be exhaustive but also overwhelming and would not only lead to confusion but might also fall short of Nickerson et al.'s (2013) requirement for a taxonomy to be concise. This need for multiple selections of characteristics per dimension is not unique to our study, as it has been expressed in related business model research (Anton et al., 2021). Some studies, such as Kundisch et al. (2021) and Oberländer et al. (2019) consider iterative revisions of the taxonomy as an integral part of the development process and not as an actual evaluation. However, others, such as Anton et al. (2021), view evaluations as beginning earlier in the process. Nonetheless, the taxonomy should not be considered as a static objective, but rather as a dynamic artifact that is subject to constant economic, technological, and regulatory changes and must be evaluated dynamically accordingly.

Conclusion

Our study on DeFi business models has filled a critical gap in the literature by systematically analyzing their dimensions and characteristics using a rigorous taxonomy development framework. Our insights into the innovative potential of DeFi business models in transforming institutional logics beyond traditional financial intermediation are valuable, yet we have also highlighted limitations due to concerns over centralized governance structures and asset security within the DeFi ecosystem. These findings provide practical insights for DeFi entrepreneurs, investors, and policymakers, allowing them to make informed strategic decisions and capitalize on opportunities presented by this emerging financial paradigm.

Our taxonomy also serves as a valuable guide for future research, market analysis, and innovation management within the DeFi sector. However, it is important to recognize that DeFi's potential for disrupting traditional financial systems is accompanied by challenges and risks. Further research is necessary to address issues of regulation, security measures, and transparency in order to fully realize DeFi's potential. As DeFi continues to evolve, it is important for stakeholders to engage in ongoing dialogue to overcome these challenges and leverage the transformative potential of this emerging financial paradigm.

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