A Replicable Framework to Drive Business Model Innovation Enabled by Web3: A Case Study in the Agri-Food Sector

A Replicable Framework to Drive Business Model Innovation Enabled by Web3: A Case Study in the Agrifood Sector

Perboli Guido, Simionato Nadia, and Vandoni Chiara

***Abstract*—This article investigates how Web3 technologies, such as blockchain, NFTs, and the metaverse, can drive business model innovation by enabling new forms of value creation, delivery, and capture. While the strategic potential of Web3 has been widely discussed, there remains a lack of operational tools to guide its implementation in real-world business contexts. To address this gap, we introduce the Web3 value exploitation design model, a step-by-step framework grounded in the GUEST methodology. The model is designed to support engineering managers in assessing Web3 readiness, aligning stakeholders, and developing decentralized business models. The framework is empirically validated through a real-world case study in the agrifood sector, offering actionable insights into how organizations can leverage Web3 to transition from centralized to decentralized, participatory ecosystems. The study contributes both theoretically and practically by bridging the gap between conceptual exploration and structured application of Web3 in business transformation.**

***Managerial Relevance Statement*—The findings of this study offer engineering managers a structured roadmap to guide the adoption of Web3 technologies within their organizations. The Web3 value exploitation design model, grounded in the GUEST methodology and validated through a real-world case study, enables managers to assess readiness, map ecosystem actors, and translate decentralized features, such as blockchain, NFTs, and smart contracts, into business model innovations. The framework outlines concrete steps for designing, implementing, and evaluating Web3-enabled strategies, helping managers move from conceptual interest to operational execution. Finally, it supports the shift toward decentralized, trustless, and participatory ecosystems by providing clear and actionable tools for business transformation.**

***Index Terms*—Business model innovation (BMI), business models (BMs), value transformation, Web3.**

I. Introduction

THE digital ecosystem is undergoing a profound transformation, driven by the advent of Web3 and the rise of the metaverse: two interconnected paradigms that redefine how individuals and organizations interact, create, and extract value in digital spaces. This shift marks a departure from centralized, platform-centric models toward decentralized, user-empowered environments characterized by immersive, interoperable, and trustless systems.

Historically, the evolution of the Web has unfolded in distinct phases. The static, information-sharing logic of Web 1.0 evolved into the participatory, user-generated dynamics of Web 2.0, which fueled the rise of platform-based business models (BMs). These platforms, built on centralized control of data and transactions, leveraged network effects to connect different user groups and became central to firms' digital strategies [1]. However, the advent of blockchain-based ecosystems has introduced a paradigm shift. The Web3 systems enable decentralized governance, enhance transparency, and eliminate intermediaries, thus unlocking new possibilities for value creation, delivery, and capture [2]. As noted by Ahluwalia et al. [3], blockchain introduces a secure and decentralized ledger system that lowers transaction and coordination costs, laying the foundation for more equitable and resilient digital infrastructures.

In parallel, the metaverse is gaining traction as a shared, persistent, and immersive digital environment where physical and virtual realities converge. Coined by Stephenson [4] in snow crash, the term now refers to interconnected virtual spaces where users, represented by avatars, can engage in real-time interaction, commerce, and co-creation. Recent contributions [5] emphasize its potential to transform consumer behavior, service delivery, and innovation practices.

Together, Web3 and the metaverse are driving structural transformations of BMs in several areas, through [6] the following.

1) Decentralized applications (DApps), that facilitate peer-to-peer exchanges and shift value creation to network participants.
2) Token economies and digital currencies, that introduce new mechanisms for value transfer, governance, and engagement. Tokens are now strategic assets, influencing monetization, loyalty, and user participation [7], [8].
3) Decentralized autonomous organizations (DAOs), that create new governance models in order to redistribute authority and reshape managerial roles [9].
4) Ecosystem innovation, that fosters collaborative and trustless platforms where value is co-created across decentralized networks.

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Although growing academic attention has been paid to Web3 technologies from a technical perspective, their implications for business model innovation (BMI) (i.e., how firms create, deliver, and capture value [10]) remain underexplored, especially from a managerial and operational standpoint [11]. While some studies frame Web3 as a form of disruptive or radical innovation [12], the literature still lacks actionable guidance for engineering managers seeking to translate technological opportunities into viable BMs.

Recent contributions [8], [13] have made important strides in this direction by conceptualizing the impact of technologies such as the metaverse, NFTs, and decentralized platforms on BMI. Their work offers valuable strategic frameworks that map how Web3 technologies affect key components of the BM and emphasize the need for a conscious and structured implementation path [8]. However, these frameworks remain at a high-level conceptual stage, outlining what should be considered but not how to implement change effectively. In particular, the literature still lacks a step-by-step, empirically validated methodology that can support engineering managers in operationalizing Web3-enabled BMs in real organizational contexts.

This article addresses that gap by introducing the Web3 value exploitation design model (Web3 VEDM), a prescriptive, sequential framework designed to guide managers through the practical integration of Web3 technologies into BMs. Validated through a real-world case study, the model contributes not only to the theoretical understanding of Web3 transformation but also offers actionable insights for navigating technological complexity, aligning stakeholders, and managing innovation processes across decentralized ecosystems.

This study is guided by two main research objectives as follows.

1) To present a replicable design framework for the strategic exploitation of Web3 technologies across different industries, thereby supporting the transition toward innovative BMs.
2) To examine how the distinctive features of Web3 and the metaverse influence BMI, with particular attention to the dimensions of value creation, value delivery, and value capture.

In doing so, this article advances both theoretical and managerial understanding of Web3-enabled innovation and positions itself as a critical next step in applied research on decentralized BMs.

The rest of this article is organized as follows. Section II presents a literature review organized into three parts: BMI, value creation through Web3 technologies, and real-world Web3 applications. Section III details the GUEST methodology, while Section IV introduces the Web3 VEDM developed in this work. Section V applies this framework to a case study, demonstrating how Web3 enables BMI. Section VI discusses the findings. Finally, Section VII concludes this article.

II. Literature Review

A. BMs and BMI

The BM serves as a blueprint for how organizations generate, deliver and capture value ([14], [15], [16]). A well-defined BM enables firms to systematically analyze cost structures, revenue streams, and profit mechanisms, thereby ensuring long-term market viability [16]. From a strategic perspective, two elements are core in any BM: value creation and value capture. Value creation refers to a company's ability to develop products or services that effectively address enduring customer needs [17], while value capture involves monetizing these offerings and distributing economic benefits among stakeholders—including internal actors (e.g., employees, managers) and external parties (e.g., suppliers, investors, society) ([14], [18]).

BM design must ensure coherence and mutual reinforcement between value creation and value capture to maintain competitive advantage ([10], [15]). Contemporary BMs are undergoing radical transformation driven by digital disruption [19], giving rise to BMI theory. This paradigm posits that companies can discover new "blue oceans" of opportunity by reimagining value creation and capture mechanisms through digital and disruptive technologies and organizational agility [16].

The emergence of Web3 and metaverse technologies represents a disruptive force in this evolutionary trajectory, enabling novel BMI pathways. These technologies challenge traditional value chain configurations through decentralized governance, tokenized incentives, and immersive digital ecosystems. This study contributes to the body of literature by examining how Web3 and metaverse characteristics reshape BMs [20], [21], with particular emphasis on transformations in value creation and capture processes.

B. New Forms of Value Enabled by Web3

The emergence of Web3 technologies and the metaverse is revolutionizing how firms create, deliver, and capture value, introducing new mechanisms that transcend the limitations of traditional centralized systems. These innovations are not merely digital extensions of existing processes, but enablers of entirely new value logics based on decentralization, automation, digital ownership, and immersive interaction.

At the heart of Web3 lies blockchain technology, which underpins platforms built on decentralized governance and distributed data infrastructures. Unlike conventional digital platforms, which rely on centralized control and third-party intermediaries, blockchain systems operate through peer-to-peer consensus mechanisms that allow participants to transact securely and transparently without relying on trust in a central authority ([22], [23], [24]). This disintermediation reduces transaction costs [25] and mitigates structural issues associated with centralized systems, such as opacity, coercion, and disproportionate market control ([22], [26]).

Unlike centralized platforms where transactions are validated by a central authority, blockchain networks rely on distributed consensus mechanisms. Transactions are verified by an independent pool of validators (e.g., Bitcoin miners) who apply peer-to-peer cryptographic protocols to maintain a secure, immutable, and transparent public ledger [24]. This trustless verification system removes the need for third-party oversight, instead aligning validators through cryptographic incentives, such as tradable tokens and cryptocurrencies [27].

Web3 introduces powerful instruments for value orchestration, notably tokenization and smart contracts. Tokenization allows the creation of digital assets that serve as both stores of value and incentive mechanisms. These tokens can be designed to coordinate user behaviors, stimulate participation, and fuel platform growth ([24]). Smart contracts (i.e., self-executing code embedded within the blockchain) enable automated governance, increasing operational efficiency and reducing the need for intermediaries in enforcing agreements ([28], [29]). One of the most transformative aspects of token-based systems is the possibility of fractional ownership, where individuals can own shares of digital (and even physical) assets. This democratizes access to investment opportunities and promotes a more inclusive and equitable economic model ([30]).

Simultaneously, the metaverse expands the boundaries of digital interaction by offering immersive, persistent environments in which users interact, trade, and collaborate through avatars and virtual assets. These experiences drive emotional engagement, support hyperpersonalized customer relationships, and open new opportunities for transactional models based on digital goods, services, and experiences ([31]).

These technologies are not only reshaping the tools firms use but they are fundamentally transforming BMI. The literature shows how Web3 enables companies to redefine their value propositions, reaching new consumer segments, and exploring alternative revenue models. For example, the metaverse allows firms to develop digital product offerings that blend real and virtual elements ([32]). Revenue streams may now emerge from virtual assets, avatar personalization, or token-based memberships.

In organizational terms, Web3 enables firms to reconfigure internal structures and external alliances, these shifts affect not just products or markets, but the very foundations of how firms organize and compete. Together Web3 and metaverse technologies unlock novel forms of value creation that challenge conventional economic and organizational models. They reframe BMs not as static configurations but as fluid, decentralized ecosystems that leverage digital infrastructure, automated coordination, and immersive consumer dynamics. However, despite the emerging body of literature, a comprehensive and operational understanding of how to integrate these technologies into viable BMs and how they can systematically drive BMI, remains limited. This study addresses that gap by contributing a replicable framework that helps managers and policymakers navigate, design, and implement Web3-enabled innovation strategies in practice.

C. Background on Web3, Metaverse, and Current Applications

The transformative potential of Web3 and metaverse technologies is increasingly evident across a wide range of industries, disrupting traditional value chains and enabling new modes of value creation. In the financial and administrative sectors, for example, blockchain-based systems are streamlining documentation and improving compliance mechanisms through immutable ledgers [33]. In parallel, the metaverse is revolutionizing how firms engage with customers, manage teams, and design products by offering immersive, persistent environments where virtual and physical realities converge [5].

Applications span diverse contexts: healthcare is exploring decentralized patient data systems and virtual diagnostics [33], while logistics and supply chains are leveraging virtual twins and smart contracts to reduce costs, optimize routes, and enhance traceability [34], [35]. In manufacturing, the metaverse is being used to integrate cyber–physical systems for remote inspections and smart production [36]. Likewise, sectors such as fashion, tourism, entertainment, education, and mobility [37] are rapidly experimenting with metaverse-based solutions to create immersive consumer experiences and support operational agility [38].

A particularly promising innovation area involves NFTs, which are being used to tokenize physical and digital assets, enhance product authenticity, and strengthen loyalty programs [7], [39]. High-end fashion brands have begun selling tokenized garments in virtual environments, while companies in sports, gaming, and events are using NFTs to enable exclusive digital interactions and create new revenue streams. In supply chains, NFTs help ensure product traceability and authenticity, and in finance, they are being integrated into tokenized asset management and new investment models.

It is thus evident that the metaverse and Web3 technologies are being implemented and analyzed across multiple domains, often with encouraging early outcomes. However, despite this growing interest, the literature still lacks a standardized, actionable methodology to guide how firms can reconfigure value creation, delivery, and capture mechanisms through Web3.

This study addresses this gap by introducing the Web3 VEDM, a replicable design framework for guiding BMI through the strategic adoption of Web3 technologies in diverse industrial contexts. The model is designed to be generalizable across sectors and provides a structured roadmap for implementation. Its validity is supported by a real-world proof of concept (PoC) case study, developed within the Nous project funded by both national and European Union innovation programs [40], and the Food Metaverse project funded by the Italian Ministry of University and Research [41].

III. Methodology

This research adopts a case study-based methodological approach to explore the transformative role of Web3 technologies in BMI. This approach enables an in-depth investigation of a real-world implementation, capturing both the complexity and the managerial relevance of Web3 integration. It is particularly well-suited for emerging and undertheorized phenomena, where context-sensitive exploration is needed to generate new knowledge and support practical application.

The core contribution of this study is the Web3 VEDM that was developed through a rigorous design process grounded in the GUEST methodology [42]. The GUEST methodology is a structured methodological framework that enables the systematic modeling of BMs under technological change (further details given in the section: The GUEST methodology). Its adoption in this research offers the following.

1) *Technological relevance:* GUEST has been applied in various digital transformation contexts and is specifically

designed to map how emerging technologies affect value creation, delivery, and capture.
2) *Structured and modular design:* It provides a comprehensive and flexible architecture that supports both analysis and communication of the logic underpinning tech-enabled BMs.
3) *Standardization and usability:* The methodology incorporates well-known tools and methods from the literature, allowing seamless transitions between phases and minimizing cognitive load.
4) *Transferability:* Its structure supports the identification of replicable patterns across domains, making it generalizable beyond the specific case.

To evaluate and validate the proposed framework, we implemented it within a real-world PoC: the WineMetaverse platform, a DApp operating in the metaverse and Web3-enabled digital commerce space. This PoC was developed as part of an innovation project funded by both National and European Union programs ([40], [41]). The PoC and the methodology have been validated by experts from the companies and the entities in the projects, ensuring that the framework was tested under realistic technological, organizational, and financial constraints.

The combination of a structured design methodology (GUEST) and a funded, real-world PoC allows us to ensure both scientific rigor in the framework's construction and empirical robustness in its evaluation, thereby reducing the risk of purely conceptual or speculative conclusions.

A. GUEST Methodology

The GUEST methodology, adopted in this study to develop the Web3 VEDM, was developed by a research group affiliated with the Politecnico di Torino ([42], [43], [44]). Originally conceived to support innovation and implementation in complex digital ecosystems, GUEST has been successfully applied in diverse sectors such as automotive, information technology, and telecommunications, where it has helped organizations articulate clear value propositions, define stakeholder roles, and structure technological deployment ([45], [46], [47], [48]).

Functioning as both a conceptual and operational framework, GUEST manages the lifecycle from idea conception to practical implementation, providing a shared structure through which stakeholders can collaboratively express their visions, challenges, and opportunities. This shared framework is especially useful in decentralized contexts, where alignment between actors and technological layers is critical.

The methodology unfolds across five structured phases, each representing a distinct step in the digital BM development process as follows.

1) *GO:* Identify key stakeholders and define their respective needs and benefits within the system.
2) *UNIFORM:* Describe the platform's architecture and core use cases identifying the value proposition, ensuring functional clarity and coherence.
3) *EVALUATE:* Assess the technological infrastructure, focusing on interoperability, scalability, and security.
4) *SOLVE:* Define the detailed solution design, including technical and organizational elements necessary for implementation.
5) *TEST:* Establish and apply key performance indicators (KPIs) to evaluate performance, impact, and sustainability.

Beyond its procedural utility, the GUEST methodology is grounded in two principal theoretical frameworks as follows.

1) Digital transformation and technology adoption models such as those proposed by Tornatzky and Fleischer [49] and the unified theory of acceptance and use of technology by Venkatesh et al. [50], which emphasize structured approaches to integrating emerging technologies.
2) Sociotechnical systems theory, particularly in the context of decentralized architectures and blockchain ecosystems, which provides the conceptual underpinning for how technological, human, and organizational components co-evolve [42].

In the context of this research, GUEST is instrumental not only in analyzing the BM transformation driven by Web3 and the metaverse but also in developing a robust and replicable framework that can support other organizations seeking to engage with decentralized technologies across various sectors.

IV. Theoretical Framework—Value Exploitation Design Model

The GUEST methodology aspects introduced in Section III are applied to develop the Web3 VEDM. This model represents a holistic, step-by-step methodology aimed at supporting the structured implementation of Web3-enabled BMs across different organizational contexts. Following its development, the Web3 VEDM is applied to the case study introduced in Section V, serving both as a practical testbed and a validation mechanism for the model's applicability in a real-world context.

Fig. 1 illustrates the sequential structure of the Web3 VEDM framework. Each of the phases will be described in detail in the sections that follow.

1) *Step 1—Stakeholder mapping and ecosystem framing:* This foundational step identifies the key stakeholders involved in the decentralized ecosystem (such as end users, validators/miners, developers, wallet providers, content creators, and community managers) and analyzes their specific roles, motivations, and value expectations. This ecosystem-centric perspective ensures that subsequent BM design decisions are anchored in multiactor value alignment, a central principle in Web3 environments where value is co-created across distributed networks.
2) *Step 2—Web3-enabled value dimensions:* In this step, the framework articulates how Web3 technologies enable novel mechanisms of value creation, delivery, and capture. This step is essential to reframe traditional business logics in light of the affordances introduced by blockchain, NFTs, DAOs, and the metaverse. Building on recent literature ([5], [51]), it identifies six core dimensions of Web3-enabled value as follows.
   a) *Decentralized governance and trust:* Web3 BMs fundamentally rely on decentralized governance structures

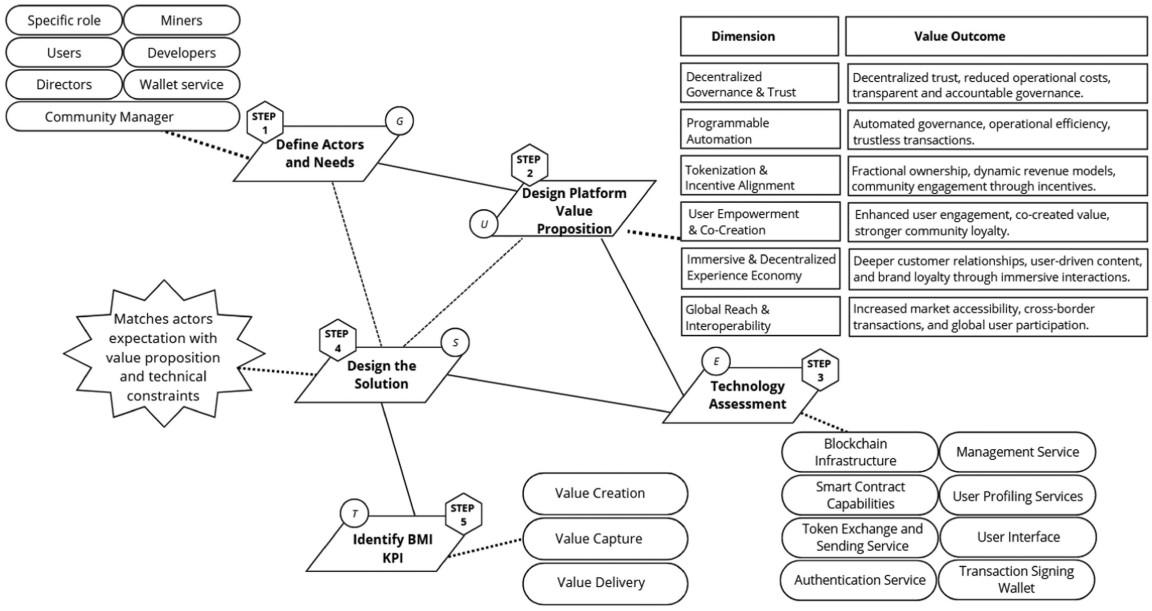

Fig. 1. Web3 value exploitation design model.

enabled by DAOs and cryptographic consensus mechanisms. By eliminating intermediaries, these models distribute control and decision-making authority among stakeholders, fostering a more democratic and transparent environment. Cryptographic validation mechanisms, such as blockchain consensus protocols, ensure that transactions and decisions are verified without the need for central oversight. This structure not only enhances decentralized trust but also significantly reduces operational costs by minimizing the role of traditional gatekeepers. As a result, businesses can build ecosystems where transparency, user autonomy, and collective ownership become core attributes, strengthening both user engagement and community participation.

b) *Programmable automation:* One of the defining features of Web3 is the ability to embed programmable logic into digital agreements using smart contracts. These self-executing contracts automatically enforce terms and conditions when predefined criteria are met, reducing the need for manual intervention and third-party enforcement. This capability supports automated governance, allowing business processes to become more efficient, secure, and reliable. Smart contracts facilitate trustless interactions by enabling automated payments, digital asset transfers, and even complex multistep transactions without human oversight. This dimension is crucial for applications where reliability and efficiency are paramount, such as decentralized finance (DeFi), supply chain management, and automated service delivery.

c) *Tokenization and incentive alignment:* Web3 technologies allow for the tokenization of both physical and digital assets, transforming them into unique, tradable tokens, such as nonfungible token NFTs and fungible utility tokens. Tokenization enables fractional ownership, where stakeholders can own parts of an asset, such as a share of a vineyard or a digital collectible. In addition, token incentives drive user engagement and participation by rewarding actions, such as community contributions, voting, or staking. This dimension not only diversifies revenue streams but also aligns stakeholder interests through incentive mechanisms. Businesses can leverage this model to create dynamic ecosystems where users are actively involved and financially motivated, fostering sustained growth and loyalty.

d) *User empowerment and co-creation:* In traditional BMs, users often remain passive consumers. In contrast, Web3 places users at the heart of value creation, transforming them into active co-creators. This dimension emphasizes user-centric approaches where individuals not only consume content but also produce, modify, and share it. Through decentralized content platforms, creators retain ownership of their outputs, leading to democratized value creation. By enabling users to actively shape product offerings and community initiatives, businesses build stronger community loyalty and foster a sense of collective ownership. This shift from passive to active participation is pivotal in forming sustainable and user-driven ecosystems.

e) *Immersive and decentralized experience economy:* The metaverse and extended reality (XR) technologies are central to creating immersive experiences within Web3 ecosystems. These virtual environments enable users to engage emotionally and socially, fostering deeper connections with brands and communities. Unlike traditional digital platforms, the immersive economy allows for experiential engagement, where users can explore, interact, and co-create in virtual spaces. Businesses leverage this dimension by offering virtual experiences

tied to physical products, such as digital wine tastings linked to NFT wine bottles. This integration of physical and digital value elevates user experience (UX) and offers unique ways to build brand identity, merging real-world and virtual interactions.

f) *Global reach and interoperability:* One of the most profound impacts of Web3 technologies is the elimination of geographical and institutional barriers. Blockchain-based systems operate on interoperable networks that transcend traditional market boundaries, allowing businesses to access global markets without requiring complex infrastructure. The borderless nature of DApps means that user bases are inherently international, promoting cross-border transactions and community-building on a global scale. This dimension empowers businesses to scale rapidly, tapping into diverse user bases and previously unreachable markets. The inherent interoperability of blockchain platforms also supports seamless interaction between various digital ecosystems, fostering innovation and collaboration across industries.

These dimensions are aligned with the forms of value creation identified in the literature review, underscoring how Web3 technologies and the metaverse fundamentally reshape BMs and serve as enablers of BMI.

3) *Step 3—Infrastructure alignment and feasibility assessment:* This technical evaluation aligns the desired value propositions with the necessary digital infrastructure components, including blockchain protocols, smart contract modules, authentication and identity systems, wallet integrations, and token exchange services. The objective is to ensure that the BM is technologically viable, scalable, and secure, mitigating implementation risks and establishing a strong foundation for innovation.
4) *Step 4—Solution architecture and BM design:* Synthesizing the information gathered from stakeholders, value analysis, and infrastructure assessment, this step defines the architectural and functional design of the Web3-enabled BM, ensuring its consistency.
5) Step 5: The final step evaluates the transformative potential of the designed model by identifying and proposing KPIs across the three BMI dimensions: Value creation (e.g., user engagement, DAO activity), value delivery (e.g., service reliability, traceability metrics), and value capture (e.g., token economy revenues, NFT transaction volumes). This step ensures that the Web3-enabled BM can be monitored, refined, and scaled based on measurable outcomes, supporting strategic alignment and ongoing innovation.

This structured evaluation ensures that the innovation driven by Web3 technologies can be measured, validated, and replicated over time.

V. Case Study: WineMetaverse Platform

To evaluate and demonstrate the applicability of the Web3 VEDM, this study applies it to a real-world case study: the WineMetaverse platform, a decentralized digital ecosystem operating in the wine and agrifood industry. This platform illustrates how Web3 technologies can be strategically integrated into traditional sectors, enabling new value propositions, immersive consumer experiences, and more equitable forms of market participation.

At its core, the WineMetaverse platform enables members of the global wine community to interact, transact, and co-create value in a highly personalized and immersive digital environment. Users can explore the blockchain to gain a transparent, traceable view of the wine production process, while purchasing a variety of products, experiences, and NFTs. The platform turns wine consumption into a journey of discovery, education, and community engagement.

A defining characteristic of the WineMetaverse platform is its fully customizable user interface (UI), which adapts to individual preferences using advanced profiling and behavioral analytics. By aligning the preferences and behaviors of users with the offerings of producers (referred to as "attractors"), the platform fosters mutual value creation. This targeted approach enhances user engagement and helps attractors reach audiences that are more closely aligned with their products and services.

The platform's vision extends beyond commerce: it aims to cultivate a conscious and sustainable approach to wine production and consumption, while serving as a novel marketing and educational channel for the global agrifood industry. Through immersive technologies and blockchain integration, the WineMetaverse educates users about environmental practices, regional heritage, and responsible consumption.

A central innovation lies in the platform's ability to digitally tokenize and exchange nonliquid assets, such as territories, expertise, and experiences, thereby making them accessible to a wider audience. This opens new avenues for market interaction, investment, and cross-sector collaboration. In the long term, the platform aspires to become a responsive ecosystem that not only facilitates transactions but also measures and adapts to the impacts of changes, including policy shifts, new stakeholder integration, and product evolution.

This initiative constitutes a PoC conducted in the Langhe region of Piedmont, as part of a broader national innovation project funded by the Italian Ministry of University and Research. The project "Food Metaverse" (Innovative Technology Infrastructure, Project No. ITEC0000025), aims to build a foundational infrastructure for the Italian food metaverse [41]. The platform also incorporates the technological outcomes of the NOUS Project, funded by the European Union under the Horizon Europe programme, which focuses on developing cloud-native, edge-enabled, and interoperable data spaces for next-generation Web3 services [40].

In the following sections, the Web3 VEDM framework is systematically applied to the WineMetaverse case study to illustrate how decentralized technologies can be strategically integrated into BMI.

A. Step 1—Define Actors and Needs (GO)

The initial stage involves pinpointing the key players engaged in the process, their roles, benefits, challenges, and needs in terms of generating gains and alleviating challenges.

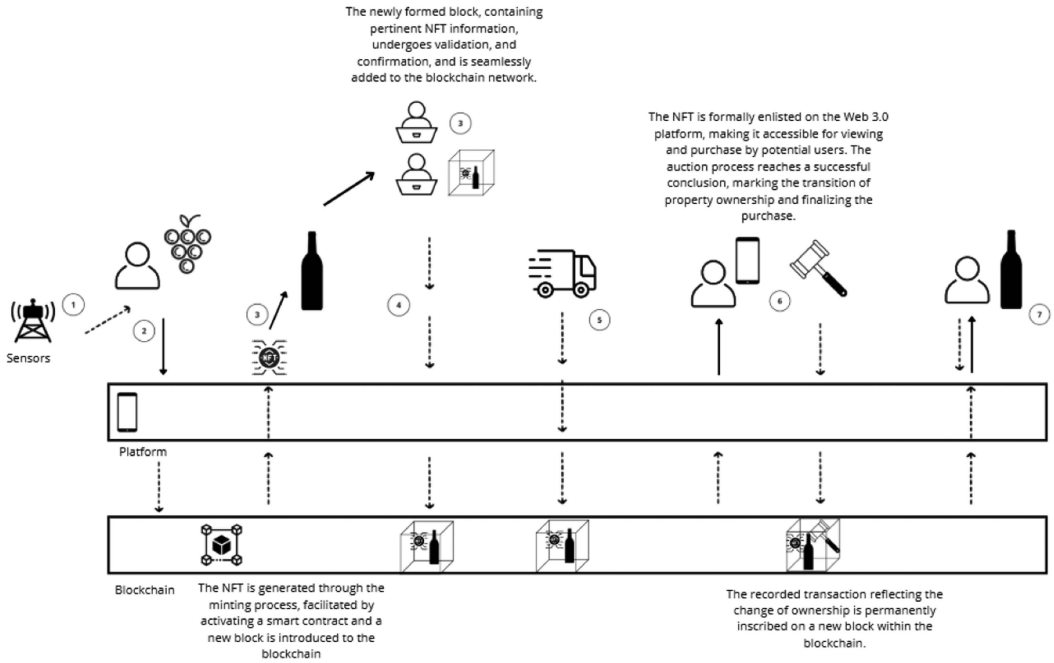

Fig. 2. WineMetaverse platform use case.

The main identified actors in the Web3 platform are classified into two distinct subgroups: Web3-enabling roles and platform-specific stakeholders.

Among Web3 roles.

1) Wallet services ensure secure token storage and transactions.
2) Network nodes/miners validate blockchain operations and maintain network security.
3) Blockchain/smart contract developers design decentralized functionalities and automate key platform processes [52].
4) Community managers foster user engagement and support the adoption of Web3 tools.

For the WineMetaverse platform, four core stakeholder roles emerge as follows.

1) Platform managers (PMs) as directors of the platform, define access roles, and ensure operational and regulatory alignment.
2) Mappers (M) as a specific platform role, evaluate attractor value propositions, functioning as neutral internal auditors.
3) Attractors (A) as a specific platform role, e.g., wineries, restaurants—offer products, experiences, and NFTs representing the cultural and sensory richness of the Langhe territory.
4) Users (U) are wine enthusiasts seeking immersive and personalized purchasing journeys through blockchain transparency and NFT engagement.

To assess value generation, we consider the needs and benefits for key actors adopting the platform.

1) Attractors benefit from enhanced visibility, direct engagement with customers, and product authenticity guaranteed via blockchain.
2) Users enjoy personalized experiences, NFT transactions, virtual tours, and detailed, traceable information on wine production, elevating satisfaction and trust.

B. Step 2—Design Platform Value Proposition (UNIFORM)

The second stage articulates how the Web3 platform generates value. The WineMetaverse platform represents a pioneering implementation of Web3 technologies in the agri-food sector; it uses NFTs and blockchain to transform how value is created, exchanged, and experienced. The system is built around the use of a fungible token (T), enabling interactions, purchases, and exchanges within the platform and with fiat currencies. The NFT infrastructure backed by a programmable blockchain can simultaneously deliver product authenticity, personalized experiences, economic incentives, and community engagement within a transparent and self-sustaining ecosystem.

Fig. 2 illustrates the integrated use case, which can be summarized as follows.

1) The process begins at the vineyard, where data about grape origin, varietals, vintage, and agricultural practices is collected via IoT-enabled sensors.
2) Producers upload sensor data to the platform, including information about production methods, chemical use, and regional characteristics. This data will form the metadata of the digital asset associated with the real asset.
3) An NFT is minted for each wine bottle or wine-related experience.
   a) NFT related to the tokenization of the wine bottle in order to allow the traceability and the collection of information from sensors and ensuring the virtual existence of the bottle in the metaverse through blockchain.

   b) NFT related to wine-experience as discounts at local restaurants or hotels with the purchase of a bottle of wine or access to exclusive experiences, such as virtual guided tours of wineries and tastings.

   The smart contract automatically governs ownership, rights to access services (e.g., discounts, virtual tours or tastings), and transaction conditions.
4) Each physical bottle is tagged with a scannable label (QR/NFC), linking it to its digital asset on the blockchain. This tag allows for traceability across bottling, packaging, logistics, and sale.
5) As the wine moves through the supply chain, each stage (logistics, storage, retail) is recorded on-chain. This guarantees immutability and authenticity, while creating a transparent and verifiable product history.
6) Users, based on their profile preferences, receive recommendations and can purchase all type of NFTs using T tokens. Transactions are secured and processed via the platform interface.
7) Postpurchase, users can verify ownership and authenticity by scanning the bottle's tag. NFT ownership also unlocks access to various digital or physical services—restaurant offers, vineyard shares, and digital collectibles.

This use case enables new forms of value across production, distribution, and consumption as follows.

1) *Decentralized governance and trust:* The platform fosters decentralized trust by using blockchain to ensure transparency and secure record-keeping. Data from IoT sensors (such as grape origin and production methods) is uploaded to the blockchain, creating verifiable digital assets (NFTs) linked to physical wine bottles. This process eliminates intermediaries, builds consumer confidence, and guarantees authenticity through immutable records.
2) *Programmable automation:* Smart contracts are integral to the platform, automating transactions and granting access to services without manual intervention. For example, purchasing a wine NFT automatically triggers related benefits, such as discounts at local restaurants or access to virtual tours. This automation reduces administrative overhead and ensures reliable service delivery.
3) *Tokenization and incentive alignment:* The platform uses fungible tokens (T) to facilitate transactions, allowing users to purchase NFTs representing wine bottles or wine-related experiences. Token incentives drive engagement, while NFTs can also denote fractional ownership of vineyards, creating new monetization opportunities for producers and investors.
4) *User empowerment and co-creation:* Users are not just consumers but active participants in the ecosystem. They can customize their profiles to receive tailored NFT recommendations and access community-driven experiences. Owning a wine NFT provides exclusive rights (e.g., event access), making users feel more connected and invested in the platform's success.
5) *Immersive and decentralized experience economy:* The platform blends physical and digital interactions through metaverse experiences. Users can attend virtual tastings, explore vineyards digitally, and access unique content linked to their NFT assets. This immersive approach enhances emotional engagement and strengthens the connection between consumers and wine producers.
6) *Global reach and interoperability:* By leveraging blockchain's borderless nature, the platform connects local wine producers with a global audience. Users from any location can buy, sell, and trade NFTs, accessing exclusive wine experiences and products regardless of their physical location, significantly expanding the customer base.

This integrated system transforms how wine is valued, sold, and consumed, combining cultural heritage with technological transparency. It establishes a replicable Web3 framework that elevates product identity, consumer trust, and sustainable BMI in the agrifood industry.

C. Step 3—Technology Assessment (EVALUATE)

During this step, the primary objective is to identify and define the technological infrastructure required to support the functionalities and value delivery mechanisms previously outlined in step 2. Building on the identified value dimensions, this phase translates conceptual requirements into a concrete technical architecture for the Web3 WineMetaverse platform. The resulting infrastructure includes the selection and integration of core components, such as blockchain networks, smart contracts, token services, and user authentication systems, ensuring alignment between technological feasibility and strategic intent.

The WineMetaverse platform adopts a hybrid architecture that combines a private ledger with a public blockchain to ensure both efficiency and transparency (see Fig. 3).

Initially, all operational and transactional data is managed within a private ledger environment, which may utilize distributed ledger technologies or trusted centralized solutions, such as Immudb [53]. To guarantee public auditability and immutable verification, a notarization service periodically records a state identifier (analogous to a Merkle root hash) on a public blockchain through a smart contract. This hybrid approach ensures the platform balances data control and scalability with transparency and trustlessness, leveraging the strengths of both private and public blockchain systems.

The architecture is composed of several core components as follows.

1) *Authentication database and service:* Manages user identities and authentication, ensuring secure access via user wallets while supporting sovereign identity principles.
2) *Ledger:* The central component that maintains all operational records, including profiles, transactions, system events, and metadata associated with NFTs.
3) *Service layer:* Comprising five key services as follows.
   a) *Profiling service:* Handles user preference analysis and personalized matching with attractors.
   b) *System service:* Manages internal system logic and communication between modules.
   c) *Metaterritorio service:* Orchestrates the mapping and scoring of attractors within the digital territory.

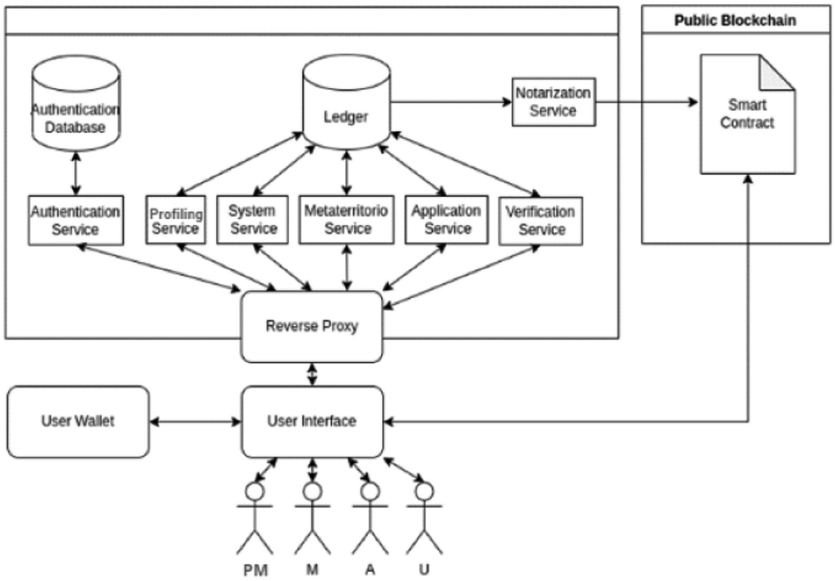

Fig. 3. System architecture: data are written to a private ledger. At regular intervals, an identifier of the state of the ledger (Merkle tree root hash) is written to a public blockchain.

d) *Application service:* Supports external application integrations and advanced functionalities.
e) *Verification service:* Manages verification of digital assets, identities, and production processes through the platform.

4) *Reverse proxy:* Acts as a middleware, managing traffic between the internal services and the external UI, ensuring security and load balancing.
5) *UI:* Provides the single point of interaction for all actors-PMs, mappers (M), attractors (A), and users (U)—facilitating access to services, transactions, and personalized experiences.
6) *User wallet integration:* Each actor's wallet is connected to the platform to handle authentication, asset management, and NFT-based interactions.
7) *Notarization and public blockchain interaction:* The notarization service periodically pushes data state proofs to a public blockchain, ensuring that the private ledger's integrity and historical states are auditable externally via smart contracts.

This modular and layered architecture ensures scalability, security, interoperability, and future-proof adaptability, aligning with the fundamental principles of Web3 ecosystems. It empowers decentralized community interaction while maintaining robust data sovereignty and auditability.

D. Step 4—Design the Solution (SOLVE)

This step is dedicated to aligning the expectations of the actors (step 1), with the value proposition of the solution (step 2) and taking into account the technical constraints that emerged during the system design (step 3). The step 4 represents the moment in which the foundational elements necessary to realize the solution are examined, including the identification of decision makers, critical aspects and resources and decision needed for successful implementation. To support this analysis, the Solution Canvas tool has been adopted (see Fig. 4).

1) Solution Canvas:

a) The governance of the project is envisioned to involve local decision-makers, notably some municipalities of the Langhe region and wine consortia, whose primary goal is to promote the adoption of the WineMetaverse platform and Web3 technologies to strengthen engagement with the territory and enhance the visibility of the wine sector.
b) The platform users consist of the previously identified categories: Attractors (wine producers, restaurants), end-users (wine enthusiasts), along with emerging professional roles enabled by Web3 adoption.
c) From a relational standpoint, PMs act as intermediaries between attractors and institutional stakeholders (consortia and municipalities), facilitating communication and governance. Institutions, in turn, interact with attractors to support the territory's promotional initiatives.
d) The implementation strategy envisages a pilot project, launched by selected municipalities or consortia, involving a limited number of producers and distributors who voluntarily adopt the WineMetaverse platform. This pilot phase is crucial for demonstrating tangible benefits, such as increased brand exposure, improved direct sales, and heightened consumer participation.
e) The strategic objectives underpinning the adoption of Web3 technologies in this solution are summarized as follows.
   i) *Increased visibility:* Offering producers a platform to reach a wider, global user base.
   ii) *Enhanced interaction:* Allowing users to directly engage with producers through booking experiences or purchasing NFTs.

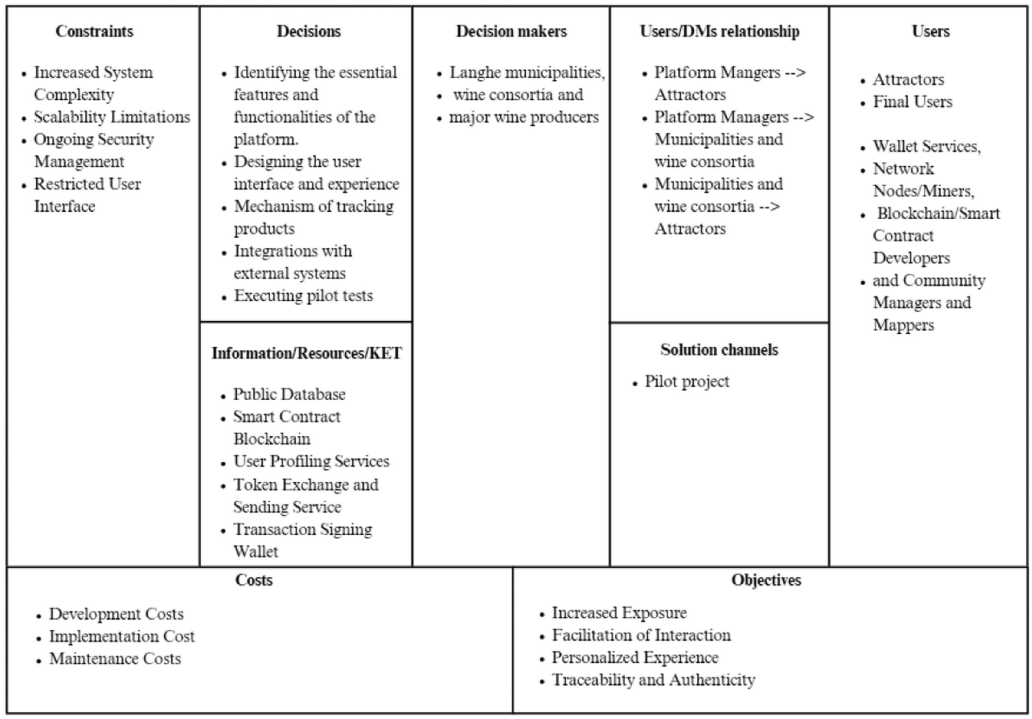

Fig. 4. Solution canvas.

iii) *Personalized experiences:* Providing a tailored UX based on individual preferences and behaviors.
iv) *Traceability and authenticity:* Ensuring verified product origins and production details through blockchain and IoT sensors.

f) Crucial decisions for the solution's development include the definition of core platform features such as user profiling mechanisms, interactive UIs, the NFT marketplace, transaction processing systems, and secure data management. Special attention must be paid to the UX, ensuring accessibility and ease of use for all actor categories. Furthermore, integration mechanisms with external systems and planning for pilot validations are essential for confirming the platform's robustness before full-scale deployment.
g) The effective realization of the platform requires key resources, previously analyzed in the architectural design phase, such as the following.
   i) A public database for storing nonsensitive system data.
   ii) A blockchain infrastructure supporting smart contract execution and token management.
   iii) Advanced profiling services for user customization.
   iv) Secure wallet services for transaction signing and asset custody.
h) However, several constraints must be carefully managed as follows.
   i) *System complexity:* The hybrid architecture (private ledger + public blockchain) increases development and operational complexity.
   ii) *Scalability limits:* While periodic anchoring to the public blockchain mitigates costs, potential bottlenecks in ledger performance must be anticipated as user volume grows.
   iii) *Security challenges:* Maintaining high security standards across two infrastructures demands continuous monitoring and upgrading.
   iv) *Interface rigidity:* A fixed UI may limit customization and accessibility options for different user profiles.
i) The cost structure related to the project is divided into three major categories as follows.
   i) *Development costs:* Including architectural design, software engineering, blockchain smart contract creation, and the integration of authentication and management services.
   ii) *Implementation costs:* Covering staff training, recruitment of cybersecurity experts, and the development of the platform by dedicated teams (including full-stack developers and blockchain engineers).
   iii) *Maintenance costs:* Ongoing expenses for platform updates, security monitoring, and database and blockchain node management.

E. Step 5—Identify BMI KPIs (TEST)

In the final step, we identify a set of KPIs specifically designed to measure how Web3 technologies, as implemented in the WineMetaverse platform, generate and capture value for stakeholders, while driving BMI. These indicators serve not only to monitor performance but also to trace structural transformations in how value is created, delivered and captured.

The selected KPIs link core technological features, such as tokenization, smart contracts, traceability, and incentive

Web 3.0 Feature	KPI	BM dimension	Indicator of Innovation
Tokenization (NFTs)	% Revenue from Tokenized Assets	Value Capture	Enables fractional ownership, new revenue streams, and democratized access to assets.
Smart Contracts	% Transactions Executed via Smart Contracts	Value Creation	Reduces manual intervention, ensures automatic fulfillment, and enables trustless service management.
Token-based Incentive Mechanis	NFT Retention Rate	Value Creation	Encourages community involvement, fosters brand loyalty, and supports continuous ecosystem growth.
	Token Redemption Rate (Loyalty / Staking)	Value Capture	
Traceability	% Product Data On-Chain	Value Creation / Value Delivery	Enhances consumer trust, supports product authenticity, and facilitates premium market positioning.
Community Engagement via Metaverse	% Active Users Participating in Metaverse Events	Value Creation	Builds a loyal user base, enhances immersive experiences, and supports co-created content.

Fig. 5. KPI table.

mechanisms, to measurable impacts on the BM dimensions: value creation, value delivery and value capture.

Fig. 5 presents a synthesized mapping of Web3 features with their corresponding KPIs, the specific BMI dimension affected, and the innovation implications. These KPIs allow for a data-driven evaluation of the extent to which the platform's architecture supports new mechanisms of disintermediation, transparency, automation, and user engagement, all hallmarks of a decentralized and trustless economic model.

The table outlines five representative KPIs selected to evaluate the impact of Web3 technologies on BMI within the WineMetaverse platform. Each KPI is directly associated with a core feature of the platform, such as tokenization, smart contracts, incentive mechanisms, traceability, and metaverse-based community engagement, and is mapped to a corresponding dimension of the BM: value creation, value delivery, and value capture.

For example, tokenization (NFTs) drives the monetization of digital assets, and the innovation in value capture is measured through the percentage of revenue from tokenized assets. This KPI reflects how the platform leverages digital ownership to create new revenue streams and democratize asset access. Similarly, smart contracts automate processes, enhancing value creation by reducing manual intervention. The percentage of transactions executed via smart contracts serves as a metric to estimate the platform's ability to streamline service management and improve operational efficiency.

User engagement and loyalty, vital components of value creation, are captured through KPIs such as the NFT retention rate and the token redemption rate (loyalty/staking). These indicators demonstrate how token-based incentives foster brand loyalty, encourage continuous user participation, and support ecosystem growth. In addition, traceability plays a crucial role in ensuring product authenticity and building consumer trust. The percentage of product data recorded on-chain indicates the degree of transparency achieved, which also supports premium market positioning by providing verifiable product history. Finally, the community engagement via metaverse feature is measured through the percentage of active users participating in metaverse events. This KPI highlights the platform's success in creating immersive UXs and fostering a loyal community, reinforcing the co-creation aspect inherent to Web3 BMs.

These KPIs offer a holistic assessment of how Web3 technologies transform BMs through decentralized interactions, automated governance, and new economic paradigms, providing measurable insights into their role as catalysts for BMI.

VI. Discussion

This study builds on existing literature that highlights the transformative potential of technologies such as blockchain, smart contracts, and tokenization in reshaping traditional BMs across various sectors ([54], [55], [56], [57]). It moves beyond conceptual discussions by introducing a structured and actionable framework, the Web3 VEDM, which supports the integration of Web3 capabilities into both existing and emerging business architectures in a systematic way. Grounded in the GUEST methodology and validated through a real-world PoC, the Web3 VEDM represents a practical and replicable roadmap to unlock the transformative potential of decentralized technologies.

From a theoretical standpoint, the research makes two main contributions. First, it develops a taxonomy of six interrelated value dimensions that explain how Web3 technologies and the metaverse reshape the way firms create, deliver, and capture value, thereby enabling BMI as follows.

1) *Decentralized governance and trust:* Web3 BMs are anchored in distributed governance mechanisms, such as DAOs and consensus protocols, which reduce reliance on centralized intermediaries, enhance transparency, and allocate decision-making power among stakeholders. This fosters collective ownership, trust, and lower operational friction.
2) *Programmable automation:* Enabled by smart contracts, this dimension supports self-executing business logic that automates transactions and processes. It minimizes the need for human or third-party intervention, ensuring efficiency, security, and scalability across domains, such as DeFi, logistics, and services.
3) *Tokenization and incentive alignment:* Web3 platforms transform both tangible and intangible assets into fungible or NFTs, allowing for fractional ownership and the design of incentive systems. This not only unlocks new

monetization channels but also aligns stakeholder motivations through token-based rewards and governance rights.

4) *User empowerment and co-creation:* Moving beyond the passive roles assigned to consumers in Web 2.0 models, Web3 empowers users to co-create content, shape services, and participate in decision-making processes. This fosters deeper engagement and strengthens network effects rooted in community-driven value generation.
5) *Immersive and decentralized experience economy:* Through XR and metaverse technologies, businesses can offer fully immersive experiences that blend physical and digital touchpoints. This dimension redefines customer journeys and supports innovative branding and service models grounded in emotional engagement.
6) *Global reach and interoperability:* Web3's borderless infrastructure allows for seamless integration across digital ecosystems and geographies. Interoperable platforms facilitate international collaborations, unlocking access to global user bases and decentralized innovation networks.

Collectively, these six value dimensions clarify not only what kinds of value are created in Web3 environments but also how this value is orchestrated, distributed, and sustained through novel technical and organizational mechanisms. These dimensions synthesize the distinctive features of decentralized ecosystems into a coherent interpretive model, offering a structured lens to understand how these technologies disrupt traditional, centralized business logic and enable new forms of value creation based on trustless interaction, programmable coordination, user participation, and global scalability.

Second, this study advances the understanding of BMI by contributing a process-based framework that operationalizes how Web3 technologies can reshape the core elements of BMs (value creation, value delivery, and value capture) [58], [59]. Unlike much of the prior literature, which often remains at a conceptual or high-level strategic view, the Web3 VEDM offers a structured and actionable methodology that guides firms from technological exploration to implementation and measurement.

The five-step architecture of the Web3 VEDM enables organizations to identify relevant Web3 features and systematically translate them into viable BM configurations. This structured process supports both strategic alignment and operational feasibility, offering clear decision points and evaluation metrics throughout the transformation journey.

The application of the model to the WineMetaverse platform case study demonstrates its practical relevance, particularly in industries traditionally resistant to digital disruption, such as agrifood and wine production. In this case, value creation is redefined through user co-creation and token-based incentives that transform consumers into active participants in the ecosystem. Value delivery is enabled by immersive technologies and blockchain infrastructure, which together ensure traceability, personalization, and trustless interaction. Meanwhile, value capture evolves through decentralized monetization mechanisms that distribute economic and governance power among stakeholders.

The solution canvas developed as part of the Web3 VEDM articulates a novel value proposition based on disintermediation and ecosystemic collaboration, moving away from hierarchical coordination toward distributed, stakeholder-driven systems. Features such as decentralized trust, automated verification, and digital ownership form the backbone of these new models, allowing firms to build loyalty-based ecosystems where value is co-produced and equitably shared.

Through empirical validation and performance indicators, the Web3 VEDM demonstrates that Web3 technologies do not merely optimize existing BMs, but actively drive BMI by enabling a fundamental rethinking of how value is created, delivered, and captured in decentralized and user-centric ecosystems

Beyond its theoretical contributions, the Web3 VEDM provides strong practical value, especially for the field of engineering management [8], [13]. The framework functions as a step-by-step, empirically validated methodology that enables engineering managers to operationalize Web3-enabled BMs within real organizational contexts. It serves as a strategic guide that bridges the gap between technological vision and concrete execution, helping organizations navigate the complexities of decentralization, tokenization, and immersive digital experiences.

From a managerial perspective, the Web3 VEDM offers clear insights for building smart, sustainable, and resilient business architectures. It illustrates how firms can evolve from centralized control toward decentralized ecosystems, where users are empowered as co-creators and stakeholders are aligned through programmable incentives, such as tokens and smart contracts. In addition, the framework highlights the role of immersive technologies, such as the metaverse in expanding value propositions, enabling new channels for customer engagement, personalization, and brand differentiation.

For engineering managers, the model provides a replicable process to assess organizational readiness, define digital strategies, implement enabling technologies, and evaluate outcomes through performance indicators. Its structured approach ensures that innovation is not only technically feasible but also aligned with business objectives and stakeholder needs.

This article contributes both to the academic literature and to managerial practice. Theoretically, it advances the understanding of how Web3 technologies drive BMI; practically, it offers a validated and actionable framework to support engineering managers and organizations in implementing these transformations in real-world settings. Considering the practical implications of the framework, we tested the acceptance and the robustness of the methodology by a series of dedicated workshops with a panel of experts. They have been selected from the companies and the research entities involved in the projects Nous and Food Metaverse projects. The experts include project managers, researchers, and on-field practitioners from 11 countries and 30 partners through a series of dedicated workshops, showing a high acceptance and understanding level of the framework and a willingness to include it in the companies' workflows. However, several challenges and limitations must be acknowledged. First, the complexity of blockchain interactions, the necessity for digital wallets, and limited public awareness remain significant adoption barriers. These issues are compounded by the digital divide, which risks excluding users with limited infrastructure or digital literacy, particularly in rural or underresourced settings.

Second, scalability concerns persist. Although hybrid architectures offer short-term relief, higher transaction volumes can introduce performance inefficiencies and escalate operational costs.

Third, regulatory uncertainty is a pressing issue. Fragmented and evolving legal frameworks surrounding token classification, data protection, and consumer rights create compliance ambiguities, particularly for highly regulated sectors.

Despite these challenges, the Web3 VEDM offers a foundational structure for rethinking BMI in the decentralized era. It not only bridges theoretical and practical dimensions but also provides a platform for future exploration of how emerging technologies can sustainably and equitably reshape economic ecosystems.

VII. Conclusion

This study explores the transformation of BMs driven by Web3 technologies and the metaverse, analyzing how these decentralized and immersive paradigms are redefining value creation, delivery, and capture. To systematically address this transformation, we introduce the Web3 VEDM, a structured, step-by-step framework grounded in the GUEST methodology, which ensures methodological rigor through its established use in digital transformation research [45], [46], [47], [48]. The framework's validity is empirically demonstrated through its application to the WineMetaverse platform, a real-world decentralized ecosystem in the agrifood and wine sector. This case study confirms the framework's operational relevance and robustness, showing how organizations can systematically implement Web3-enabled BMI in practice.

While existing research has recognized the disruptive potential of technologies such as blockchain and smart contracts ([54], [56], [57]), much of the literature remains focused on technical aspects or high-level strategic considerations. Recent studies by Bartoli et al. and Fasano et al. [8], [13] have begun to bridge this gap by highlighting how Web3 technologies can influence BMI. However, these contributions often remain conceptual in nature and lack actionable guidance for implementation. As such, there is still a limited empirical and operational understanding of how Web3 technologies can be systematically integrated into viable BMs. To address this gap, our study presents the Web3 VEDM as a practical and replicable methodology that supports the design and implementation of Web3-enabled BMs. The model provides engineering managers and decision-makers with a comprehensive tool to evaluate technological readiness, align stakeholders, and identify the value mechanisms activated by Web3. It also enables the measurement of transformation through clearly defined KPIs, adding evaluative depth often missing in prior work.

One of the key contributions of this study is that Web3 technologies and the metaverse do not merely enhance existing BMs but fundamentally rethink value mechanisms. These technologies shift organizations from hierarchical coordination to decentralized ecosystems, where value is co-created and distributed through mechanisms, such as tokenization, community governance, and immersive UXs. In this way, Web3 directly impacts the three core dimensions of BMI (value creation, value delivery, and value capture) offering new possibilities for engagement, monetization, and organizational design.

The Web3 VEDM responds to these opportunities by offering a structured five-step process that guides companies through the transformation. The framework acts as a roadmap to strategically embed Web3 capabilities within business operations. Practically, firms can use the model to identify how decentralized technologies might affect each component of their BM and assess feasibility and impact within their specific industry context.

In doing so, the Web3 VEDM provides both a theoretical and practical contribution to the field of BMI. It extends traditional frameworks to accommodate the unique characteristics of Web3, such as decentralization, programmable automation, and digital ownership, and translates them into actionable pathways. For engineering managers, the model offers a robust, validated tool to navigate this complex transformation and build smart, sustainable, and user-centric businesses. For researchers, it offers a foundational structure for further studies on BMI in decentralized ecosystems.

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