A Modeling Approach for Blockchain-inspired Business Models: An Extension of the e^3-Value Method

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Abstract

Blockchain enables new ways of organizing economic activities. Blockchain promises to reduce costs and time associated with intermediaries and strengthen trust in an ecosystem of actors. The impact of this promising technology is reflected in an emerging stream of research and various companies exploring the potential uses of blockchain technology and building new blockchain-inspired business models. While there are promising use cases of this new technology, research and practice are still in their early stages in terms of changing existing and creating new business models.

We propose an extension of the e^3-value method to capture and represent the characteristics of blockchain-inspired business models. The approach is particularly useful for the value-based analysis of blockchain-inspired business models and the fundamental economic evaluation of these. It provides the foundation for capturing, communicating, innovating and experimenting with blockchain-inspired business models. We demonstrate the practicality of the extended e^3-value method by evaluating and applying it to an existing blockchain business model.

1. Introduction

Blockchain technology attracted the attention of research and industry over the past few years [1, 2]. An important driver of this development has been the increasing adoption of cryptocurrencies. The underlying blockchain technology uses protocols that define the exchange and storage of information using cryptography. This enables tamper-proof, decentralized, transparent and irrevocable storage of transactions between parties [3]. Blockchain has the potential to provide a foundation for the creation of new business models and to fundamentally change existing business models (e.g. [1, 4]). Of particular interest is, among others, the removal of intermediaries in an ecosystem of assets or the security aspects of the technology.

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Inspired by use cases in a wide range of industries, including finance, supply chain management or energy [1, 5] and the expectation of business value, blockchain technology is being considered by an increasing number of companies as an enabling technology [5]. Among other things, blockchain can help authenticate physical goods or information, facilitate disintermediation, improve operational efficiency, and enable new security approaches, thereby impacting established business models and creating new ones [1, 2].

Research on blockchain has gained momentum in information systems (IS) research. Recent work emphasizes the importance of blockchain to transform organizations [6]. IS research is directing its attention to blockchain as a tool or application for solving business and societal problems [6]. However, we need to better understand the potential benefits, value creation mechanisms, and impact of blockchain, especially given the uncertain development of the technology [5, 7]. Consequently, the concept of business models offers a promising perspective to assess how blockchain can impact existing (e.g. by improving operational efficiency) or new business models (e.g. by removing intermediaries in an ecosystem of actors) and lead to new forms of value creation and value capture [8]. Research regarding blockchain business models focuses on the generic impact of blockchain on business models [2], the development of taxonomies [1], or the impact on business models in a specific industry (e.g. [9]).

The business model is a key component of a company's ability to create, deliver, and capture value [10]. But business models are too complex to be handled without abstraction. This means that working with business models actually means working with a model of the business model [11]. To describe these models, business model representations (BMR) are used. BMRs are used, among other things, to improve the understanding, analysis and communication of the underlying logic of a business model (e.g. [12]).

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Previous research has shown how blockchain can create new and transform existing business models (e.g. [1, 6]). To better understand the value mechanisms and impact of blockchain, it is necessary to highlight the unique characteristics of blockchain business models [1], such as new service offerings and trade opportunities [1, 9] or new forms of intermediation that build on the unique symbiosis of technology and actors in the ecosystem to offer new validation as well as orchestration activities [9]. Most importantly, there is a lack of systematic support for the implementation of blockchain business models in practice. BMRs provide a promising way to represent these unique aspects by modeling a blockchain business model. Of the available BMRs, none explicitly addresses the characteristics of blockchain business models on a qualitative level, which means that there is no suitable BMR to represent blockchain business models [4]. There are a variety of different BMRs with diverse objectives (e.g. [12, 13]). The lack of cumulative research is the reason for the large number of different BMRs [14]. Thus, in business model [15] and design science research [16] there is a need for more cumulative research, i.e. the evolving development of existing BMRs. Existing BMRs offer a wide range of possibilities to be extended or further developed (e.g. [17, 18]). In order to represent these distinctive characteristics of blockchain business models and to contribute to the cumulative research on business models, the extension of an established BMR with blockchain specific elements appears to be promising.

Based on previous research on blockchain business models, we extend a specific BMR to enable the accurate representation of blockchain-inspired business models. Based on the current literature in business model research, we decided that the e^3-value method [13] is the most appropriate BMR. Due to its network-based notation [17], the e^3-value method is particularly suitable for the representation of blockchain business models that are significantly influenced by inter-operational partnerships in ecosystems and the value co-creation by multiple actors [1]. We extend the e^3-value method in two ways: First, we extend the graphical notations to reflect blockchain-specific characteristics. Second, we extend the e^3-value method by adding the ability to capture additional information. In extending the e^3-value method to capture blockchain-specific characteristics, we were guided by the following research question: *How can the existing BMR be extended to include blockchain-specific elements of business models?*

By providing an adoption of the e^3-value method for blockchain business models, we contribute to the emerging stream of literature on blockchain business models. The business model perspective provides the basis for the analysis of value creation in blockchain business models and can therefore offer additional benefits for the application in research and practice.

2. Foundations

2.1. Blockchain

Despite the high level of attention in research and practice, definitions of blockchain are still emerging and no uniform definition has yet been adopted. Lange et al. [19] have proposed a definition of blockchain that focuses on the core characteristics of the technology.

"A blockchain is a transaction-based, chronologic, immutable and synchronized distributed ledger shared over a peer-to-peer network. In a blockchain (BC), transactions are stored in interlinked transaction sets, referred to as blocks. They execute and record single transactions using consensus algorithms and bundle them into transaction sets using cryptographic techniques." [19]. Blockchain offers four key benefits, including: tolerance for node failures; a single view of events; transparent, auditable, predictable, and traceable activity; and data ownership without central authority [20]. For the realization of blockchains, some basic concepts from computer science and especially from cryptography are used. These serve to create the data structures in blockchains and and to enable their function. Du et al. [3] emphasized five IT artifacts of blockchain technology that support this realization of blockchain.

Distributed ledgers are databases maintained at different nodes instead of a central location. The nodes are identical and each contains all the transactions. Distributed ledgers or blockchains can be either permissionsless or permissioned.

Consensus mechanisms are algorithms which allow secure updating of records. The ledgers can only be updated when the majority of the nodes agree on the validity of the data. These trust-building mechanisms are used to address trust problems in a peer-to-peer network. The consensus mechanism should meet the requirements, namely consistency, availability and fault tolerance. This is to ensure that there is a common global view of the information and to prevent information asymmetries.

Encryption mechanisms consisting of a public key and a private key. The public key is used to encrypt the data and the private key is used to authenticate the participant. In addition, blockchain hash functions fulfill two safety requirements, namely one-wayness and collision resistance.

Smart contracts are digitally signed, computable, self-executing agreements among participants. They automatically verify and enforce the terms of the agreement.

The *immutable audit trail* ensures that participants can access, inspect, and add to a ledger, thus creating an audit trail. Because the ledger cannot be modified or deleted, the audit trail is immutable.

2.2. Business Models and Business Model Representations

Business models have become an important topic in research and practice over the past decade [21, 15]. A business model can be defined by an activity system consisting of interdependent and independent organizational activities focused on a focal enterprise, including those carried out by the enterprise, its partners, suppliers or customers to satisfy the perceived needs of the market and other interested parties. The firm's activity system can transcend the focal operation and span its boundaries, whereby a company can not only create value with its partners but also appropriate some of that created value itself [22]. The business model concept has become a commonly used and powerful construct to describe the mechanisms of value creation and capture of a company. But no common understanding of business models has yet been established. This inconsistent understanding is also reflected in the different approaches to representing business models [17]. A BMR can be defined as the model of a specific business and provide a graphical representation of it [17]. BMRs are used to understand the key elements and mechanisms in a specific business domain and their relationships, to communicate and share the understanding of a business model among business or technology stakeholders [12], to design the information and communication systems supporting the business model [13], to experiment with innovative business concepts [10], to change and improve the current business model [12]. For this purpose, there are different approaches to represent a business model (e.g. [12, 13]) [1].

These different BMRs pursue different objectives. BMR research can be divided into two research streams. The first research stream is based on flow logic, taking into account value flows and activities, a prominent example being the e^3-value method [13]. The second research stream tries to provide a holistic view of the business model or an offering at the system level with a prominent example being the Business Model Ontology (BMO) [12]. The variety of different BMRs is due to the lack of cumulative research, as most publications propose alternative BMRs instead of evolving existing BMRs [14]. The need for more cumulative research can be found in both design science [16] and business model research [15]. Established BMRs, such as the e^3-value method or the BMO, offer a variety of ways to extend or evolve them. For example, BMR can be adapted to the characteristics of services [14], a technology [18], to generate business plans [23] or for the integration of real options [17].

[1] See also [17] for a comprehensive overview of the existing BMRs and their main characteristics

2.3. The e^3-Value Method

The e^3-value method was developed for representing business models and ecosystems with a value model. The method has originally been developed for the design and evaluation of e-commerce businesses. However, the e^3-value method has also been applied in a variety of other industries [17].

Creating e^3-value model begins with the involved actors and the values they create and exchange. To these value exchanges financial figures can be added for determining the economic performance of the actors in the network. An e^3-value model represents the structural aspects of a business model, with the focus on value creation. The model does not provide any information about the timing of the processes. However, time-related aspects can be included in the financial analysis of the business model, though they are not represented in the graphical model or the underlying formal ontology [17].

The main concepts of the e^3-value method are the following [13] – see also Figure 1:

1. *Actors*: An actor is an economically, and often also legally, independent entity. Actors perform various value activities to increase their economic profit or their utility. In a successful business model, every actor should generate an economic profit. If several actors have the same characteristics regarding their value exchanges and use the same decision function for value interfaces, they may be grouped in a *market segment*. *Composite actors* can be used to group at least two actors with the same value interface.

2. *Value exchange*: The value exchange connects two value ports with each other and represents the potential exchange of value objects between the actors. *Value objects* are exchanged by the actors. An object of value is a *product*, a *service* or a *consumer experience*. The exchanged value objects are of economic value to one or more actors.

3. *Value port*: The provision and request of value objects between actors is carried out through value ports. The *value interface* groups the individual value ports. They indicate which value objects an actor offers and exchanges in return for other value objects through the value port. The conditions under which an exchange of values can take place are expressed on the value interface by a decision function.

4. *Value activity*: In order to create profit or utility, actors carry out value activities. They enable an allocation of value activities to the actors.

The e^3-value method has further elements that are based on a simplified form of use case maps [13]. *Dependency elements* are used to represent dependencies within actors. The dependency elements can be split or joined by *AND* and *OR connection elements*. These two constructs are used to build a *scenario path*. A *start* element - or consumer need - is the start of a scenario path and represents the specific need of an actor. A *stop* element - or boundary element - marks the end of a scenario path.

A start stimulus represents the beginning of a scenario path and is an event. The event is possibly triggered by an actor and in this case is represented within the box of the actor. The stop stimulus is connected to the last segment of a scenario path and indicates that the scenario path ends.

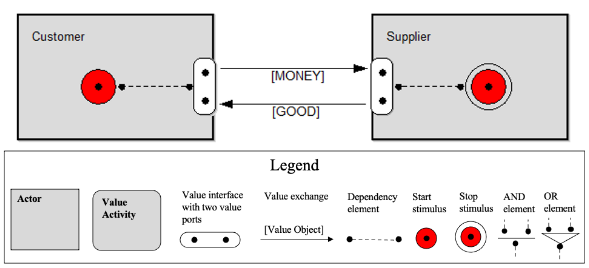

Figure 1. Notation of the e^3-Value Method

Once a model has been created, the economic feasibility of a business model can be assessed in quantitative terms. This is based on an assessment of the value of the objects for all actors involved. If all the actors generate a profit or increase their economic utility, the feasibility of the business model is confirmed.

The e^3-value method focuses on creating trust, i.e. whether the business model is of interest to all participating actors, and not on the exact calculation of all profits. The method takes the approach of considering the net inflows and outflows of value objects, where the net value of these flows should be sufficient to cover all other expenses. The evaluation consists of preparing profit sheets in terms of their costs and benefits for the actors involved [13]. The profit sheets can be prepared at the level of the actor or the value activity to determine their profitability[2].

3. Related work

Although blockchain-inspired business model research has received little attention so far in the research community, there is already work being done on developing ontologies to describe blockchain technology or business networks.

Ontologies have been developed for the semantic modeling of blockchains. One of these ontologies is BLONDiE (Blockchain Ontology with Dynamic Extensibility) [24], which focuses on describing the native structures of a blockchain and some related information. BLONDiE includes cryptocurrencies, transactions and other characteristics of blockchain. The ontology is strongly oriented towards the specifications of cryptocurrencies and therefore reflects the technical functioning of blockchain. Another approach in this context is EthOn (Ethereum ontology) [25], which provides a description of the central blockchain terms and describes their relationship. EthOn rests strongly on the technical concepts of Bitcoin and Ethereum and does not provide the possibility to capture business aspects and value mechanisms in a business network.

An approach for describing blockchain business networks is the Blockchain Business Network Ontology (BBO) [4]. The ontology is extended by a model-driven approach to capture the characteristics of blockchain-driven business networks. The approach uses different layers to represent the networks from the business model to the technical implementation.

Another direction for blockchain business models is concerned with the development of taxonomies and typologies for technology-specific business models. In this context, various business model patterns have been identified, which show possible options for innovating business models through blockchain technology [1]. Other typologies describe the characteristics of blockchain business models, e.g. [26].

Another approach used the e^3-value method to identify and evaluate blockchain use cases and also demonstrates the value of BMR for business analysis and strategic decision making [27].

[2]See also [13, 17] for the preparation of profit sheets and [13] for an exemplary e^3-value model

4. Research Methodology

Because our objective is to create a new, innovative, and useful artifact, we chose a design science research approach. The result of this research provides an extension of the e^3-value method for representing the characteristics of blockchain-inspired business models and the implementation in a prototype. We consider the design science research approach to be particularly appropriate, as it provides an iterative and structured process for developing and evaluating a modeling method. The approach provides a suitable basis for creating an artifact with high usefulness, whereby it is closely linked to existing knowledge and a relevant, real-world problem [28].

In this research we followed the procedures from design science research [29] and the procedures from the design of modeling methods [30]. The research starts from the observation that there is a lack of understanding of value creation in blockchain-inspired business models and current BMRs cannot represent the characteristics of blockchain business models. For this general problem, we also found confirmation in the current IS literature [4].

In a second step, we defined qualitative goals for the solution. In defining the goals, we considered the fundamental properties of the e^3-value method and extended them with requirements for representing blockchain business models. These requirements were derived from literature sources and real-world blockchain applications. The structured literature review focused on value mechanisms in blockchain business models and resulted in 18 relevant articles. Although these extensions limit the reusability of the modeling method for other purposes, this has the benefit of a more accurate representation of blockchain-inspired business models. For minimizing this trade-off, we further defined that the prototype should also have the ability to model standard e^3-value models [30].

In a third step, the modeling method was designed. This included the definition of the modeling language and the modeling procedure as well as the development of the algorithms. Subsequently, the modeling method was prototypically implemented using the ADOxx metamodeling platform [31]. The choice for ADOxx was driven by the wide usage of the platform in academic projects and its industry-level functionalities.

In a fourth step, the application of the prototype for solving the problem was demonstrated. For this purpose, various specific business models were modeled using the new modeling method. In this paper we illustrate one of these modeled business models.

In a final step, the artifact was evaluated. The defined goals were compared with the results of the demonstration. We discuss the components of the implementation, the resulting possibilities and limitations, and possible further developments.

5. A Modeling Approach for Blockchain-inspired Business Models

For introducing the blockchain-specific extensions for the e^3-value method, we focus on the generic components of a modeling method. Therefore we describe first the extension of the e^3-value modeling language and the adapted modeling procedure. Subsequently, we briefly explain the developed mechanisms and algorithms.

For extending the e^3-value modeling language with blockchain-specific characteristics, we started from the business model components *value proposition*, *value creation and delivery system* and *value capture*. This structure was found particularly suitable because it had already been used in previous research on blockchain business models, e.g. [32, 1], and the e^3-value method is fundamentally based on these concepts.

The value proposition describes what the organization can offer a customer, why the customer is willing to pay for it and how the organization creates a competitive advantage. The technology can change existing value propositions or create entirely new ones [9, 1]. The impact of blockchain on the value proposition is largely due to the technical characteristics of blockchains – see section 2.1. The influence on the value proposition can be witnessed by the optimization of costs and speed, security enhancements, improved verifiability, traceability and reliability, and disintermediation [1, 5, 9]. Thus, for capturing the influence, we extended the element *value exchange* with several attributes to represent the blockchain-specific value proposition. The attribute *blockchain-specific value proposition* can be used to depict the impact of blockchain on the value proposition in a specific business model. In doing so, we oriented ourselves to the findings on the influence of blockchain on the value proposition.

The impact on the value proposition is further related to the underlying assets of the blockchain. Assets circulating and being exchanged via blockchains can be physical(e.g. goods in a supply chain), virtual (e.g. digital assets in games), monetary (e.g. cryptocurrencies), or user-specific (e.g. IP, labor or data) [1]. The use of blockchain for different assets offers opportunities to change and improve the value proposition. Therefore, we added the attribute *underlying asset* for recognizing these assets.

The value creation and delivery system describe how an organization creates value and delivers that value to its customers. This describes the resources and capabilities, the organization and the position in the value network of an organization. Blockchain requires companies to reconsider the key resources and activities shaping their business model [33]. The influence of blockchain can lead to a reduction of effort, novel service offerings and new collaborations with other stakeholders in value creation. The new forms of this collaboration are characterized by the reduced relevance of trust, smaller transaction volumes and new partners [9]. Blockchain creates new value chains and the positioning of a company in the network may change. These changes are shaped by new forms of collaboration and the inclusion of new players, through the reduced entry barriers for the participants [9, 1]. For representing the influence of blockchain on value creation, we extended the element value activity with various attributes and added a *blockchain symbol* – see Figure 3. The attribute *value chain position* provides information about the position of the value activity in the blockchain value chain. With the attribute *blockchain-sourcing*, the sourcing of the blockchain can be captured. The underlying blockchain can be described in more detail by the *blockchain-type*. To illustrate the impact of blockchain on collaboration in value creation, we used the roles and types of participants specified by the BBO [4]. The attribute *blockchain participants* allows depicting participants of the value creation without cluttering the graphical representation of the business model.

In addition to new forms of collaboration for value creation, blockchain also enables a new form of organization called *decentralized autonomous organization* (DAO), e.g. [9, 32]. A DAO creates new value creation potential, fundamentally changes the organization of the value chain and creates a new organizational structure [1, 9, 34]. Because of the characteristics that distinguish a DAO from a traditional composite actor, we extended the e^3-value method with a dedicated *DAO* element. The DAO is represented in the same way as the actor, but with a dashed line and the blockchain symbol. To capture the characteristics of a DAO, we extended the new actor with several attributes. Through the attribute *DAO affiliations*, the relationships of the other actors in the model to the DAO can be depicted [1].The attribute *smart contracts* can be used to describe their usage in more detail, as they are a key component for the realization of DAOs [32]. The attributes *blockchain value chain position* and *underlying blockchain* capture further information about the application of the blockchain [1].

Value delivery is affected by blockchain, in particular by the use of blockchain for the transfer of value via the blockchain. The impact of is seen in lower costs, higher transaction speeds, audit-ability and traceability of transactions (e.g. [1, 2, 5]). Therefore, we have extended the existing value exchange relationship to represent the value transfer over blockchain. In case the value transfer happens over blockchain, the value exchange is extended by the blockchain symbol. The blockchain usage for the value transfer can be described by the attributes *blockchain usage*, *blockchain type* and *underlying blockchain*.

Finally, value capture describes how an organization extracts value from its value creation, i.e. generates revenue and makes profit. This describes the revenue sources and the economics of an organization. Blockchain can enable traditional revenue streams such as subscription fees, transaction fees, free services or funding through advertising or other revenue streams. However, the use of technology also offers new opportunities for revenue streams, such as cryptocurrencies, tokens or Initial Coin Offerings (ICO) (e.g. [1, 2]). In order to capture the impact of blockchain on the revenue stream, we have added the attribute *blockchain-specific revenue stream* to the value exchange element. In Figure 2 the major components of the modeling method are shown, including the blockchain-specific extensions.

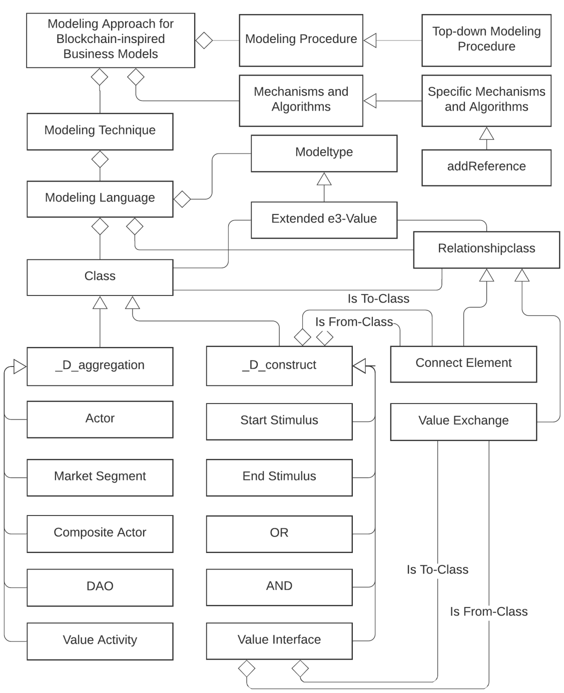

Figure 2. Excerpt of the Major Components of the Extended Modeling Method

The extensions of the graphical notation of the modeling language were derived (I) from the standard graphical notation of the e^3-value method and (II) from the general best-practices for graphical modeling [35], which indicate for example that a graphical notation has a clear mapping of concepts to symbols, is consistent with previous practice, and does not have an overload of symbology.

Figure 3 illustrates the three most important adaptations of the graphical notation: the new actor DAO, which is represented by a rectangle with dashed lines and the blockchain symbol, the extension of the value exchange with the additional blockchain symbol in case of a value transfer via blockchain, and the extension of the value activity.

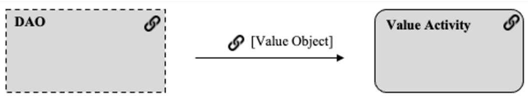

Figure 3. Example for the Extended Notation

As already mentioned, various attributes were added to the elements for capturing blockchain-specific properties and at the same time not overloading the graphical notation. In defining the attributes, we were guided by previous research on blockchain business models and, in particular, by the ontologies developed, as well as the various typologies and taxonomies [1, 26]. We have predefined different dimensions of these attributes. These dimensions can be extended by the modeler. Table 1 illustrates the blockchain-specific attributes which extend the e^3-value method.

The modeling procedure is based on the cyclical modeling procedure of the e^3-value method [36] and adapted to capture the blockchain-specific characteristics. The steps of the modeling procedure are as follows:

Operational scenario identification: The first step is the identification of one or more deployment scenarios. The scenario should be described in short sentences, focusing on the product, service or experience desired by a customer.

Actor identification: A list of actors should be created for the selected deployment scenario. It is assumed that these actors are profitable.

An actor versus market approach: The offers made by the actors are to be examined. This can be based on the offers of an actor or on the offers demanded by the market.

Value object identification: The value objects are identified. The value objects indicate what is offered or requested by an actor. The value object must be of economic value to at least one of the actors.

Extended attribute	Predefined dimensions
DAO	
DAO-affiliations	-
blockchain value chain position	blockchain provider, blockchain enabler, blockchain mediator, blockchain user, other
blockchain type	Public, private, consortium
underlying blockchain	Bitcoin, Ethereum, other, several
consensus mechanism	Self-created, existing, modified
DAO-participants	Name, type of the participant (natural person, legal person, smart contact, device), role of the participant (observer, initiator, broadcaster, committer, validator, other role)
Value activity	
blockchain value chain position	blockchain provider, blockchain enabler, blockchain mediator, blockchain user, other
blockchain type	Public, private, consortium
underlying blockchain	Bitcoin, Ethereum, other, several
consensus mechanism	Self-created, existing, modified
blockchain-participants	Name, type of the participant (natural person, legal person, smart contact, device), role of the participant (observer, initiator, broadcaster, committer, validator, other role)
Value exchange	
type of value exchange	Value proposition, revenue stream, not specified value exchange
blockchain usage	Yes, no
blockchain type	Public, private, consortium
underlying blockchain	Bitcoin, Ethereum, other, several
blockchain-specific value proposition	Intermediation improvement, cost optimization, speed optimization, security enhancement, data traceability and verification, blockchain offering, other
underlying asset	Physical asset, virtual asset, user-specific asset, money, no asset specification
blockchain-specific revenue stream	Subscription fee, fee per transaction, Professional services, maintenance fee, consulting fee, utility token, other

Table 1. Blockchain-specific Extensions of the Attributes

Grouping value ports into value interfaces: The value ports that offer or request the value object should be specified. Two value ports are grouped into one value interface and represent the end of a value exchange between two actors. A value interface with two value ports must therefore have two value exchanges in opposite directions.

Scenario path identification: The scenario paths show which value objects are exchanged due to a customer's need. The scenario path is created from the customer need using connect elements and continues through the value interface and value exchange to another actor. The scenario path is terminated with a boundary element.

6. Application of the Blockchain-specific Extensions

To evaluate the prototype and demonstrate its value, we applied it to specific business models[3]. Due to the limitation of space, we present here only one example in the form of the business model of Aragon and the participating actors[4].

In order to present Aragon's business model, we start the explanation by presenting ResearchHub that is based on Aragon (see Figure 4). ResearchHub aims to create value by simplifying scientific publishing processes. The blockchain business model challenges the traditional way of doing business (i.e. creating value). ResearchHub is a DAO and therefore was also represented by the DAO actor (I). The ResearchHub DAO aims to simplify the publication of scientific articles. ResearchHub provides its DAO participants, i.e. the scientific community (II), with a platform for publishing. In return, the publishing scientists receive tokens, the ResearchCoin (RSC). The tokens were created by the DAO and offer scientists the opportunity to increase their reach. The articles published on ResearchHub are freely available and can be evaluated by the scientific community, for which the publishing author also receives RSC tokens. ResarchHub uses Aragon to implement their DAO.

Aragon is a real-world DAO that specializes in providing blockchain-based infrastructure to realize DAOs. The Aragon DAO was initiated by the Aragon Association and simplifies the possibility for DAO initiators to create and manage their own DAO. For this purpose, the DAO provides a DAO framework and a web-based decentralized app (dApp). We modeled Aragon accordingly through the DAO actor (III). By using various blockchain-specific attributes, we can also capture the usage of the Ethereum blockchain.

The creation of the DAO can be initiated by a customer, who must provide an Ethereum (ETH) debit for it. For modeling with extended e^3-value method, a market segment was used for this purpose (IV). Thereby, the transfer of cryptocurrency can be represented by the value transfer via blockchain and consequently the revenue streams of Aragon can be captured.

Through the attribute DAO affiliation, we can capture the relationship of Aragon One to the Aragon DAO. Aragon DAO collaborates with various service providers, such as Aragon One (V). These service providers develop software tools for the Aragon DAO in return for grants. These software tools are used, among other things, to provide Aragon DAO customers with facilitated DAO management, such as smart contract templates and other services that facilitate DAO management. These services are also paid for by the DAO through ETH contributions.

[3]The used prototype can be found under DOI: 10.5281/zenodo.4485610

[4]For understanding how Aragon operates, users can consult the documentation on it's website or [37]

7. Discussion

To improve the understanding of the potential benefits, value mechanisms and impact of blockchain on business models, the concept of business models offers a promising perspective [8]. Current BMR approaches do not take into account the characteristics of blockchain-inspired business models [4]. This inhibits the qualitative consideration of these blockchain-specific characteristics in business model design. The application of the extended e^3-value method reveals its applicability for modeling blockchain business models and their unique characteristics. In this context, the exemplary application to the business model of Aragon demonstrates the major capabilities of the extended e^3-value method. The most obvious advantage is certainly the modeling of a DAO. The actor can now be accurately represented and relationships of other actors to the DAO can be captured with the attribute *DAO-affiliations*. In addition, it is possible to represent the influence of blockchain on value creation and to describe the blockchain usage by the various attributes (e.g. *blockchain value chain position*, *blockchain type*, *blockchain-participants*). The extension of the value exchange via blockchain makes it possible to represent the value transfer via blockchain, such as in the Aragon business model, the payment with the cryptocurrency ETH. By the extension of the value exchange, blockchain-specific value propositions and revenue streams can also be illustrated, showing what an actor offers to customers, how this is influenced by blockchain technology and generates revenue accordingly.

Based on our experience from the application of the extended e^3-value method, we assume that this method is of immediate usefulness to practitioners involved in the design and analysis of blockchain-inspired business models. These extensions allow blockchain-specific aspects to be modeled within an e^3-value model, improving the practicality of the method in this domain.

8. Conclusion, Limitations & Future Research

In this research, we made a connection between blockchain and BMR by extending the e^3-value method. We have built on the current research on

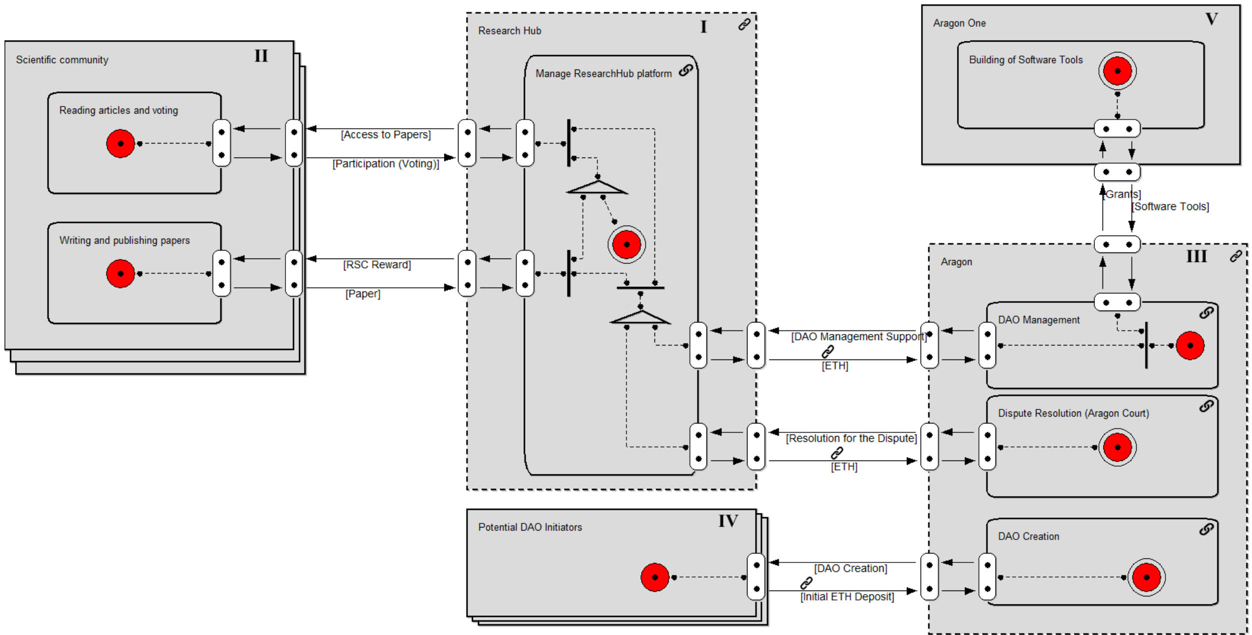

Figure 4. Extended e^3-Value Model of Aragon

blockchain business models to extend the e^3-value method to represent blockchain-specific elements in business models. We implemented the necessary constructs of the e^3-value method on the ADOxx metamodeling platform and extended it with the blockchain-specific enhancements. We illustrated how the blockchain-specific extensions and prototype implementation can be applied exemplary with the Aragon business model. Our research contributes to the emerging literature on blockchain business models by providing a method to represent these business models by extending the e^3-value method. The extension of the e^3-value method incorporates the findings from previous research and uses them to represent blockchain-specific elements. The findings and vocabulary of previously developed taxonomies were used to describe blockchain-specific characteristics [1, 26]. Developed ontologies for describing blockchain business networks were also used to describe the participants in the value creation process [4]. Finally, the extension of the e^3-value method contributes to the applicability of the well-known method in the specific domain.

There are also some limitations to the current implementation of the prototype that need to be considered and addressed. These result from the current state of research regarding the impact of blockchain on business models and as the technology is developing very fast, the application on the level of business models is changing. Thus, only the previous findings could be used to extend the e^3-value method. The automatic creation of profit sheets was not considered in the prototype. However, the profit sheet can be created manually based on the information in the model. We plan to implement this extension of the prototype in the future to facilitate the economic assessment of blockchain business models. In addition, as part of future work, we plan to conduct a detailed evaluation of our approach by considering more use cases with different characteristics. However we consider the selected use cases, such as the exemplary Aragon use case, to be information-rich.

References

[1] J. Weking, M. Mandalenakis, A. Hein, S. Hermes, M. Böhm, and H. Krcmar, “The impact of blockchain technology on business models – a taxonomy and archetypal patterns,” *Electronic Markets*, vol. 30, no. 2, pp. 285–305, 2020.

[2] W. Nowiski and M. Kozma, “How can blockchain technology disrupt the existing business models?,” *Entrepreneurial Business and Economics Review*, vol. 5, no. 3, pp. 173–188, 2017.

[3] W. Du, S. Pan, D. Leidner, and Y. Wenchi, “Affordances, experimentation and actualization of fintech: A blockchain implementation study,” *Journal of Strategic Information Systems*, vol. 28, no. 1, pp. 50–65, 2019.

[4] S. Seebacher and M. Maleshkova, “A model-driven approach for the description of blockchain business

networks," in *51st Hawaii Int. Conf. on Syst. Sci.*, pp. 3487–3496, IEEE, 2018.

[5] M. Lacity, R. Sabherwal, and C. Srensen, "Special issue editorial: Delivering business value through enterprise blockchain applications," *MIS Quarterly Executive*, vol. 18, no. 4, pp. 9–19, 2019.

[6] M. Rossi, C. Mueller-Bloch, J. B. Thatcher, and R. Beck, "Blockchain research in information systems: Current trends and an inclusive future research agenda," *Journal of the Association for Information Systems*, vol. 20, no. 9, pp. 1388–1403, 2019.

[7] M. Risius and K. Spohrer, "A blockchain research framework: What we (don't) know, where we go from here, and how we will get there," *Business and Information Systems Engineering*, vol. 59, no. 6, pp. 385–409, 2017.

[8] M. Iansiti and K. R. Lakhani, "The truth about blockchain," *Harvard Business Review*, vol. 95, no. 1, pp. 2701–2712, 2017.

[9] S. Schneider, M. Leyer, and M. Tate, "The transformational impact of blockchain technology on business models and ecosystems: A symbiosis of human and technology agents," *IEEE Transactions on Engineering Management*, vol. 67, no. 4, pp. 1184–1195, 2020.

[10] S. M. Shafer, H. J. Smith, and J. C. Linder, "The power of business models," *Business Horizons*, vol. 48, no. 3, pp. 199–207, 2005.

[11] R. Casadesus-Masanell and J. E. Ricart, "From strategy to business models and onto tactics," *Long Range Planning*, vol. 43, no. 2, pp. 195–215, 2010.

[12] A. Osterwalder and Y. Pigneur, "An e-business model ontology for modeling e-business," in *15th Elec. Com. Conf.*, pp. 75–91, 2002.

[13] J. Gordijn and H. Akkermans, "Designing and evaluating e-business models," *IEEE Intelligent Systems*, vol. 16, no. 8, pp. 11–17, 2001.

[14] A. Zolnowski, C. Weiss, and T. Böhmann, "Representing service business models with the service business model canvas - the case of a mobile payment service in the retail industry," in *47th Hawaii Int. Conf. on Syst. Sci.*, pp. 718–727, IEEE, 2014.

[15] C. Zott, R. Amit, and L. Massa, "The business model: Recent developments and future research," *Strategic Management Journal*, vol. 22, no. 1, pp. 493–520, 2011.

[16] F. Niederman and S. T. March, "Design science and the accumulation of knowledge in the information systems discipline," *ACM Transactions on Management Information Systems*, vol. 3, no. 1, pp. 1–15, 2012.

[17] D. Kundisch and T. John, "Business model representation incorporating real options: an extension of e3-value," in *45th Hawaii Int. Conf. on Syst. Sci.*, pp. 4456–4465, IEEE, 2012.

[18] K. Pousttchi, "A modeling approach and reference models for the analysis of mobile payment use cases," *Electronic Commerce Research and Applications*, vol. 7, no. 2, pp. 182–201, 2008.

[19] M. Lange, S. C. Leiter, and R. Alt, "Defining and delimitating distributed ledger technology: Results of a structured literature analysis," in *Int. Conf. on Bus. Process Manage.*, pp. 43–54, 2019.

[20] K. Christidis and M. Devetsikiotis, "Blockchains and smart contracts for the internet of things," *IEEE Access*, vol. 4, no. 1, pp. 2292–2303, 2016.

[21] M. M. Al-Debei and D. Avison, "Developing a unified framework of the business model concept," *European Journal of Information Systems*, vol. 19, no. 3, pp. 359–376, 2010.

[22] C. Zott and R. Amit, "Business model design: An activity system perspective," *Long Range Planning*, vol. 43, no. 2, pp. 216–226, 2010.

[23] M. Wieland and H.-G. Fill, "A domain-specific modeling method for supporting the generation of business plans," in *Modellierung 2020*, (Bonn), pp. 45–60, Gesellschaft für Informatik e.V., 2020.

[24] H. Ugarte, "A more pragmatic web 3.0: Linked blockchain data." `https://semanticblocks.wordpress.com`. Accessed: 2021-04-17.

[25] J. Pfeffer, "Ethon - an ethereum ontology." `https://ethon.consensys.net`. Accessed: 2021-04-20.

[26] N. Rückeshäuser, "Typology of distributed ledger based business models," in *Proc. 25th Eur. Conf. on Inf. Syst.*, pp. 2202–2217.

[27] G. Poels, F. Kaya, M. Verdonck, and J. Gordijn, "Early identification of potential distributed ledger technology business cases using e3value models," in *Advances in Conceptual Modeling*, (Cham), pp. 70–80, Springer, 2019.

[28] A. R. Hevner, S. T. March, and J. Park, "Design science in information systems research," *MIS Quarterly*, vol. 28, no. 1, 2004.

[29] K. Peffers, T. Tuunanen, C. E. Gengler, W. Rossi, Matti; Hui, V. Virtanen, and J. Bragge, "The design science research process : A model for producing and presenting information systems research," in *1st Int. Conf. DESRIST*, pp. 83–106, 2016.

[30] N. Visic, H.-G. Fill, R. A. Buchmann, and D. Karagiannis, "A domain-specific language for modeling method definition: From requirements to grammar," in *9th Int. Conf. on RCIS*, pp. 286–297, IEEE, 2015.

[31] H. Fill and D. Karagiannis, "On the conceptualisation of modelling methods using the adoxx meta modelling platform," *Enterp. Model. Inf. Syst. Archit. Int. J. Concept. Model.*, vol. 8, no. 1, pp. 4–25, 2013.

[32] Y. Chen and C. Bellavitis, "Blockchain disruption and decentralized finance: The rise of decentralized business models," *Journal of Business Venturing Insights*, vol. 13, no. 10, pp. 151–166, 2020.

[33] V. J. Morkunas, J. Paschen, and E. Boon, "How blockchain technologies impact your business model," *Business Horizons*, vol. 62, no. 3, pp. 295–306, 2019.

[34] L. Schlecht, S. Schneider, and A. Buchwald, "The prospective value creation potential of blockchain in business models: A delphi study," *Technological Forecasting & Social Change*, vol. 166, no. 7, 2021.

[35] J. Rumbaugh, "Notation notes: Principles for choosing notation," *Journal of Object-Oriented Programming*, pp. 11–14, 1996.

[36] J. Gordijn and H. Akkermans, "Value-based requirements engineering: exploring innovative e-commerce ideas," *Requirements Engineering*, vol. 8, no. 5, pp. 114–134, 2003.

[37] H.-G. Fill, "Enterprise modeling: From digital transformation to digital ubiquity," in *Federated Conference on Computer Science and Information Systems*, pp. 431–434, 2020.