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Blockchain as a Service (BCaaS): A Value Modeling Approach in the Education Business Model

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Abstract

The adoption of Blockchain has caused the organization to rethink how it operates and adds value to its current processes. Some scholars refer to Blockchain as the Black Swan of the 21st century, which will have a greater impact than the introduction of the Internet. Currently, there is little discussion about Blockchain technology and the value model approach and how organizations can close the gap between strategy and operational planning to successfully implement this technology in organizations. This paper explores the relationship and implications of Blockchain technology in relation to the value chain model in education. This paper proposes a value modeling approach for implementing Blockchain in the education sector and demonstrates how a solution works in practice. The novelty of the research will be from both theoretical and practical perspectives. The study will appraise enhancement that can be made within the existing literature on Blockchain and the value chain model, and how the alignment of the two concepts can be used to improve the use of the current value chain model in the education sector.

Keywords

Blockchain, Blockchain Based Software Engineering, VPC, VDML, Smart Contracts

1. Introduction

Blockchain technology is considered one of the significant breakthroughs since the invention of the internet. Gartner's forecast revealed that Blockchain's business value-add would be reached $176 billion by 2025 and $3.1 trillion by 2030 [1]. The Blockchain technology allows the exchange of a value without the need of central authority [2] [3] and [4]. For many authors, Blockchain is the new way of interacting within the digital world [5] and avoiding the middleman. This makes the technology relatively cost-effective [6], avoiding conflicts and risks arising from several actors' interactions in a transaction. This ranges from a business that involves data sharing or managing information to financial transactions. Organizations are now phasing the next revolution incorporating different disruption technologies and reshaping their business processes to cope with the rise of the digital world innovation. However, these rapid changes have a severe effect on organizations' cultures; how we do things around here will impact how disruptive technologies will be incorporated in the operations level. It is anticipated that new technologies will increase effectiveness, transparency, trust, traceability, and data sharing and shake an organisation's policies and procedures. An investigation of 600 executives by PWC (2018) revealed that 84% out of them have at least some involvement with the Blockchain technology [7].

Therefore, in the new global economy, Blockchain has become a central part or a need of an organizational ecosystem even if it is in embryonic form. The system is characterized by the ongoing relationship and interconnectivity of the different actors. Thus, managers, senior executives, and all the various parties interacting with the ecosystem will somehow be affected by this change. Therefore, it is essential to explore further how the value will be created for the system to be sustainable and how it can be communicated and realized by the different actors affected.

Value creation is an essential component of an organization's ecosystem and plays a key role in ensuring sustainability, resilience, and effectiveness. The Oxford dictionary defines value as the "reward that something is held to derive, the importance of worth and usefulness." Whereas, value proposition (VP) is the value that any organization is delivering to its customer. VP is a significant element of organizational strategy and can add to its effectiveness. In general, the VP plays an essential role in communicating the aim or the value to the participants and other related parties [8]. Vargo and Lusch (2004) talk about the evolution of value creation over time by considering interactivity, connectivity, and ongoing relationships that shift the focus from a centric organization to the customer [9]. As a result, scholars today are more concerned with the dynamics of complex systems in which different parties co-create value; for instance, the organisation with its customers [9]. Frow (2014) also argues that the nature and role of the value proposition is controversial. There is a need to study its conceptualization from the perspective of a service ecosystem [10]. In 1988, Lanning, M. and Michael, E. published a paper in which they described VP with an obvious and simple statement "VP is the benefits that the firm will provide to the customers" [11]. The same work describes VP as an element of supporting the strategy because it allows the customers to understand the explicit benefits and associated with a price and cost [11]. The chosen VP demonstrates how the business environment incorporates activities through communicating and collaborating to deliver value. So the discussions are much emphasized to the ecosystem in the context of co-creating VP through collaborative interactions of different actors and systems. Sirianni *et al.* (2019) conducted a systematic review of 45 articles and present how cloud computing technology create value in the context of service business models [12].

Holbrook (2006) emphasizes the need to view value as situational [13], while Edvardsson (2011) and Helkkula (2012) believe that value is influenced and driven by social forces, while the focus is on all the different actors that integrate into the company's system and participate in a co-creation context [14] [15]. Therefore, a holistic view of the process is crucial for effective co-creation of value proposition.

The use of blockchain technology in education is still in its infancy. The adoption of Blockchain technology in education ecosystem requires additional effort to develop an appropriate way to co-creating value propositions so that the various parties interacting and collaborating in the system can understand and realize the benefits. The introduction of blockchain technology in education will reduce bureaucracy as well as time and costs for all the parties involved students, institution, government bodies, and employees.

To date, however, there has been little discussion about blockchain technology and the value model approach. The purpose of this paper is to provide a detailed description on how blockchain and value proposition modeling can be used together to bridge the gap between strategy and operational planning so that this technology can be successfully implemented in organizations. This research addresses the impact of blockchain technology on the value chain model? The paper provides background on the importance and surprise of blockchain technology, followed by a description of both blockchain technology and the value modeling approaches. The paper proposes a model for implementing blockchain technology in education based on analysis of publicly available sources. Readers will have the opportunity to see how this solution works in practice and how the risks are mitigated, and gains are fully realized. The paper concludes with some limitations identified in this research.

In Section two, we provide a brief description of the research methodology, followed by the third section on the exploration of the various key concepts related to this study. The integration of the blockchain and value chains is mapped and further explored. Section five analyzes a use case in education and concludes the article in Section six.

2. Research Methodology

According to Taylor (1962), there is a significant relationship between questions and information [16]; in most cases, the question is the trigger for the information and dictates the input and output of the research. Therefore, structuring the right questions is an essential step in conducting appropriate research. Our initial examination of the blockchain literature helps us to formulate the right research question. This study examines the relationship and impact of blockchain technology on the education value chain business model.

However, so far, there has been little discussion on the relationship between the value chain and Blockchain. Research has focused on blockchain application in certificates [17] rather than business implementation and value creation. The first systematic study on the use of Blockchain in education was published by Almmary *et al.* in 2019, reviewing 2321 articles from nine major databases. Key findings from Almmary *et al.* (2019) indicate that the majority (41%) of research is concentrating on issuing and sharing student records, with another 29% focused on the storage and exchange of competencies and learning outcomes. Another 19% deal with assessing students' professional skills, while the remaining 18% focus on protecting learning objects, privacy, and security of learning systems, and other applications deal with fees and credit transfers [17].

Based on the aim of this study the following research questions were formed:

RQ1: what impact does the blockchain technology on the value chain model in the education business model?

A similar research concept was identified by Bagheri and Movahed (2017) while investigating the effect of Internet of Things (IoT) on the education business model [18]. This research examined how an IoT platform can change the education business model and add new value propositions in such organizations using the Canvas business model approach [18]. The following Figure 1 describes in detail the steps used to conduct the research.

Our research follows up on a similar study by exploring how blockchain technology can impact the business model in education and create new value propositions. It was decided that the best method for this investigation would be a qualitative one by firstly reviewing the existing literature on key concepts and secondly identifying the particle merging between the different concepts.

3. Background

Sharoshi Nakamoto published a paper in October 2008 [7] and shared it with the community a month after the collapse of Lehman Brothers. Bitcoin was introduced to the world a year later in January 2009 [19]. We can argue that these two

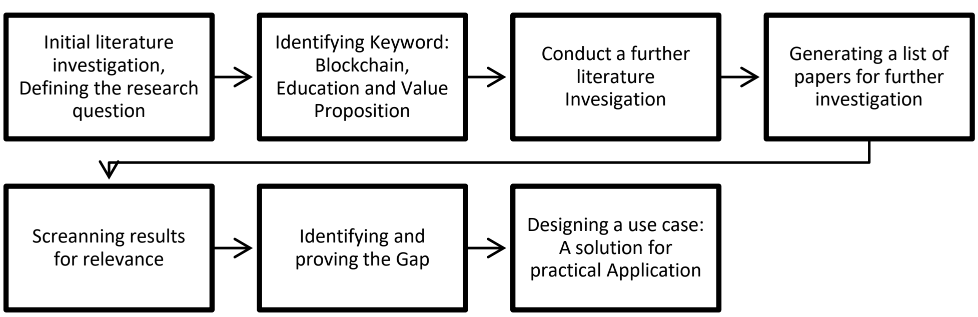

Figure 1. Research steps.

elements are helping to evolve business from a traditional way of doing things to a more modern way. It is expected that the use of this form of cryptocurrency and the revolution of blockchain technology will greatly affect the complex design and governance [8].

Blockchain is still considered to be in its embryonic form, however, a lot of scholars are referring to this technology as the new internet [20] [21] [22]. Therefore, most organizations need to be reviewing their ecosystem to realize the blockchain technology value proposition and communicate with the different actors participating. Currently, its benefits are not fully recognized by the various actors. There is some short of resistance; thus, it will enhance any organisation innovation activity if its value is fully understood. As Greenspan (2015) argues, blockchain is both an economic and computer science innovation [23]. Several studies have found a lack of consistency in the definition of innovation [24]. While various definitions of the innovation as a term have been suggested, this paper will adopt the description used by Crossan and Apaydin (2010). Their definition explains innovations as production or adoption, assimilation, and exploitation of a value-added novelty in economic and social spheres; renewal and enlargement of products, services, and markets; development of new methods of production; and establishment of new management systems. "It is both a process and an outcome" [25]. Crossan and Apaydin's (2010) interpretation of innovation involves the exploitation of value for economic and social ecosystems recognized through the development of new and the renewal of old processes and products.

In recent years, much work has been done to distinguish blockchain technology from bitcoin. In 2013, the major discussion revolved around bitcoin, and only in late 2014-2015 that the debate shifted to blockchain and distribution ledgers [26]. The first is a form of digital cryptocurrency or a medium of exchange, and the second is the technology that runs the Bitcoin. Bitcoin is one of the most successful applications of Blockchain technology. As Sally Davies simply explains, "Blockchain is to Bitcoin" what the Internet is to email [27]. Therefore, in 2008, Nakamoto's paper explained how Blockchain would enable Bitcoin is a peer-to-peer electronic money network with tamper-resistance proof [19]. Blockchain technology is a distributed database or tamper-proof, shared ledger that stores transactions in a peer-to-peer network in the form of blocks.

Each block is an invoice of information [28]. Each block is stamped and linked to the previous block. The first blocks are called Genesis, a Greek word referring to birth. Blockchain permanently records the history of transactions between different parties (peers) and stores the data in blocks. This solves one of the significant problems with data tampering. Blockchain systems include: the protocol rules, consensus, ledger, and cryptography. Protocol rules are simply the rules for reaching agreement [29], an algorithm that defines the mechanism for all nodes participants and how they interact. It solves the Byzantine problem in the absence of a central authority to reach consensus between untrusted parties despite the failures. Consensus is an agreement reached by the group—all transactions participating in the system must reach an agreement. Proof-of-work is a consensus strategy used by the network [30]. The blockchain is a distributed ledger with a data structure that affects the architecture of the system. The correct state of the ledger is when all transactions are in the correct order. This can achieve a Proof-of-Work (PoW). PoW is used in Bitcoin for mining; all miners solve a complex cryptographic problem with advanced computing hardware power. The first to solve the problem share it with the rest of the participants (nodes) to reach consensus [29]. The miners who solve the problem first receive a reward for solving the complex problem. Nakamoto made it automatic from the system as an initiative for the miners to participate in the system. The blockchain can only be updated by consensus among the system participants, and any part of the data is available at any time easy to verify [28].

The systems can be open/public or private/permissioned, raising a necessity for identifying its participants. When anyone can have the power of reading and access, a blockchain is referred as open/public. When only authorized parties have access, it is referred to as closed. Depending on the parties involved, the blockchain can be refereed as permissioned or permissionless, depending on whether they need permission to perform a transaction. In the case of public/permissionless, all involved parties worldwide with Internet access can access a transaction and view the blockchain transaction log. Therefore, in principle, blockchain platforms can be divided into two forms: 1) an open/permissionless one that allows anyone to participate either as a miner or as a regular node, (e.g. Ethereum platform) or 2) a private/permissioned blockchain platform that restricts access to a set of known actors that need to identify and authenticate themselves, as in most business-to-business applications, (e.g. Hyperledger Fabric platform). The following **Table 1** is a work done by Martin Valenta, and Philipp Sander in 2017 comparing the three leading blockchain platforms. Therefore, **Table 1** outlines the main features of the top three blockchain platforms used by the enterprises [31]. For the purpose of this research, the focus was on the industry to understand the usability.

The key features of blockchain are that it is decentralized, immutable, global, transparent, self-verifiable, provides a high level of trust, integrity, security, and anonymity, solves the problem data manipulation, and can ensure the security and authenticity of a peer-to-peer transaction. In addition, blockchain technology can enable faster innovation, closer customer relationships, and lower costs [32]. Several applications of blockchain technology leverage the idea of smart contracts developed by Nick Szabo in 1997. More specifically, smart contract between parties that are published on the Blockchain. According to Karamitsos *et al.* (2018) "A smart contract is a code program identified by an address on the Blockchain network" [33]. These types of contracts are very popular because they cannot be modified; untrusted parties can make transactions, so no centralized authority is needed and the system provides transparency.

Table 1. Main features of the three top blockchain platforms [31].

Characteristics	Ethereum	Hyperledger Fabric	R3 Corda
Industry Focus	Cross-Industry	Cross-Industry	Financial Service
Description of platform	Generic Blockchain	Modular Blockchain	Distributed Ledger for Financial Sector
Governance	Ethereum developers	Linux Foundation	R3 Consortium
Mode of operation	Permissionless, public or private	Permissioned, private	Permissioned, private
Consensus	-Proof-of-work (PoW) -Ledger level	-Byzantine Fault Tolerance (BFT) -Transaction level	-Raft -Transaction level
Smart contracts	Smart contract code (e.g., Serpent, Solidity)	Smart contract code (e.g., Go, Java)	Smart contract code (e.g., Kotlin, Java) -Smart legal contract
Currency	Ether -Tokens via smart contract	None -Currency and tokens via chaincode	None

Blockchain has main challenges that can be referred under two categories technical and ecosystem; first is about slow speed/scalability, high electricity consumption for PoW, miners treatment of blocks to generate more revenue, immutability (data cannot be altered), and security (through the use of public and private keys) [34]. In contrast, the second one concerns the ecosystem, such as the lack of regulations, the low awareness of people, and the slow adoption of the technology by companies. Despite all these challenges, Blockchain is expected to have a significant impact on the majority of industries among educational institutions [35] [36] [37].

Fundamental Principles

Scholars are examining the transformation of the traditional education business model to a more modern approach that incorporates the digital age. The education business model is a complex system in which includes; people, objects, and processes that interact and collaborate to deliver education. Educational institutions, both private and public, are highly influenced by the internal and external environment. In 2010, Osterwalder and Pigneur proposed "A nine building block business canvas" in their book Business Model Generation. This canvas incorporates the following elements; value proposition, channels, customer relationships, customer segments, revenue streams, key activities, key resources, key partnership, cost structure [18]. Two main blocks characterize the Value Proposition Canvas (VPC): the value proposition and the customer segment. The purpose of the canvas is to relate the needs of the work with the customer segment and the organization value proposition (VP) to achieve the perfect fit in the market. A typical metadata model is shown in the following **Figure 2**. **Figure 2** describes the different elements related to the customer segment: the customer jobs, the gains and pains relates to the VP part of the product/service, the gain creators, and the pain relievers.

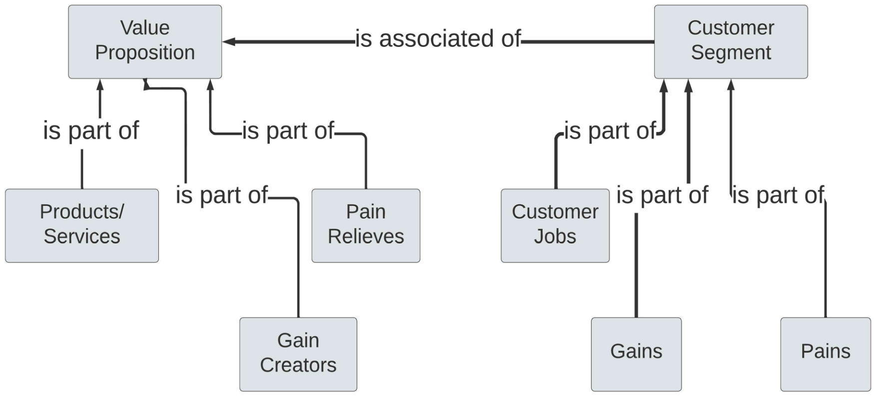

Figure 2. VPC model [38] [39].

The Value Delivery Modeling Language (VDML) was introduced by the Object Management Group (OMG). Michael Porter defined the concept of the value chain in 1985, which is the basis for the VDML methodology. Although the original value chain concept is primarily applicable to the manufacturing industry, it has been used in other industries as well (Stabell and Fjeldstat, 1998) [40]. The use of the value chain prompted management to prioritize customer value and, based on these results, evaluate the company's performance, including supply chains. Within the value chain, there are supporting and operational functions such as human resource management, logistics, and accounting that impact the organization.

James Martin [41] in his book "The Great Transition" (Martin, 1995), further developed the concept of the value chain as a value stream. A value stream methodology establishes a link between the customer's values and the manufacturing activities and capabilities that contribute to those values. The VDML model develops the coexistence of the value stream with the value proposition in terms of customer value and translates it into satisfaction levels for stakeholders.

VDML enables the integration of various modeling techniques with business analysis. It is a conceptual design model composed of various stakeholders and activities, capabilities, resource management, and business values. Consequently, a VDML model can support multiple viewpoints-different abstractions of the design of an enterprise. With these characteristics, VDML is a suitable candidate tool for the value delivery development using blockchain technology. The main components of VDML are as follows.

- Organization Units: Are the collaboration of people and departments involved in value delivery.
- Collaboration of business networks: Consists of various business organization involved in goods and services.
- Collaboration of community networks: Represents specific professional groups that deliver value.
- Capability Method: It is a template that describes the activities and roles that deliver a capability as a result of collaboration between organizations.

The VDML components are depicted in the following **Figure 3**.

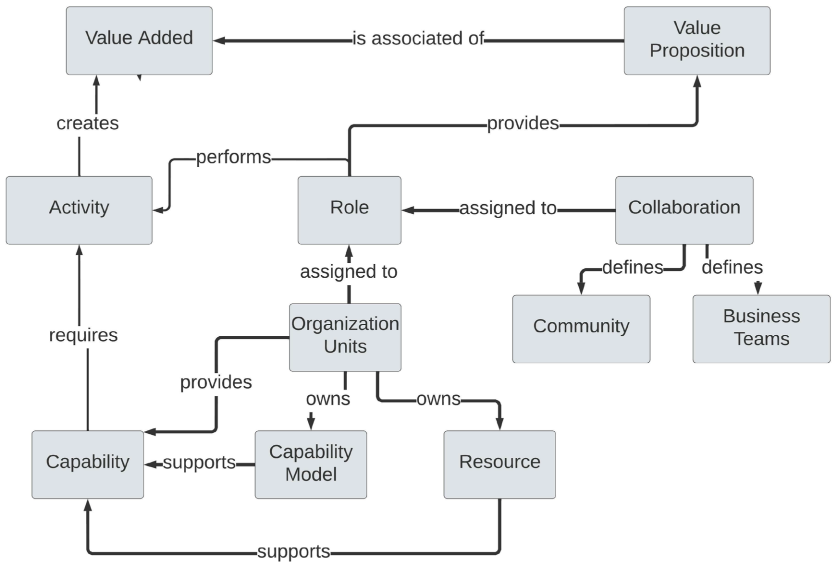

Figure 3. VDML model.

VDML approach, the two most important factors for analysis are the creation and exchange of value. A value is a quantitative outcome delivered to a participant/actor with a deliverable. A deliverable is the result of the transformation of multiple values.

Value added element represents value properties contributed by different activities participating in the delivery of the service. For a service, the value-added element for the same type of value is aggregated to determine the impact of the value proposition element. The value-added element for that value can help identify activities and supporting capabilities that might be improved to enhance recipient value.

Capability is fundamental to the delivery of a service and VDML is a framework for optimized and identified capabilities within the organization. Service delivery is accomplished by the use of capabilities that add value through the execution of activities. Organizational units are responsible for the capabilities and their delivery through internal resources or outsourcing. Resources are a pool of talented people with skills, and knowledge, and tools, as well as equipment and tools that support the execution of the capabilities.

Collaboration is another fundamental concept of VDML It is the interaction between multiple actors for a common goal. Collaboration can define the roles of participants through different activities that can be visualized as activity networks. In our study, collaboration is represented with four different types: Business Network, Capability Methods, Organizational Units, and Community. A business network consists of economically independent collaboration participants that create economic value for the community. An organizational unit is part of the collaboration with the entire organizational structure and is responsible for resources. The use of the capability method is a well-established approach to collaboration in VDML. Its main function is to enable collaboration between different elements such as people, roles, activities, resources, deliverables, and results. When a request triggers a capability method, selected roles are distributed to people who perform specific activities. Subsequently, these individuals use resources and tools to achieve results. An activity network is used to describe the capability method in detail. Activities are the main part of the activity network and define the workload and efforts for the different participants roles within collaboration.

The next step of this study is the mapping between the objects represented in the VPC and VDML metamodels.

4. Conceptual Framing

Our proposed VPC and VDML are designed for the two most widely used open-source blockchain platforms:

1) Ethereum is a mature, smart contracting cross-industry public/permissionless platform designed for mass consumption. The main features for this platform are as follows:

- Organization Type: Any vertical industry
- Consensus Protocol: Proof of Work (PoW)
- Participants: Ethereum Developers
- Smart Contract Support: Yes
- Ledger Type: Permissionless

2) Hyperledger Fabric—which is a private/permissioned B2B-focused modular blockchain platform that is designed for plug-and-play components around consensus and membership services. The main features for this platform are as follows:

- Organization Type: Any vertical industry
- Consensus Algorithm: Byzantine Fault Tolerance
- Participants: Developers-Linux Foundation
- Ledger Type: Permissioned

Table 2 shows the mapping between the VPC and VDML approaches.

Table 2. Mapping objects between VPC and VDML approaches.

Value Proposition Canvas (VPC)	VDML
Value Proposition	Value Proposition
Customer Segment	Role
Products and services	Business item
Pain relievers	Value added
Gain creators	Value added
Gains	-
Pains	-
Customer jobs	Activity
-	Org unit/Participant
-	Collaboration

VPC model is a potential tool for the value proposition definition in the Blockchain context. The various components described in the previous section composed of different components. The mapping of the components is depicted in the following **Table 3**.

Table 3. Value proposition components.

Value Proposition components	Blockchain components
Products/Services	Smart Contract dApp BCaaS
Gain Creators	Transparency Security sharing data Decentralized approach Fair Pricing
Pain relievers	Elimination of centralized processes No intermediaries Security

For the customer segment components, the mapping of the objects with the blockchain context is depicted in the following **Table 4**.

Table 4. Customer segment components.

Customer Segment components	Blockchain components
Customer Jobs	Creation of new jobs
Pains	Scalability The difficulty of technology adoption No mature technology Elimination of jobs
Gains	Speed Increase customer loyalty Trust Minimize the interactions with intermediates

4.1. Blockchain VDML Model

Blockchain VDML model provides a robust collaboration of transactions (activities) and smart contract (capability method) linked to responsible actors (organization units) and the management of activities through validation and trust. A capability method is an enterprise architecture process that resides at the value layer and whose primary function is to provide capabilities. The VDML model is applicable in the blockchain context. An association table between VDML and Blockchain is presented in the following **Table 5**.

Table 5. Blockchain VDML model.

VDML objects	Blockchain objects
Organisation units	People and Departments involved in the blockchain network
Business network collaboration	Blockchain actors and stakeholders
Community network collaboration	Miners, Developers
Capability method	Smart Contract
Activities	Transactions/Trust/Validation/Mining

The blockchain VDML model is the following as shows in Figure 4.

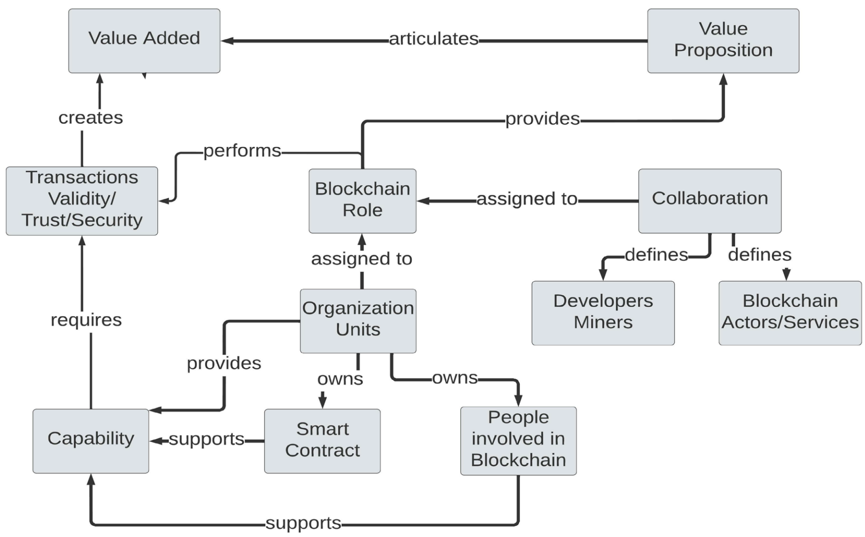

Figure 4. Blockchain VDML metamodel.

This VDML metamodel provides a higher level abstraction of the relation between the value proposition and the customer. The "activities" building block defines what functions (validity and trust) are required to create, capture, deliver the value proposition to the targeted customer. According to VDML, activities require capabilities. Capabilities are applied through activities. For istance, one of the capability that is required to perform the activity "Certificate Validation" is the capability "Smart Contract". As Figure 4 suggests, all blockchain actors and stakeholders that collobarate, in the business network may provide and receive value propositions from each other.

4.2. Mapping VPC and VDML Blockchain Models

For VPC and VDML modeling this study uses mapping techniques for metamodels. As shown in Figure 5, the main components of the VDML are mapped to the dimensions of VPC. In addition, all associations between VPC components and dimensions are also represented in the VDML diagram. Thus, VDML-based models provide a structured and detailed representation of VPC items and their relationships.

Figure 5 shows the mapping VPC and VDML blockchain models.

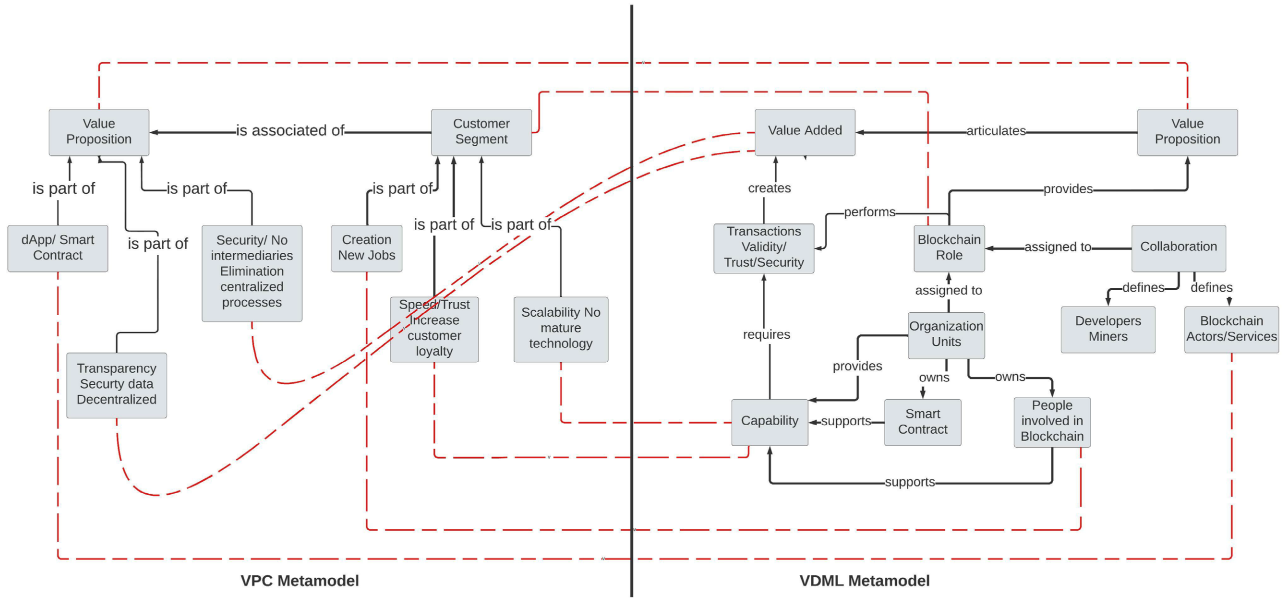

Figure 5. Value Proposition Canvas (VPC) and VDML metamodels mapping.

5. Use Case—Academic Certificates

This use case will be considering the education sector and, more specifically, the value of issuing certificates using blockchain technology. So, before moving on, it is useful to understand the risks and opportunities that this sector is experiencing in order to make appropriate arguments. So, is blockchain the appropriate technology to mitigate the risks and capitalize on the opportunities in certificate issuance? And if so how can blockchain be introduced as a service? And how can the education sector realize the value of implementing such technology? The education sector has suffered from fake degrees for more than 40 years. Allen Ezell and John Bear, in their book Degree Mills: The Billion-Dollar Industry, argued that until the risk of faking a degree has been relatively low until now. They found that more than one million people are in possession of a fake degree, which has been a criminal offense in the U.S. since 2006.

The purpose of this use case is to validate the VPC and VDML metamodels and notation, and to provide the knowledge of how VDML can be used to develop a blockchain model for evaluating a proposed change in academic education.

The VPC model is a potential tool for defining the value proposition in the blockchain context. The various components described in the previous section composed are made up of different components. The mapping of the components is depicted is shown in Figure 6.

Table 6 shows the blockchain VDML model for academic use case.

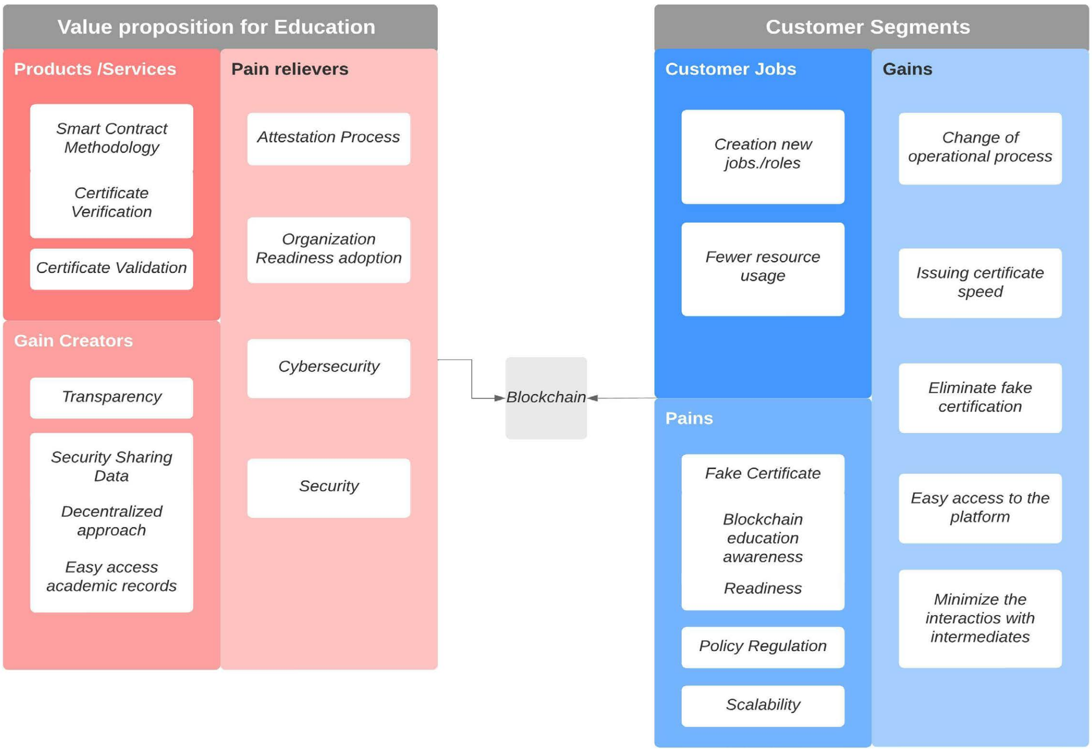

Figure 6. Value Proposition Canvas (VPC).

Table 6. Blockchain VDML model for Academic.

VDML objects	Blockchain objects
Organization units	University Departments: Finance, HR, Student Administration, office of Quality, IT and Alumni.
Business network collaboration	Hosted University, Government institution (Ministry of Education), and private organizations (Recruitment)
Community network collaboration	Miners, Developers, University IT department
Capability method	Smart Contract /Certificate
Activities	Transactions/Trust/Certificate Validation/Mining

In the following it is shown how each of the VPC products/services is expanded a corresponding VDML diagram. For this study the certificate validation is selected from VPC services and the corresponding activity in VDML. A VDML activity network diagram that highlights that activity can be stated as shown in Figure 7.

Then VDML capability management diagram is presented in Figure 8. According to VDML activities require capabilities. For instance, one of the capabilities that are required to perform the activity "Certificate validation" is the capability "Smart Contract" as provided and managed by the "Blockchain Network" of the University. The capability management diagram for the certificate validation with a capability offer highlighted is presented. It shows some of the university organization units responsible for certain capability offers, apply their capabilities by performing capability methods and managing resources.

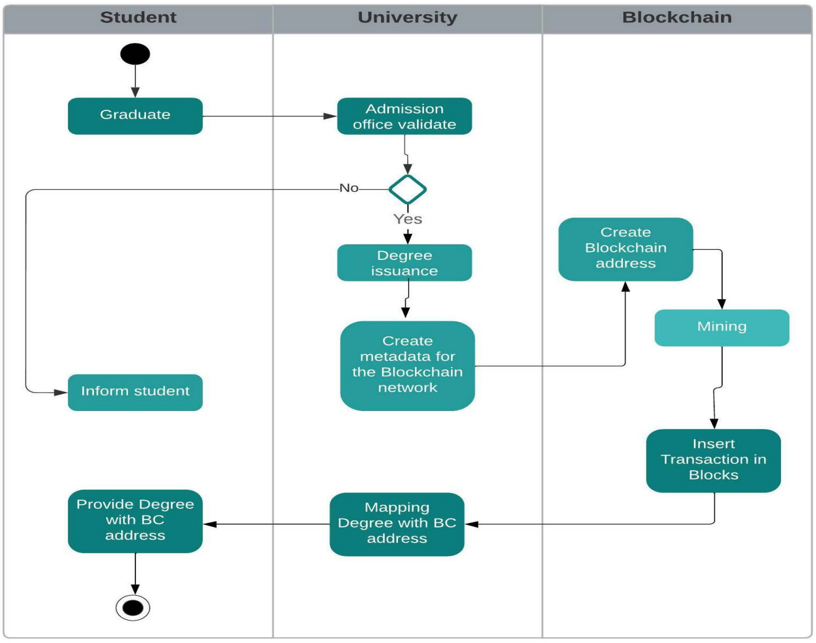

Figure 7. Blockchain certificate issuance.

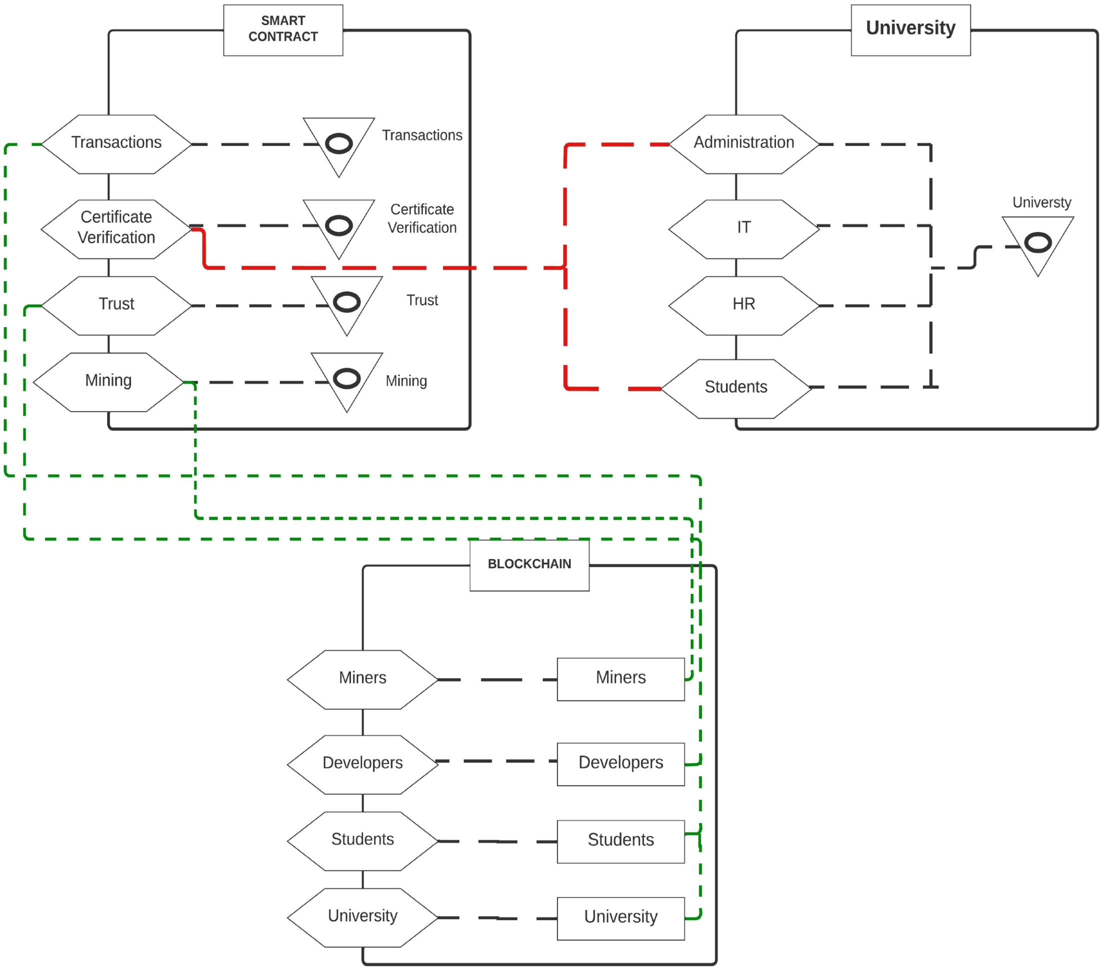

Figure 8. VDML capability management diagram.

A large box represents an organization unit, named in the small box at the top of the larger box. The stretched hexagons on the left side of the organization units boxes represent capability offers of the associated organization unit. The rectangles connected to the capability offering by bold, dashed lines represents the methods by which the capability is provided. The fine, dotted lines illustrate how a capability (method) depends on other capabilities (capability offers).

6. Conclusions

This research has focused on blockchain technology. Blockchain technology still needs significant research to be integrated into the academic environment. The risk of such technology operating in anarchy has significant implications for the culture, economic, and financial stability of organizations, governments, and society as a whole. This paper contributes to the question of how disruptive innovations can be better introduced without losing sight of value.

This paper proposes an improvement that can be made in the education sector in the context of blockchain integration. Part of the literature review conducted in this area has shown that there is limited research on the use of both concepts to improve strategic planning and business operations in the education sector. This research proposes a new theory that considers Blockchain as a Service (BCaaS) from the perspective of a value modeling approach.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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