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# HOW WILL BLOCKCHAIN TRANSFORM THE ED-TECH INDUSTRY? INTEGRATION OF BLOCKCHAIN TECHNOLOGY IN LEARNING MANAGEMENT SYSTEMS (LMSs) IN TURKEY

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## ABSTRACT

*We are witnessing cut-throat competition in the business world, and rapid changes in technology are transforming business models. Blockchain technology has been implemented in various industries, such as finance, real estate, and healthcare. Yet, Blockchain applications are still in the early stages in the education sector, and the number of educational institutions utilizing the full strength of Blockchain technology is limited. Learning Management Systems (LMSs) are the backbone of any education program. However, traditional learning management systems are not geared towards special-needs learners. They do not adapt well to the new academic landscape that has transformed with the immense adoption of Massive Open Online Courses (MOOCs). As Blockchain offers a decentralized and distributed approach, integrating Blockchain technologies in the educational sector may generate numerous opportunities. In this study, the benefits of Blockchain applications will be discussed. Moreover, the impacts of using Blockchain technology in Learning Management Systems (LMSs) on user experiences and developer experiences will be presented with a survey and semi-structured in-depth interviews, which will be conducted in an ed-tech start-up in Turkey. Hence, this study will put forward the implications of the integration of Blockchain technology on LMSs, focusing on users' experiences in learning processes and developers' experiences in building the LMS application. Due to the research gap regarding the applications of Blockchain technology in LMSs, this study may produce valuable contributions by providing a thorough analysis of the benefits and challenges of integrating Blockchain technology in LMSs, for researchers as well as companies operating in the ed-tech industry.*

***Keywords:*** *Blockchain, Learning Management Systems (LMSs), Ed-tech Industry, User Experience*

## 1. INTRODUCTION

We are witnessing cut-throat competition in the business world, and rapid changes in technology are transforming business models. Blockchain technology has been implemented in various industries, such as finance, real estate, and healthcare. Yet, Blockchain applications are still in the early stages in the education sector, and the number of educational institutions utilizing the full strength of Blockchain technology is limited.

Since the invention of Bitcoin, a digital currency, in 2008, many researchers and professionals have become more interested in blockchain technology. When the industry is overgrowing, demand for more research in Blockchain emerges to explore and showcase its

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full potential. According to the study of Dabbagh, Sookhak, and Safa (2019), only the Web of Science (WoS) has recently indexed more than 1000 scientific papers on Blockchain.

Blockchain is a decentralized ledger that securely, independently verifies, and transparently records all transactions that have taken place on top of a peer-to-peer network (Dabbagh et al., 2019)**.** The decentralized nature of the blockchain network makes it reliable and it also helps to align the associated databases as transaction records are updated over time. The reliability of the applications built using blockchain technology is ensured by preventing any operational failures to influence the entire system (Bhaskar, Tiwari, & Joshi, 2020).

The Blockchain technology became well-known in 2008 when the Bitcoin system adopted it to track and store transactions in a decentralized manner. In fact, the original generation of blockchain systems (Blockchain 1.0) evolved into several platforms today regarded as Blockchain 2.0, including IBM Blockchain, Hyperledger Sawtooth, Ethereum, Hyperledger Fabric, and Quorum (Hu et al., 2021). As a result, Blockchain applications now cover many diverse grounds. Nevertheless, these new applications add essential elements to next generation platforms, such as platform interconnection or more sophisticated "smart contracts." As a result, a new generation of solutions known as Blockchain 4.0 is currently being created (Colomo-Palacios, Sánchez-Gordón, & Arias-Aranda, 2020).

It is important to note that technology and financial services spent more than $1 billion in 2016 on implementing Blockchain, which has proven how rapidly the blockchain market is growing. This amount is likely to rise sharply over the following years. The blockchain market is predicted to grow even more in the coming years, the volume of which is predicted to reach $67.4 billion by 2026. This is because of increasing technological investments, significant usage of blockchain-based solutions in banking and cybersecurity, and widespread use for payments, smart contracts, and digital identities.

Given that the education sector has been embracing new technologies to extend and enhance various educational processes for more than a century, it is not surprising that introducing Blockchain has increased interest in learning through multiple means of knowledge presentation (Dabbagh et al., 2019). Blockchain applications are still in the early stages in the education sector, and the number of educational institutions utilizing the full strength of Blockchain technology is limited although Blockchain seems to have an enormous potential to help the whole educational industry.

On the other hand, an emerging topic in the education sector is integrating Blockchain into the learning management system (LMS). LMS is an integrated lecture-based system with a platform for online learning, including information presentation, e-learning materials, and assessing student work; communication with peers and instructors, submission of homework, and an active learner-to-learner discussion between participants.

LMSs, also known as learning platforms, distributed learning systems, course management systems, content management systems, and instructional management systems, combine a variety of pedagogical and course management tools to enable the creation, development, and

delivery of online learning environments. It is primarily a framework that allows students to access materials from lectures, discussions, and exams and serves as a platform for virtual interaction between teachers and other students (Goh, Hong, & Gunawan, 2013).

As Blockchain offers a decentralized and distributed approach, integrating Blockchain technologies in the educational sector can generate numerous opportunities. Blockchain brings various benefits such as enhanced data security, increased accountability, and transparency, lower transaction and data storage costs, verification of student identities and digital certificates, and improvements in the evaluation of learning outcomes and student performance (Alammary, Alhazmi, Almasri, & Gillani, 2019). Chen, Xu, Lu, and Chen (2018) argued that there had been several instances of degree fraud. This can be prevented by using Blockchain when granting degrees to students straightaway. As the world's miners check, validate, and maintain the data contained in Blockchain that has been linked with users' IDs, the distributed ledger on the Blockchain is guaranteed to be reliable and unchangeable. As a result, authority and dependability are both guaranteed, thus reducing the risk of fraud. Moreover, Blockchain can be used to encourage students to be more motivated and engaged in the learning process by using the "learning is earning" principle thanks to its resemblance to currency (Sharples & Domingue, 2016). Thus, it may help LMSs to improve learner retention rates. The blockchain learning ledger specifically keeps track of the users' learning experiences and their progress in terms of knowledge and skills. According to a set of detailed standards, each can be converted into a digital currency and kept on a blockchain network. Through their study efforts, students will receive incentives, which is known as "learning is earning." Most Blockchain studies in the education sector focused on certification, tokenization, and data privacy.

While Blockchain is transforming the education sector, it reflects how we looked up to the traditional LMS. Therefore, applying the advantages of the Blockchain on LMS brings a modern era to the field of education. Even though Blockchain is a hot topic in the educational sector, there are no specific studies on blockchain-based LMS to our knowledge. In this study, the benefits of Blockchain applications will be discussed. Moreover, the impacts of using Blockchain technology in Learning Management Systems (LMSs) on user experiences and developer experiences will be presented in an in-depth interview, which will be conducted in an ed-tech start-up in Turkey. Hence, this study will put forward the implications of the integration of Blockchain technology on LMSs, focusing on users' experiences in learning processes and developers' experiences in building the LMSs application. Due to the research gap regarding the applications of Blockchain technology in LMSs, this study may produce valuable contributions by providing a thorough analysis of the benefits and challenges of integrating Blockchain technology in LMSs, for researchers and companies in the ed-tech industry.

The remainder of the paper is organized as follows: Section 2 presents the theoretical background, Section 3 describes materials and methodology followed by Section 4, which

describes the results. Section 5 discusses the conclusion and implications, and Section 6 highlights the limitations as well as suggestions for future research.

## 2. THEORETICAL BACKGROUND

### Blockchain- An overview

The important benefit of Blockchain over current technologies is that it allows two parties to conduct secure online transactions without the involvement of a third-party middleman. By leaving out the third party, processing costs can be decreased while transaction security and effectiveness are increased (Dabbagh et al., 2019).

Blockchain can be modelled in two ways: permissioned and permissionless Blockchain. permissioned blockchains often known as private blockchains which need permission to join. Examples include Monax and Multichain, for instance. On the other hand, a blockchain without permissions enables open system participation. Bitcoin and Ethereum are traditional instances of these blockchains, as are Monero or Zcash more recently. Control and governance mechanisms of these models are drastically different from the perspective of technology evolution (Colomo-Palacios et al., 2020). Blockchain has developed tremendously over time, progressing from its initial iteration to its fourth edition. Following are the major developments of Blockchain industry:

### Blockchain 1:0

The first and most obvious application of distributed ledger technology (DLT) is cryptocurrency. This enables the execution of financial transactions based on blockchain technology or DLT, frequently used interchangeably for simplicity. The most notable example in this area is Bitcoin. It serves as a digital payment system, "currency for the Internet," and is sometimes referred to as the "Internet of Money."

### Blockchain 2:0

Smart Contracts are the brand-new central idea. They are self-sufficient computer programs that run automatically under predetermined conditions, such as facilitating, verifying, or enforcing contract fulfilment. One significant benefit of this technology is that Smart Contracts cannot be altered or compromised. Therefore, smart contracts enable transparent contract definition, which solves the moral hazard issue while lowering the cost of verification, execution, arbitration, and fraud prevention. The Ethereum Blockchain, which aims to enable the development of Smart Contracts, is the most well-known in this area.

### Blockchain 3.0

Decentralized applications that avoid centralized infrastructure are referred to as DApps. Most DApps run their backend code on a decentralized peer-to-peer network, a blockchain because it uses decentralized storage and communication. A conventional app, in contrast, runs its backend code on centralized servers. Like a conventional App, a DApp can have

frontend code and user interfaces written in any language that can call its backend. A Dapp, however, has the option of hosting its frontend on a decentralized storage system like Ethereum's Swarm.

**Blockchain 4.0**

With the foundations set by older versions, Blockchain 4.0 provides methods and strategies that enable blockchain technology to be used for commercial needs. Blockchain 4.0 focused on Industry 4.0 demands such as automation, corporate resource planning, and integration of various execution systems. However, this industrial transformation necessitates a higher level of privacy protection and trust; here is where blockchain comes into play. Blockchain technology results in business integration, which enables cross-system/cross-blockchain business activities, such as machines ordering replacement components safely and autonomously.

**Blockchain and Education Sector**

Future technology will be developed for students' benefit because the education sector's scope is so enormous. However, digitalization brought some difficulties to the education sector as security of data, the privacy of students, and increased proportion of digital learning compared to classroom learning. Hackers are searching for sensitive information in the education sector. The traditional education system is less secure than blockchain technology, since sensitive information is stored in traditional systems. A few common issues the traditional education sector faces are certificate forgery, digital grading difficulty, and using copyright content when teaching students. Because they are susceptible to numerous security attacks, conventional systems cannot handle these issues.

To overcome these challenges, various universities and institutions now use Blockchain technology in the education sector (Sharples & Domingue, 2016). Most of these are using Blockchain technology in academic degree management and evaluation of learning outcomes. As the first institution to use blockchain technology to store degrees, Holberton School planned to include all types of educational data to be matched on the blockchain ledger with the user's ID. It incorporates classroom learning style, prior experience with small-scale academic projects, comprehensive educational history, and many more (Chen et al., 2018). Similarly, The University of Nicosia is the first institution to administer student certificates via MOOC platforms using blockchain technology (Sharples & Domingue, 2016). The Massachusetts Institute of Technology (MIT) and the Learning Machine company collaborated to design a digital badge for online learning based on blockchain technology (Skiba). Students who joined MIT Media Lab projects and qualified for the assessment received a certification, which would be collected as a non-fungible token (NFT).

Furthermore, complete transcripts can be created using blockchain technology. In a traditional transcript, we could only include the content of subjects and the outcomes from that examination. However, Blockchain can formulate the whole transcript by including the information about research experience, skills, online learning experience, and individual

interests. These data can be accessed appropriately and safely on a blockchain network (Chen et al., 2018). At the same time, Turkey has launched the country's first university-level blockchain centre in 2018, seeking to close the blockchain expertise gap and ensure wide deployment of the technology.

The benefit of utilizing Blockchain in education is widely discussed in the literature. For example, Swan (2015) claimed that Blockchain technology helps the education sector by enabling the retrieval of data across all linked parties due to its architecture as a digital network (for example, a person's educational achievements are saved through hashes).

A key component of blockchain technology is tokenization. Teachers will soon be able to motivate students by rewarding them with cryptocurrencies, if they perform well or complete a specific major (Chen et al., 2018). The gamification component of teaching methodology with tokens has shown to be very successful. In addition, academic institutions will be able to incentivize students to repay their student debts on time with the tokens earned.

Similarly, Blockchain's immutable ledger technology creates a chronological record of current events. This works well for reviewing transcripts, showing a full report card, and updating students on their progress. When students turn in an assignment using Blockchain, they cannot "lose" it or argue that the teacher misplaced it. More interestingly, an adaptation of Blockchain in education can lower the costs of education for the students as well as for the institutions providing education. The public domain and freely redistributable open educational resources, such as books, podcasts, and movies, may be made available to everyone using the blockchain technology. Blockchain can enable a cheap and safe sharing of these resources in a public network.

Now, as we realize, the benefits of Blockchain technology to the education sector are booming. However, how does a learner take the most advantage of it? From a learner's perspective, reaping most of the benefits offered by a platform is essential to ease the learning process. That is where an LMS plays a major role. In fact, many countries have implemented significant technological investments to improve the capacity and quality of education. Despite all the prospects of investing in technological infrastructure, tools, and career development, many countries are still lagging behind especially in terms of the quality of education. They lack the technological resources to adopt and integrate LMS in learning and teaching (Buabeng-Andoh, 2018).

The educational sector is undergoing significant changes and reforms. Therefore, it is wise to consider how information and communication technologies are used in university teaching and learning as well as educational measurement and evaluation (Oguguo et al., 2021). Technology in the classroom is not new; it has been used for many years, and computers are now widely used in higher education institutions in the developed world. Conventional approaches were pushed to their limits by an attempt to integrate technology into the interaction between teaching and learning. The use of modern technology, such as learning

management systems in education, is crucial to staying current with technological advancements in the teaching and learning fields (Munabi, Aguti, & Nabushawo, 2020).

In this respect, LMS stands out as an essential information system that manages and distributes educational content while providing support and guidance to enhance teacher-student interactions (Indahyanti & Sukarjadi, 2015). Similarly, LMS helps educational institutions create, implement, and evaluate learning systems. It is frequently utilized by universities and other higher education organizations to build an extensive digital instructional infrastructure (Eraslan Yalcin & Kutlu, 2019).

There seems to be a positive relationship between LMS and learning outcomes of students, as learning abilities of students tend to increase in classes that utilize LMS (Maslov, Nikou, & Hansen, 2021). Students' capacity to learn inside and outside of the classroom is positively impacted by the accessibility of the course materials provided by the LMS (Nair & Patil, 2012).

Although the primary functions of an LMS have not changed, learning management companies' attention has switched to creating customized solutions, as technology advances and businesses strive for a larger market share (Eraslan Yalcin & Kutlu, 2019). As LMS plays a vital role in bringing all learning features into one platform, the discussion of integrating Blockchain into the LMS has started. For example, Lévy, Stumpf-Wollersheim, and Welpe (2018) claimed that Blockchain could be used as a storekeeper for various educational data, from individual certificates to different sets of performance data. So blockchain integration to the existing LMS will help the learners to keep their data secure and private. In addition, there are numerous ways that Blockchain technology might improve education. Tokens, for instance, might be used to inspire students (Chen et al., 2018). For instance, in the traditional education system, the students are motivated by the grade they get from college/universities. However, what if the college/universities facilitate rewarding the students with tokens while they complete any task or project?

More specifically, Blockchains that support smart contracts can be used to carry out automatic learning and tasks. As a result, it is possible to encode lessons and courses into the Blockchain to complete them automatically through specific criteria. For example, a teacher might assign tasks to the students, and smart contracts on the Blockchain may automatically check each assignment. After finishing all responsibilities, teachers will get paid in cryptocurrency tokens, and students will receive their credits. This arrangement is applicable for entire courses. Likewise, when student data, such as credentials, and acquired skills, are saved on the Blockchain, and are not controlled by a single central authority, such as a university, the student can store those data for as long as they wish and has complete ownership and control over them.

On the other hand, this establishes trust in the eyes of employers by demonstrating the accuracy of the material presented in students' resume. Moreover, Blockchain can automate

most educational tasks and lessen manual work in the conventional educational system. In addition, schools and universities could decrease costs by eliminating intermediaries in many operations. As a result, educational institutions incur lower costs, which may be reflected in lower student fees meaning saving money for students.

Most universities still follow the traditional patterns from the Middle Ages, where teachers taught, and students learned. Even most modern online models, including MOOCs, implement the ideas we oversee in traditional ones in the fields of content development, content accessibility and teaching approach. Poor implementation and performance in these fields usually leads to low student retention as well as low user motivation (among teachers and students). These factors may frequently result in a business strategy that harms users through high costs, a poor return on investment, and unaffordable student debts.

Blockchains have already changed the economic landscape through cryptocurrencies. So, it is essential to analyse how blockchains could impact education in the present and future scenarios. Furthermore, the literature found an enormous research gap regarding the applications of Blockchain technology in LMSs. Hence, this study may produce valuable contributions by providing a thorough analysis of the benefits and challenges of integrating Blockchain technology in LMSs, for researchers and companies in the ed-tech industry.

**LOKUM: A Blockchain-based Learning Management System**

LOKUM is an LMS developed by Tech Career Yazılım Danışmanlık Anonim Şirketi, a Turkish Ed-tech company. LOKUM is designed to reimagine learning with the power of Blockchain. LMS is used by both government and private sector institutions in universities, formal education, and corporate training. The problem of scaling with the increasing number of users in the current LMS systems is that the control mechanisms are not strong enough to prevent the problem of forgery in documents. However, with a Blockchain-based, gamified, and scalable LMS, authentication can be done securely. While document fraud can be prevented by recording processes on the Blockchain, the scaling problem can be eliminated with the latest software infrastructure. Furthermore, identity verification will be ensured by keeping personal data under protection with blockchain technology, while data security and privacy will be ensured.

In the current education systems, there is a solid attempt to overcome the identity verification problems and to document the diplomas, certificates and trainings received as well as recording the processes, and private data in the databases of the systems and institutions. LOKUM, with its Blockchain integrated feature, will secure the user's data, avoid forgery regarding certificates and diplomas, and smoothen identity verifications. Another problem faced by current LMS is scaling. The majority of the LMSs are developed with old technologies. Although the high growth of data with developing technologies is forecasted, they cannot provide a solution to managing the "big data" created by the introduction of web2, web3, and industry 4.0 and they remain unchanged for years. At the same time, LOKUM is built in a way that must be scalable, secure, and futuristic. The front-end of the LOKUM is written in JavaScript with a modern framework called React, while the server

side is written in a framework known as Spring boot. This application also uses the technologies such as Kafka and Zookeeper. It also uses the power of cloud engineering with AWS to deploy all services. All these applications are containerized in Docker; hence, they can be scaled in the future. Moreover, this orchestration of containerization has been done by using Kubernetes. For Blockchain integration, Solidity has been used as a language and Matic for the deployment of contracts.

The advantage of the LOKUM over other LMS is that it is blockchain-based and scalable, and processes can be followed transparently. With a new generation LMS, innovation will be achieved both in the product and in the process. A high-tech LMS may offer a high added value by meeting and exceeding current needs of learners. Following are the key benefits of LOKUM as a Blockchain-based LMS over a traditional LMS, which were identified through the in-depth interview conducted with the Chief Developer of LOKUM:

- It is easy to track the trainees' performance and collect user feedback within itself.
- Blockchain technology allows unchangeable recording of transactions and information such as identity verification and document/certificate validity verification.
- It provides a personalized learning experience with artificial intelligence-based data analytics
- It increases user interaction with gamified design mechanisms, including tokenization as a reward system for the trainees.
- It provides full mobile access to the instructional management system without reducing its usage capacity or features.
- It enables learners to open their crypto wallet within the system and make transactions.
- It offers an exclusive video/audio messenger system to improve the communication of learners

Considering the significance of the integration of Blockchain technology on LMSs and the research gap in this field, this study will analyse the impacts of using LOKUM, a Blockchain-based LMS from the perspective of learners and developers through a survey and semi-structured in-depth interviews.

## 3. DATA AND METHODOLOGY

As this study investigates the impact of integrating Blockchain into LMS, the participants are categorized as users and developers. Users are the trainees utilizing the LOKUM platform as their blockchain-based LMS. At the same time, developers' perspectives are also collected to understand the framework of LOKUM and its future potential as a Blockchain-based LMS. To understand the user’s perspective over LOKUM we distributed 30 questions to 40 participants and among 30 questions, 18 are designed as a four-Likert scale.

We also interviewed two blockchain developers who worked behind the LOKUM, with experience in JavaScript, HTML5, CSS3, React Native, NodeJS and MongoDB. To understand users' experience with Blockchain-based LMS, we conducted semi-structured in-depth user experience interviews with six trainees who is using LOKUM as their LMS. The interview is based on a formative measurement model of user experience developed by (Topolewski et al., 2019). In the adapted model by Topolewski the eight user experience properties are excluded from the model, since those properties do not apply to the sample Blockchain-based LMS at the current stage. The properties include attentiveness, helpfulness, respectfulness, responsiveness, collaborativeness, communication, confidence, and comprehensiveness. The adapted user experience properties stand for human, social and business dimensions. The human dimension describes emotional and cognitive factors, the social dimension illustrates emphatical and interpersonal factors, and the business dimension shows economic and technological factors. The definitions of the user experience properties which were used to develop the questionnaire are as follows:

Table 1. User Experience Properties

| **Properties** | **Description** |
|---|---|
| Entertaining | Degree to which the Blockchain-based LMS entertains users |
| Pleasantness | Degree to which the Blockchain-based LMS is pleasant to use |
| Productivity | Degree to which the Blockchain-based LMS helps users to be more productive |
| Usefulness | Degree to which the Blockchain-based LMS allows users to carry out specific tasks |
| Novelty | Degree to which the Blockchain-based LMS is new to the user |
| Efficiency | Degree to which the Blockchain-based LMS allows users to be efficient |
| Reliability | Degree to which the Blockchain-based LMS is reliable |
| User-Friendliness | Degree to which the Blockchain-based LMS is easy-to-use and intuitive enough |
| Attractiveness | Degree to which the Blockchain-based LMS is visually attractive |
| Enjoyment | Degree to which the Blockchain-based LMS is enjoyable |
| Fulfilment | Degree to which the Blockchain-based LMS allows users to achieve properly a task |
| Engagement | Degree to which the Blockchain-based LMS allows users to engage in their task |
| Meaningfulness | Degree to which the Blockchain-based LMS allows users to provide meaningful results |
| Convincingness | Degree to which users are convinced of using Blockchain-based LMS soon |
| Willingness | Degree to which users are willing to re-use |
| Recommend | Degree to which users are willing to recommend using |

| | |
|---|---|
| | Blockchain-based LMS |

## 4. RESULTS

### 4.1 Descriptive Analysis

A questionnaire including 30 questions is distributed to the trainees using LOKUM as their LMS. Among 30 questions, 18 are designed as a Four-Likert scale. The rest of the questions are designed to understand trainees' experience with LMS and their descriptive opinion about LOKUM. As shown in Appendix 1, 24 trainees use LOKUM daily for their learning, 4 use LOKUM twice a week, and 11 depend on LOKUM thrice a week. At last, just 1 trainee uses LOKUM once a week. This shows that the participant for this survey is actively using LOKUM as their LMS. Appendix 2 explains the experience of participants in using LMS. It is evident that 21 participants are familiar with LMS whereas 19 participants are using LOKUM as their first LMS. At the same time, appendix 3 shows that only 1 participant has had an experience with a Blockchain-based LMS during their college or e-learning. Therefore, 39 participants are new to the Blockchain-integrated LMS. Finally, there is an exciting finding regarding trainees' knowledge of the Blockchain platform. As shown in Appendix 4 and 5, the study found that 23 participants had very low knowledge of Blockchain, 13 had below average, 1 above average, and 3 had excellent knowledge of Blockchain. However, after using LOKUM as their LMS, 25 participants claimed above-average knowledge on Blockchain, while 8 participants claimed they had excellent knowledge on Blockchain.

Last but not least, when we asked about their preference for using a Blockchain-based LMS over other traditional LMSs in the market, 37 participants chose a Blockchain-based LMS over a traditional LMS. In contrast, 3 chose a traditional LMS, which is shown in appendix 6.

Descriptive analysis of the survey (Four-Likert scale) is given in Table 2 and Table 3.

Table 2. Descriptive Analysis of Statements in the Survey

| Statements | SA | A | D | SD | Total | Mean | SD | Max | Min |
|---|---|---|---|---|---|---|---|---|---|
| ***Usefulness of LMS*** | | | | | | | | | |
| I would prefer using Learning Management Systems (LMS) to facilitate my learning process | 26 | 13 | 0 | 1 | 40 | 3.6 | 3.122 | 26 | 0 |
| Learning Management Systems (LMS) are useful because they organize the learning content effectively | 24 | 15 | 0 | 1 | 40 | 3.55 | 3.074 | 24 | 0 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Learning Management Systems (LMS) are useful because they easily track learner progress and performance | 24 | 15 | 0 | 1 | 40 | 3.55 | 3.074 | 24 | 0 |
| Learning Management Systems (LMS) are useful because they allow for greater flexibility | 24 | 13 | 2 | 1 | 40 | 3.5 | 3.041 | 24 | 0 |
| Learning Management Systems (LMS) are useful because they encourage social learning and communication | 21 | 17 | 1 | 1 | 40 | 3.45 | 2.983 | 21 | 0 |
| | | | | | | ***3.53/4*** | | | |
| ***Preference for Blockchain- based LMS*** | | | | | | | | | |
| I prefer Blockchain- based Learning Management Systems (LMS) because they provide data privacy | 21 | 17 | 1 | 1 | 40 | 3.45 | 2.983 | 21 | 0 |
| I prefer Blockchain- based Learning Management Systems (LMS) because they are automated | 20 | 17 | 2 | 1 | 40 | 3.4 | 2.941 | 20 | 0 |
| I prefer Blockchain- based Learning Management Systems (LMS) because they have limited intermediaries | 16 | 21 | 2 | 1 | 40 | 3.3 | 2.837 | 21 | 0 |
| I prefer Blockchain- based Learning Management Systems (LMS) because they are easy to use | 20 | 17 | 2 | 1 | 40 | 3.4 | 2.941 | 20 | 0 |
| | | | | | | ***3.38/4*** | | | |
| ***Use of Blockchain in Education*** | | | | | | | | | |
| Blockchain should be widely used in the education sector | 18 | 19 | 1 | 2 | 40 | 3.325 | 2.881 | 19 | 0 |
| Blockchain is the future of education | 19 | 17 | 2 | 2 | 40 | 3.325 | 2.89 | 19 | 0 |
| I would prefer using blockchain-based LMS for my further educational purposes | 17 | 21 | 1 | 1 | 40 | 3.35 | 2.881 | 21 | 0 |
| | | | | | | ***3.33/4*** | | | |
| | | **Overall Mean** | | | | **3.43/4** | | | |

*SD: Strongly Agree*

*A: Agree*

*D: Disagree*

*SD: Strongly disagree*

Table 2 describes the usefulness, preference of LMS, and participants' agreement over the use of Blockchain in the education sector. The usefulness of LMS has been identified with five questions, and the result found greater usefulness of LMS in participants' learning process with Mean= 3.53. Furthermore, there is a high preference rate for Blockchain-based LMSs over traditional LMSs (Mean= 3.38). The preference has been analyzed with four benefits of Blockchain: data privacy, automatic, limited intermediaries, and ease to use. Similarly, participants have a high agreement ratio over using Blockchain in the education sector (Mean=3.33). The overall mean value is **3.43,** indicating a favorable agreement among participants on the usefulness, preference of LMS, and participants' agreement over using Blockchain in the education sector.

Table 3. Descriptive Analysis of Questions in the Survey

| Questions | E | V | S | N | Total | Mean | SD | Max | Min |
|---|---|---|---|---|---|---|---|---|---|
| ***Blockchain in learning*** | | | | | | | | | |
| Does learning management system (LMS) improve training? | 18 | 16 | 5 | 1 | 40 | 3.275 | 2.837 | 18 | 1 |
| Does Blockchain-based LMS improve the learning process? | 21 | 10 | 8 | 1 | 40 | 3.275 | 2.864 | 21 | 1 |
| How confident are you with using blockchain (in terms of security and privacy) for your training? | 17 | 16 | 7 | 0 | 40 | 3.25 | 2.802 | 17 | 0 |
| | | | | | | ***3.26/4*** | | | |
| ***LMS (LOKUM)*** | | | | | | | | | |
| Does training with Lokum improve your knowledge of Blockchain? | 13 | 15 | 11 | 1 | 40 | 3 | 2.588 | 15 | 1 |
| How satisfied are you with Lokum? | 21 | 16 | 3 | 0 | 40 | 3.45 | 2.975 | 21 | 0 |
| How comfortable do you feel using Lokum? | 16 | 19 | 5 | 0 | 40 | 3.275 | 2.811 | 19 | 0 |
| | | | | | | ***3.24/4*** | | | |
| | | **Overall Mean** | | | | **3.25/4** | | | |

*E: Excellent*

*V: Very*

*S: Slightly*

*N: Not at all*

Table 3 summarises the response of participants to questions on Blockchain in education and the role of LOKUM as an LMS. There is a positive response from trainees over the role and importance of Blockchain in learning (Mean=3.26). Similarly, respondents expressed that using LOKUM contributes to better awareness of Blockchain than their previous knowledge of Blockchain (Mean =3). Other factors such as overall satisfaction (Mean=3.45) and comfort level (Mean=3.27) showed a positive response. The overall mean value (3.25) inferred a positive reaction from trainees over LOKUM.

### 4.2 Qualitative Analysis

The qualitative data were analysed based on the holistic user experience model developed by (Topolewski et al., 2019)**.** Below, we provide detailed explanations of the interview data and elaborate on the findings according to the respondents' intention to use LOKUM, a Blockchain-based LMS system, and the three dimensions of the user experience model:

- The human dimension: emotional and cognitive factors.
- The social dimension: emphatical and intention to use factors.
- The business dimension: economic and technological factors

**Emotional Factor**

Regarding the effect of emotional factors, the results showed that the attractiveness of LOKUM can be evaluated as very attractive. However, it still has much potential to be more attractive. At the same time, attractiveness can be judged as clear, simple, and minimalistic. LOKUM is a blockchain-based LMS; hence not all trainees expect enjoyment using LOKUM. All interviewees found that LOKUM is easy to use. Bringing all the essential learning tools in one place makes training more enjoyable. It is suggested that enjoyment can be improved by integrating a community page in LOKUM. Currently, trainees are using a separate application for chatting and engagement over training purposes. The chatting and community engagement will improve if it is integrated with LOKUM. Some interviewees mentioned it is difficult to use a different application for engagements while using LOKUM for learning purposes.

Similarly, the trainees are interested in sharing their ideas and perspectives outside the scope of their training topics with their community; hence, implementing a community page will improve their enjoyment. One of the interviewees mentioned that it is required to design changes in the mobile version and suggested having a mobile application as people prefer mobile for watching training sessions. One of the interviewees also mentioned the benefits of a journal feature (a notebook feature to keep trainees' updates), which helps in remembering the key aspects learned during the training. In contrast, another interviewee suggested adding more features to the journal to make it more reliable. Another interviewee indicated that seeing the training progress and pending tasks helps avoid procrastination in learning, as the six interviewees mentioned that LOKUM improves their performance. The reasons include a notification button whenever new tasks are assigned, previous ones are pending, and a personalized training calendar.

**Cognitive Factor**

Regarding the effect of cognitive factors, the outcomes indicated that the opinions could be divided into comprehensiveness and helpfulness of using LOKUM. All interviewees evaluated LOKUM as good, and it improved their training performance. However, a few interviewees also mentioned that more features could be added to increase the engagement in the LMS. According to all interviewees, all training sessions are well structured. Many

commented on integrating discussion forums, in-person communication (video/audio), emails, and a Q&A section to increase engagement in training.

One interviewee mentioned the need for a personal messaging system with the mentor, based on the session they are watching since trainees sometimes may want to ask questions instantly to clarify their doubts. Five out of six interviewees would like to have mentor-hours facilities under LOKUM. As comprehensiveness provided by LOKUM may change the mode of communication between trainees and trainers, they stated that trainers' encouragement can improve comprehensiveness. According to most of the interviewees, LOKUM is meaningful and engaging, although significant changes and features should be added. The content (e.g., workshop sessions) is the main factor influencing the meaningfulness of LOKUM. The interactivity of the content and having everything in one place is found to be engaging and helpful in planning the training process. Moreover, most of the interviewees indicated that LOKUM motivates trainees to complete the task without forcing them as in the conventional teaching method. Also, some indicated that the pending task button supports increasing engagement. At the same time, 5 of the interviewees indicated that they prefer to implement more gamification in LOKUM, for example, integrating peer quizzes to have healthy competition and earn rewards as tokens to improve engagements.

**Emphatical Factor**

Regarding the effect of emphatical factors, the outcomes demonstrated that attentiveness and responsiveness were mostly assessed as good or relatively high. However, most interviewees suggested improving the home page and the design of pending tasks and training calendars. Training notifications about new content and tasks were assessed by many interviewees as helpful in making learning plans according to the upcoming sessions and tasks and reminding the trainees. When asked to suggest new features to improve the responsiveness, many suggested implementing the mobile application. The reasons provided for the mobile application suggestion include the difficulty of carrying a laptop everywhere, convenience of mobile applications when watching training sessions, especially during traveling, and the ease of use compared to laptop, except during coding time.

**Intention to Use**

Regarding the trainee’s intention to use LOKUM as their Blockchain-based LMS, the results showed that everyone would be happy to use it for other learning processes. All the interviewees mentioned their concerns about how they might need LOKUM after their training. The solutions suggested by the interviewees to tackle these concerns include bringing a community page, discussion forum, and alumni page, which will help them continue using LOKUM. All the interviewees are ready to use LOKUM as long as they have something to learn and take away. The willingness to use LOKUM is unique as they all use it as a helpful tool, rather than an entertaining platform. Two interviewees are unaware of the full potential of LOKUM, for example, the potential features of Blockchain and the integration of their crypto wallets to their profile. After learning the Blockchain features of

LOKUM, they showed more interest in using LOKUM. LOKUM would mostly be recommended as a Blockchain-based LMS for software development training, although opinions differ depending on the experience of trainees. This proves that product awareness of LOKUM will help the trainees realize its full potential. LOKUM can be recommended because it is easy to use, to track progress by looking at the profile view, to view the pending tasks. Moreover, LOKUM can be recommended as all relevant information is placed suitably in the same place, and better content is provided by hands-on tasks. It is frequently mentioned by interviewees that LOKUM has a clear structure, it offers basic functionality, it is efficient to use, and it makes it easy for trainees to concentrate on daily tasks. However, one interviewee expressed a neutral opinion about recommending LOKUM to others due to limited communication and collaboration capacity through discussion forums, and community page elements. One interviewee suggested making LOKUM available for outside communities and unregistered users, so that they can access essential features provided by LOKUM, such as event details and free trials.

**Economical Factor**

Based on various viewpoints, the findings regarding the impact of economic aspects revealed that LOKUM was seen as a valuable and effective learning platform. LOKUM is helpful because it provides an overview of the training performance and all relevant training sessions. LOKUM not only provides the curriculum, but also acts as an intermediary to facilitate the user experience by guiding and tracking the learning process. One interviewee mentioned that "LOKUM could be slow, in terms of opening the website, which could be improved". Another interviewee stated that "LOKUM could implement collaborative work by improving teamwork. 5 interviewees mentioned that LOKUM is easy to navigate and use, except for one, who said it could be easier to use with some new features and mobile applications. According to 5 interviewees, LOKUM is very pleasant to use, while it is neutral for 1 interviewee. All the interviewees indicated they improved their productivity to a large extent by using LOKUM. For many LOKUM is not entertaining but adding gamification and community page could make a significant change in this respect. Changing UI/UX by implementing new features and changing the colour pattern can be proposed.

**Technological Factor**

Regarding the effect of technological factors, the interviews exhibited that LOKUM is novel for multiple reasons. Four interviewees said that they never used an LMS during college or any learning period. Two interviewees said that they used LMS but had never used a blockchain-based LMS before. It was mentioned that LOKUM is reliable, but the degree of reliability could be improved with better functionality and features. According to most of the interviewees, LOKUM is intuitive, easy to use, and generally efficient for training with structured content. They emphasized that LOKUM helped them in several ways through training tasks and assignments, i.e., by submitting the assignments and journal to the trainer, managing their time, accessing the information needed for completing the tasks and

monitoring their progress. The interviewees also showed their interest in integrating more blockchain features in LOKUM, except one interviewee, who mentioned that it should be an option as there will be people who would like to use traditional LMS. When LOKUM's user-friendliness was discussed, it was revealed that LOKUM is easy to use and gets better over time as indicated by all the interviewees. However, most interviewees suggested that friendliness can be improved by avoiding server downtime, website inaccessibility, and login issues. Few interviewees mentioned the importance making a tutorial video on "how to use LOKUM" as it helps trainees explore all Blockchain-based LMS features.

## 5. CONCLUSION AND IMPLICATIONS

This research uses a mixed-method approach to evaluate the impacts of LOKUM, a Blockchain-based LMS, on users' and developers' perspectives. This study also assesses the perceptions of trainees with respect to a Blockchain-based LMS (LOKUM) as a learning platform. To this end, we distributed a questionnaire with 30 items; 18 of which were designed as a Four-Likert scale. The questions focused on "the perception of users over a Blockchain-based LMS over traditional LMS" and "the potential solutions to the challenges of using Blockchain in the learning management". Apart from the questionnaire, we conducted an in-depth user experience semi-structured interview with six trainees using LOKUM as their LMS. The interview is based on Topolewski's formative measurement model of user experience. The developers' perspective was also collected with 2 developers to evaluate the potential of LOKUM as an LMS. The results revealed that trainees considered LOKUM an accessible and insightful learning-related tool that facilitates the learning process. For several trainees, LOKUM was found to helpful in engaging trainees in their learning processes through several features, such as tracking progress, having all session recordings on one platform, a personalized calendar, and an individual crypto wallet. In addition, the results showed that few trainees are unaware of the full potential of LOKUM as a Blockchain-based LMS. Therefore, it is suggested that making a tutorial video on "how to use LOKUM" may help trainees explore all Blockchain-based LMS features. LOKUM was also found to be generally quite reliable, with only minor technical issues, which almost never caused any significant problems during the training sessions. The qualitative data analysis showed that the trainees mostly used LOKUM to attend training sessions, track their performance and progress, and identify upcoming events and tasks. Some trainees stated that looking up information on LOKUM was better than looking for information in the traditional LMS they had used before. Moreover, LOKUM was frequently a topic of discussion with other people in the social context or group dynamics from the perspective of users. This means that most interviewees want to expand the usefulness of LOKUM to outside users and alumni as a community page. They would like to have a discussion forum, event updates, and chat system added to the on the community page of LMS to retain communications with other users, trainers and mentors. In fact, trainees use LOKUM actively mostly during the training, while they do not use it actively after they finish their training. After they graduate,

the lack of a community page under LOKUM leads trainees to use other platforms such as WhatsApp, Facebook, Rocket Chat, Discode, and Slack.

Not but not least, when we asked about their preference for using a Blockchain-based LMS over other traditional LMSs in the market, 37 participants chose a Blockchain-based LMS over a traditional LMS. In contrast, 3 chose a traditional LMS, shown in appendix 6. Furthermore, the research question regarding "the potential solutions to the problem faced by learners using Blockchain-based LMS" revealed that many trainees were unaware of the full potential of all LOKUM's features. Although, it can be argued that it is impossible to expect trainees to know all features, they could be informed by tutorial videos or by popup windows in the UI, as proposed by one trainee, so that they can be aware of the features proposed to be added in LOKUM. For example, few trainees did not know that LOKUM has a feature to integrate their crypto wallets into user profiles. All the interviewees seem to be satisfied with the content presented in the LOKUM expressing that it is interactive, engaging, and visually pleasing. One trainee suggested improving the visual appeal of LOKUM by making some colour changes while maintaining the already-present clearness and simplicity. However, UI (User Interface) was not found to be an essential priority, and thus it was suggested for the LOKUM developers to focus on improving other features first.

Many trainees proposed to enhance communication features on LOKUM by modernizing discussion forum mechanisms, employing private messages, chat functions, and group communication tools. Remarkably, many trainees acknowledged that better communication tools could offered by LMS like LOKUM. Therefore, it could be argued that the LMS UX (User Experience) could be enhanced if the missing features and functionalities indicated are closely considered and added by the developers. Blockchain integration over LOKUM is in the early stages as many features are still in the R&D stage. However, the trainees are welcoming the Blockchain technology into their learning process. The study found that Blockchain knowledge has increased tremendously over the usage of LOKUM. This is mainly because all trainees must create their accounts in Matic (cryptocurrency) as a part of the training. They will use their Matic account to hold their records and NFTs. By applying the actual use of Blockchain and cryptocurrencies, the trainees can learn while doing.

Besides, developers and designers of LOKUM may pay more attention to the UI, communication features, and compatibility of LOKUM with other web platforms and the learnability of LOKUM by trainees. At the same time, trainers and the operations should provide product awareness to the trainees to help them to make the most out of it. Furthermore, a mobile version of LOKUM must be implemented to increase the engagement of trainees. In terms of future plans of LOKUM, the developers shared that AI (artificial intelligence) would be integrated along with Blockchain to enhance the engagements such as online evaluation, understanding trainees' satisfaction level, recommending content over completing the task, and sending an alarm to trainers when a trainee needs special attention. Therefore, the developers expect that the current lack of engagement in LMS would be reduced with Blockchain and AI features.

Even though Blockchain is a hot topic in academics, studies focusing on the implications of the integrating Blockchain to LMS are scarce. It has been demonstrated by the survey and the interviews conducted in the study that many features of LOKUM are significant determinants of trainees' learning outcomes. Comprehending the changes in trainees' perceptions of LOKUM may provide a better understanding for the Blockchain-based LMS developers to enhance the LMS features in the future, which may help developers to sustain a higher level of user satisfaction. Hence, this study may contribute to the literature by providing valuable insights and practical implications on how a Blockchain-based LMS user experience can be improved for the Turkish Education sector.

As expressed by Cavus and Zabadi (2014) there are concerns about the real-time synchronous discussion and chat function of LMSs, our finding also infers that features which enhance the discussion and lives chats are essential components of trainees' learning path.

## 6. LIMITATIONS AND SUGGESTIONS FOR FUTURW RESEARCH

There are some limitations to this research. For example, we have done our best to collect, document, and analyse the data as carefully as possible. However, not every aspect of user experience has been discussed in this study. Thus, it opened the door to future research that different models could be used to conduct semi-structured in-depth user experience interviews. Moreover, the Questionnaires were not designed based on any theoretical model, but instead from a user's perspective, so it could be suggested to re-design the questionnaires for further studies.

In this study, we focused on only one Blockchain-based LMS and its user experience, so it may not give a generalized user perception over the Blockchain integration in education. Therefore, it is recommended to research more than one LMSs to get different perspectives. It is also noted that the number of participants in the current study is 40, so it can be increased for more comprehensive responses. Even though this study covers the developers' perspectives on integrating Blockchain-based LMS, future research could explore the scope and challenges of understanding Blockchain's business scope in education.

In this study, the benefits of Blockchain applications were discussed. Moreover, the impacts of using Blockchain technology in Learning Management Systems (LMSs) on user experiences and developer experiences were presented with a survey and semi-structured in-depth interviews, which were conducted in an ed-tech start-up in Turkey.

This study aims to put forward the implications of the integration of Blockchain technology on LMSs, focusing on users' experiences in learning processes and developers' experiences in building the LMS application. Blockchain applications are still in the early stages in the education sector, and the number of educational institutions utilizing the full strength of Blockchain technology is limited. Learning Management Systems (LMSs) are the backbone of any education program. However, traditional learning management systems are not geared

towards special-needs learners. They do not adapt well to the new academic landscape that has transformed with the immense adoption of Massive Open Online Courses (MOOCs). As Blockchain offers a decentralized and distributed approach, integrating Blockchain technologies in the educational sector may generate numerous opportunities. Yet, most public and private institutions operating in the education industry may display a hesitant attitude towards embracing Blockchain, as it is a novel technology. Thus, it may be crucial to demonstrate the feasibility and the space of opportunities arising from using Blockchain in the education sector, especially regarding cost reduction in education. Reducing costs for educators will bring down the costs of education for the learners. Hence, the overall sector can benefit by expanding its capacity through the integration of Blockchain in their business models.

The implications drawn from this study's findings may motivate public and private institutions operating in the education industry to speed up the process of integrating Blockchain features in education to generate value for the players in the ed-tech sector as well as for learners in Turkey. Furthermore, due to the research gap regarding the applications of Blockchain technology in LMSs, this study may produce valuable contributions by providing a thorough analysis of the benefits and challenges of integrating Blockchain technology in LMSs, for researchers and companies operating in the ed-tech industry.

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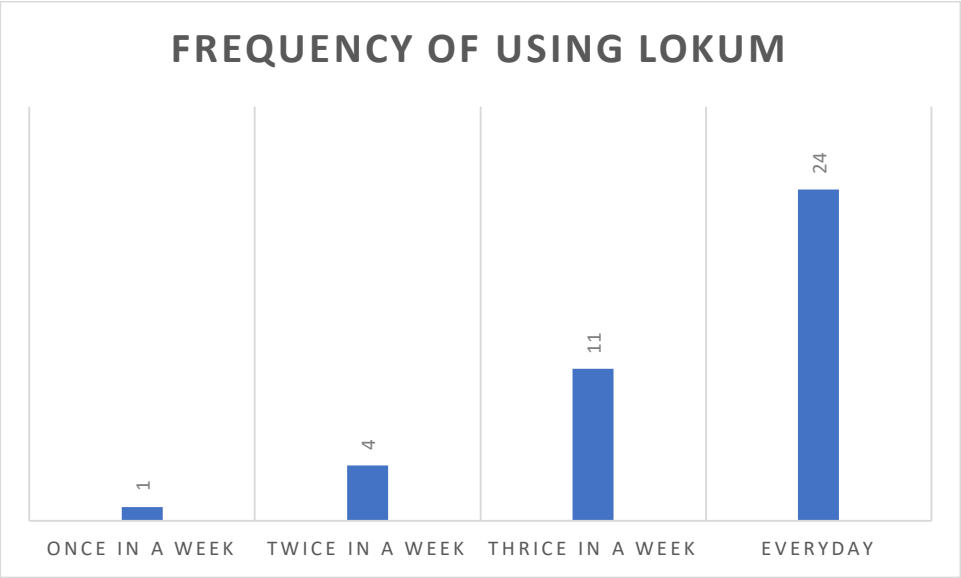
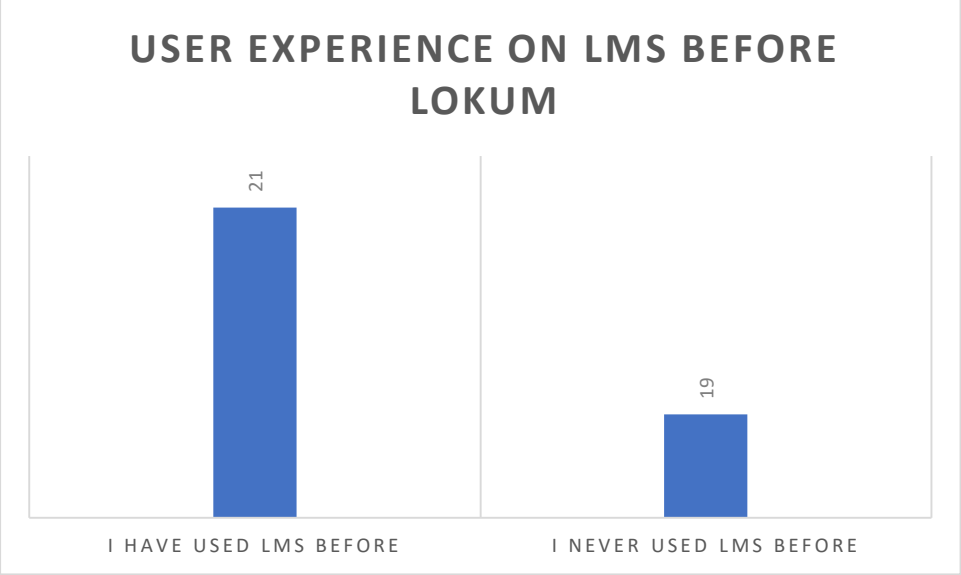
## 8. Appendices

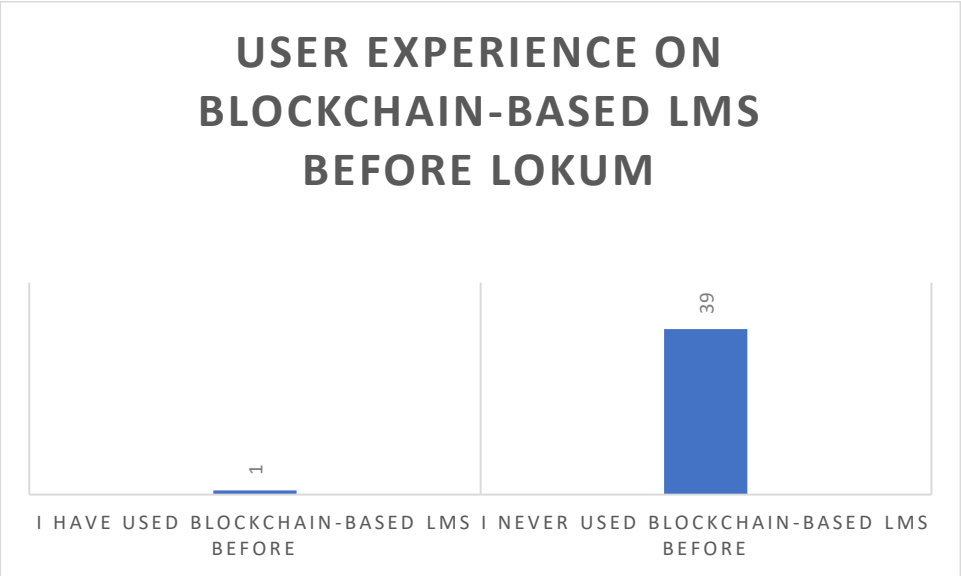
Appendix 1



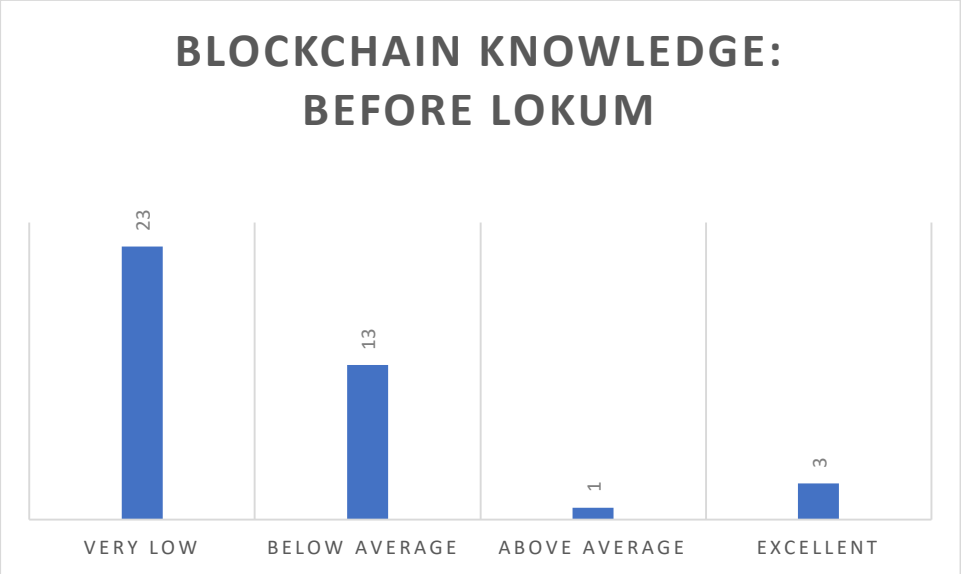

Appendix 2




Appendix 3

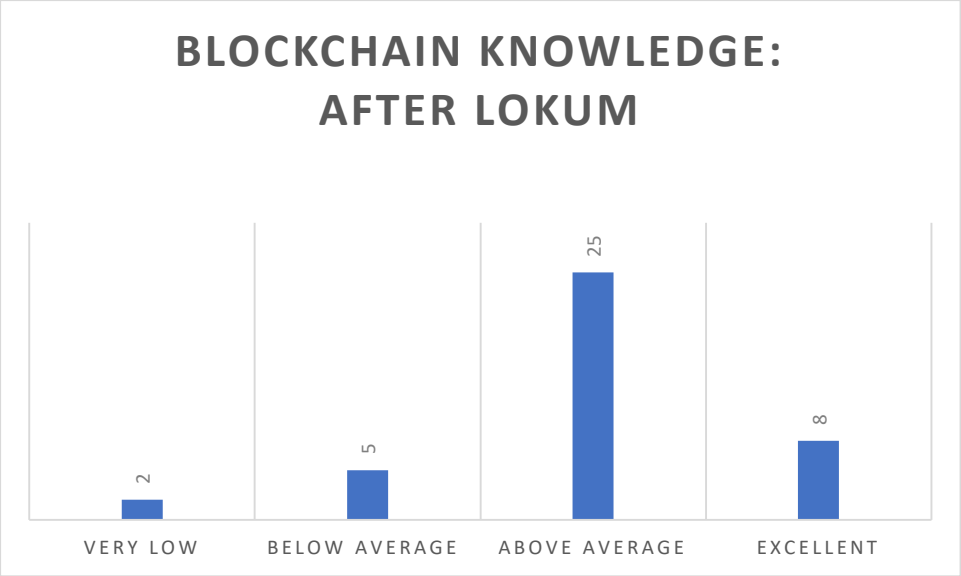

USER EXPERIENCE ON BLOCKCHAIN-BASED LMS BEFORE LOKUM
1
39
I HAVE USED BLOCKCHAIN-BASED LMS BEFORE
I NEVER USED BLOCKCHAIN-BASED LMS BEFORE

Appendix 4


BLOCKCHAIN KNOWLEDGE: BEFORE LOKUM
23
13
1
3
VERY LOW
BELOW AVERAGE
ABOVE AVERAGE
EXCELLENT

DOI NR. 10.5281/zenodo.7181508

Appendix 5




Appendix 6