

NEXTJS E-COMMERCE WEB APPLICATION WITH BLOCKCHAIN PAYMENT PROCESSING

Amit Saxena, Mayank Pandey, Keshav chauhan, Lipakshi Rana, Pushpendra

Department of Computer Science and Engineering, Moradabad Institute of Technology

¹er.amitsaxena79@gmail.com, ²mayankpandeyofficial404@gmail.com, ³davrajs34@gmail.com,
⁴lipakshirana2080@gmail.com, ⁵pushpendra7036@gmail.com

ABSTRACT

In today's digital age, the significance of e-commerce websites has surged, especially with the growing demand for online shopping experiences. This research paper delves into the development of an e-commerce website using Next.js, a React framework known for its efficiency in building robust and scalable web applications. The integration of payment processing mechanisms is a crucial aspect of any e-commerce platform, ensuring secure transactions for both buyers and sellers. By leveraging Next.js along with payment processing solutions such as Stripe or PayPal, this paper explores the implementation process, addressing key challenges and considerations. Through thorough analysis and practical examples, this research provides insights into the architecture, functionality, and benefits of Next—Js— based e-commerce websites with seamless payment processing capabilities. Simultaneously, the research acknowledges and dissects the challenges associated with utilizing Next.js. These include issues related to version compatibility, the quality of available documentation, and the dynamic and evolving nature of the framework. In conclusion, the research offers a comprehensive evaluation of the advantages and disadvantages encountered while employing Next.js in conjunction with JavaScript, MongoDB, and React for full-stack development. The thesis serves as a valuable resource for developers seeking to leverage this technology stack, offering a nuanced understanding of the trade-offs and best practices for better decision-making.

KEYWORD – Blockchain, E-Commerce, Web Development, Client/ Server.

1. INTRODUCTION

Web development encompasses the utilization of programming languages, frameworks, and third-party libraries to construct web applications and websites. This process includes various stages such as planning, designing, development, and testing (Geek for Geeks, 2023). Recently, there has been a notable trend towards full-stack development, which involves creating web applications on both the front end and back end. Frontend development is concerned with the user interface, managing components like text, buttons, links, and forms. Conversely, backend development, also known as server-side development, involves handling behind-the-scenes operations, including data structuring, organization, retrieval from the server, and interaction with the front end to process data. Several technologies, frameworks, and libraries now facilitate full-stack development. Prominent frontend frameworks in this domain include React, Angular, and Vue.js, while popular backend frameworks are Node.js, Ruby on Rails, and Django. Additionally, backend development often requires database technologies, both relational and non-relational, such as MySQL, PostgreSQL, MongoDB, and Redis (W3Schools, 2023). This evolution towards full-stack development has streamlined the creation of more sophisticated, scalable, and accessible web applications. After evaluating various research alternatives, the author concluded that developing an application using Next.js offers a robust practical and theoretical approach to this subject. Furthermore, given the extensive server-side capabilities of Next.js, it presents an ideal choice for a comprehensive introduction and analysis of the framework's benefits.

TECHNOLOGY STACK

Next.js

Next.js is a React framework for building full-stack web applications. You use React Components to build user interfaces, and Next.js for additional features and optimizations. Under the hood, Next.js also abstracts and automatically configures tooling needed for React, like bundling, compiling, and more. This allows you to focus on building your application instead of spending time with configuration. Initially introduced in 2016 as an open-source project on GitHub, Next.js was first created to simplify the process of building server-rendered React applications, which at the time required a lot of infrastructure configuration. The main mission was to create a framework that could abstract away some of the more complicated parts of building server-rendered applications and allow developers to focus more on high-quality user

experiences. In 2019, the initial company named ZEIT which owned Next.js was acquired by Vercel, which currently owns, develops, and maintains the framework. Today, Next.js has become one of the most popular frameworks that accounts for 16.67% of usage among developers (Stack overflow, 2023) and powers over 35,000 sites at companies like Uber, Nike, and Starbucks. (HG Insights, 2023) Thanks to its simplicity, versatility, powerful features, and excellent documentation, Next.js has become a go-to choice for building server-rendered React applications. (McRae8May2023).

Node.js

Node.js, released in 2009, is an open-source, cross-platform runtime environment for JavaScript, built by a Google engineer named Ryan Dahland. Node.js has made it possible to implement JavaScript code in other environments apart from the browser. Google's V8 engine that Node.js was built upon, allowed the JavaScript code to be compiled into machine-level code. The compiled code is then executed instead of the traditional interpreted JavaScript code. (Satheesh & 6 Kroll 2015, 2) Node.js is single threaded by nature, meaning all requests happen within the same thread. However, Node.js resolves these requests asynchronously, which inevitably provides more performance and scalability for busy-traffic web applications. Remarks of Node.js lies within its event-driven and asynchronous nature. The event loop is a key component that enables Node.js to perform non-block I/O operations. Node.js application always starts an event loop upon initialization, and all upcoming requests are added to the event queue. These requests can either be synchronous or asynchronous. The event loop then decides on the appropriate callback functions to handle such requests. (NodeJS 2023).

MongoDB

MongoDB is a popular open-source, cross-platform NoSQL database released in 2009, optimized for handling large amounts of unstructured data in modern web applications and the cloud era. Unlike other traditional relational databases which store data in tables with fixed columns, MongoDB stores data in JSON-like format documents with dynamic schemas. A schema is a pre-defined database structure in the Relational Database Management System that includes tables, fields, and relationships within the database. MongoDB has an edge over other schema-related databases in terms of its flexibility in data structure. As data is stored in dynamic JSON-like objects, modifications made to the fields and records are considerably easier than in relational databases with predefined schemas. MongoDB is also a cross-platform database that runs on various operating systems and computer architectures. MongoDB is available on Windows, Linux, and MacOS. (Sharma 2021) MongoDB also offers a free multi-cloud developer data platform called 'MongoDB Atlas' which allows operating MongoDB within different cloud services such as AWS, Google Cloud, and Azure. (MongoDB 2023) As a result, the MongoDB database is highly scalable and remains the top choice for Fortune 100 enterprises as well as startups. (Sharma2021).

Ether.js

Ether.js is a comprehensive and modular JavaScript library designed for interacting with the Ethereum blockchain, providing a simplified interface for developers to build decentralized applications (dApps), manage Ethereum accounts, and interact with smart contracts. Its modularity allows developers to use

only the necessary components, optimizing application size and performance. Compatible with both modern web browsers and Node.js, Ether.js is versatile for front end and back-end development. The library's simplified and intuitive API abstracts the complexities of the Ethereum blockchain, facilitating various blockchain-related tasks. Additionally, Ether.js enables seamless interaction with smart contracts, offering functionalities to deploy, call, and listen to smart contract events.

MetaMask Wallet

MetaMask Wallet is a widely popular cryptocurrency wallet and gateway to decentralized applications (dApps), functioning primarily as a browser extension and mobile app. It enables users to manage their Ethereum and other ERC-20 tokens, engage with decentralized applications, and securely store their private keys. MetaMask features an intuitive user interface, making it accessible for both beginners and experienced cryptocurrency users, thereby simplifying the management of digital assets and interactions with dApps. In terms of security, MetaMask stores private keys locally on the user's device, providing greater security compared to centralized exchanges, and it also allows users to create backup seed phrases for account recovery. MetaMask is extensively used for engaging with decentralized applications across various sectors, such as decentralized finance (DeFi), gaming, and Non-Fungible Tokens (NFTs), facilitating seamless interactions directly through the browser or mobile app. It supports customizable network settings, enabling users to connect to different Ethereum networks and add custom Remote Procedure Call (RPC) settings, which enhances its versatility for developers and users exploring diverse blockchain environments. Moreover, MetaMask supports a wide range of ERC-20 and ERC-721 tokens, allowing users to manage multiple digital assets within a single wallet.

2. LITERATURE SURVEY

E-commerce websites have become increasingly popular in recent years, as more businesses recognize the benefits of online selling. Here is a brief literature review on e-commerce websites: In a study published in the *Journal of Electronic Commerce Research*, researchers examined the factors that influence consumers' trust and purchase intention on e-commerce websites. They found that factors such as website quality, perceived risk, and perceived value all have significant effects on consumer behavior. Another study, published in the *Journal of Internet Banking and Commerce*, examined the impact of website design on customer satisfaction and loyalty. The researchers found that websites that are visually appealing, easy to navigate, and provide relevant information are more likely to lead to positive customer experiences. In a study published in the *International Journal of Business and Management*, researchers analyzed the impact of social media on e-commerce website adoption. They found that social media can play an important role in driving traffic to e-commerce websites and increasing sales. Another study, published in the *Journal of Business and Retail Management Research*, examined the impact of product presentation on customer behavior on e-commerce websites. The researchers found that product presentation, including images and descriptions, has a significant impact on consumer behavior and can influence purchase decisions. Overall, the literature on e-commerce websites highlights the importance of factors such as website design, trust, value, and social media in driving customer behavior and increasing sales. Businesses that prioritize these factors in their e-commerce strategy are more likely to see success in the online marketplace.

3. METHODOLOGY

The proposed e-commerce website will be designed in the IEEE format, which provides a structured and organized approach to website design. The website will be designed using NEXTJS, TAILWINDCSS, and MongoDB and will be hosted on a secure server. The website will have a simple and user-friendly interface, with easy navigation options. Simulations, experiments, and testing are essential components of any e-commerce website design. Experiments will be conducted to evaluate the website's user interface, features, and functionality. Testing is essential to ensure the website's security, especially when dealing with sensitive information such as student personal and financial information. The website will undergo rigorous testing to ensure that it is secure and complies with

industry standards such as the Payment Card Industry Data Security Standards (PCI DSS). The testing will also ensure that the website is compatible with different web browsers and devices. In conclusion, simulations, experiments, and testing are critical in the design of an e-commerce website for Users. They ensure that the website is efficient, secure, and user-friendly, providing a seamless online shopping experience for users.

Admin Interface:

1. Admin logs in
2. Admin inserts item
3. Admin removes item
4. Admin modifies item

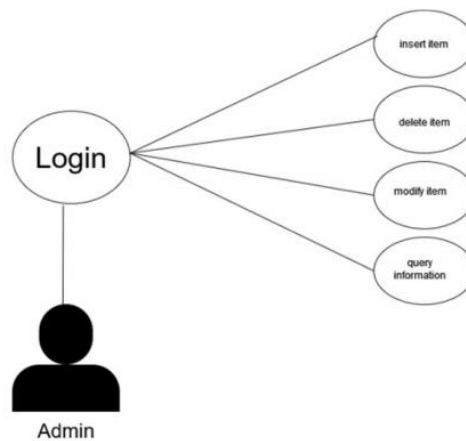


Fig. 1 Admin Interface

Customer Interface:

1. Customer shops for a product
2. Customer changes quantity
3. The customer adds an item to the cart
4. Customer views cart
5. Customer checks out
6. Customer sends order

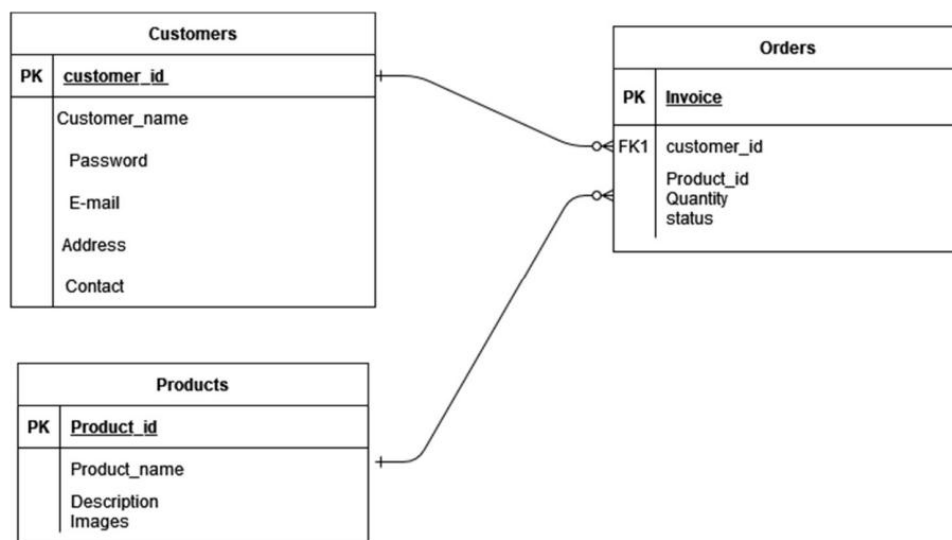


Fig. 2 Customer Database Table

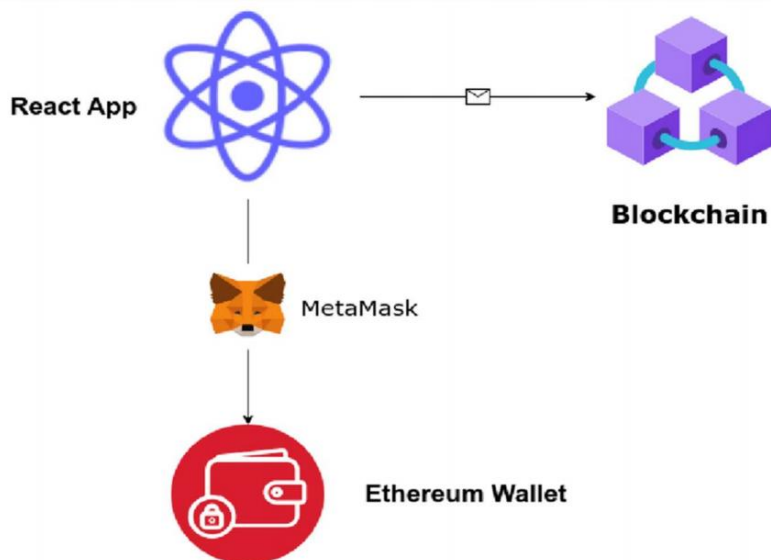


Fig. 3 Basic Architecture of Payment Processing.

4. BLOCKCHAIN PAYMENT PROCESSING

Blockchain technology emerged in 2008 with the introduction of Bitcoin by an entity known as Satoshi Nakamoto. It functions as a decentralized and distributed ledger system designed to securely record online transactions. This innovative system relies on cryptographic tools such as hash functions and digital signatures to link and secure records continuously. The key feature of blockchain is its decentralization, which means transactions are recorded across numerous computers globally, making it virtually tamper-proof. Any attempt to alter a record retroactively would require changing all subsequent blocks in the chain, a task that would necessitate collusion across the entire network. This decentralized nature also eliminates the need for a third-party intermediary, allowing participants to verify and audit transactions at minimal cost, thus reducing the risk of unauthorized interventions. Moreover, blockchain operates transparently, enabling users to monitor and control the flow of their information and transactions within the distributed ledger. Every modification to the public blockchain is visible to all participants, enhancing trust and accountability within the system. Additionally, blockchain addresses the issue of double spending, a common concern in digital transactions, by requiring confirmation from multiple parties before a transaction is added to the ledger. Despite its numerous advantages, blockchain technology faces challenges, notably regarding its performance. Bitcoin, for instance, has a limited capacity, processing only about 7 transactions per second, which is inadequate for high-volume and high-frequency transactions. Attempts to enhance performance by increasing block creation rates or block sizes have drawbacks that impact the protocol's efficiency. To address scalability issues, alternative mechanisms with different consensus mechanisms have been proposed. Additionally, second-layer payment channels offer a promising solution by facilitating direct peer-to-peer transactions off the main blockchain, thereby increasing throughput without significantly altering the underlying blockchain system. In response to existing gaps and challenges, we propose a Secure Versatile Light Payment (SVLP) system based on blockchain technology. Our contribution includes the development of a new payment system model that prioritizes security, privacy, low power consumption, flexibility, off-chain payments, and offline payments. We present a modular generic construction and an efficient implementation of the SVLP system, leveraging basic cryptographic primitives such as one-way functions and digital signatures. Furthermore, we establish a formal security model for the SVLP system and analyze its performance across various parameters. Efforts to enhance the scalability and technical aspects of blockchain technology have led to notable advancements. For instance, the GHOST protocol improves scalability by revising the chain selection rule, while structures like the block DAG offer higher transaction rates. Additionally, proposals such as pegged sidechains and Peer Census systems aim to enhance interoperability and consistency within blockchain networks. Several methods have been proposed to improve transaction speeds, including modifications to the Bitcoin protocol and the

implementation of off-chain transaction channels like the Lightning Network and Raiden Network. These solutions enable faster and more efficient transactions while reducing the burden on the main blockchain.

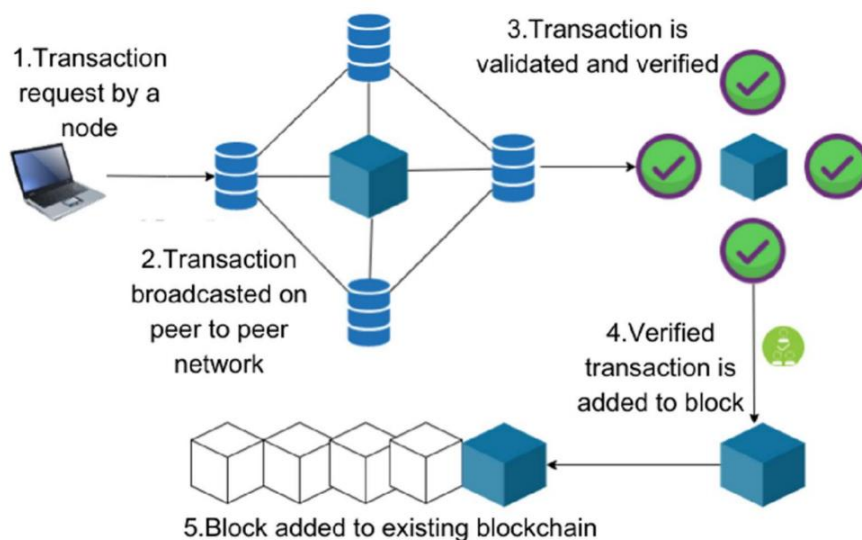


Fig 4. Transaction flow in Blockchain Network.

5. QUESTIONNAIRE DESIGN

Respondents

In this experiment, the author randomly selected different types of respondents. There should be no limitations in the analysis of consumers on e-commerce platforms. Online shopping is not only the choice of young people but also middle aged and old people with higher purchasing power. According to research provided by Data Center, 58 percent of Internet users shop online multiple times a month, and more than 40 percent of this group are middle-aged users. From 2013 to 2018, the amount of online shopping transactions in China increased from 2,679 hospitals to 5,737 billion yuan, with a compound growth rate of 84.6%. Moreover, in 2020, the number of online shopping users in China reached 782 million, accounting for 79.1% of the total Internet users [5]. Whether or not the percentage of middle-aged and older users continues to grow, with such a large population base, the survey must include as many different types of users as possible to ensure the diversity and credibility of the survey. Through the research on the service industry, McDougall found that customer value-perceiving (i.e., transferred value) can promote the formation of service industry loyalty. In e-commerce mode, the value-perceiving of customers is composed of product quality, service quality, price, brand image, etc. When the value-perceiving of customers is high, they will show behavioural loyalty and attitudinal loyalty [6]. Hence, the author surveyed two different perspectives. The author asked users to choose their favourite platform for specific reasons among the four online shopping platforms mentioned above. There are reasons to choose: cost performance, product quality, software design, after-sales service, and product variety. Moreover, the author hopes to classify consumers by gender and age to understand the impact of these factors on their consumption behaviour. The author thinks these two factors are the most critical. Female users may be more inclined to buy daily necessities and beauty products. Male users are more likely to favour electronics products, sports products, and fashion products. Middle-aged users may buy healthcare products and pay more attention to quality. Young users and older users may choose products with high-cost performance. Data collection: In the process of the survey, the author collected 580 results from questionnaires and sent out a total of 1,300 questionnaires. The questionnaire was collected by the WeChat mini program on the Internet.

THE OBSERVATIONS

As shown in Figure 1, 249 women and 331 men participated in the survey, accounting for 43% and 57% respectively. Table 2 shows that consumers' preferences for platforms are Taobao > JD > Tmall > Pinduoduo. Product quality, product variety, product quality, and cost performance are the most positive responses for each of the four platforms. JD has received good comments in terms of product quality, cost performance, and after-sales service. However, there are many problems with product variety and UI design. There are no obvious problems with Taobao other than its software design. The overall audience of Tmall is small, and it gets positive responses for product quality and after-sales service. Pinduoduo has the smallest audience and is poorly evaluated in other aspects except for cost performance. By analysing Figure 2 at the same time, all respondents can be separated into eight groups. Among eight groups, the four most common audience groups of these four platforms are respectively men aged 18-30, women aged 18-30, women aged 30-50, and men aged over 50.

CODE

URL: <https://github.com/MAYANKpandey14/Oasis-Ecom>

6. RESULTS AND DISCUSSIONS

1. Convenience: An e-commerce website for students provides a convenient way for them to purchase products and services online. This convenience can save students time and effort in their busy schedules, as they do not need to physically visit a store. The convenience factor can be a significant driver of adoption for e-commerce websites, especially among younger generations who are more accustomed to online shopping.

2. Product range and availability: Another advantage of e-commerce websites for students is the wide range of products and services available. Students can find a variety of products on an e-commerce website, ranging from textbooks, electronics, stationery, gadgets, and more. Additionally, e-commerce websites can provide access to products that might be unavailable in their local area.

3. Cost and discounts: E-commerce websites for students can be cost-effective, especially when compared to brick-and mortar stores. Generally, e-commerce websites offer competitive pricing, as well as discounts and promotions. This can make it more affordable for students to buy the products they need for their studies and daily life.

4. Trust and security: Trust and security are important considerations for e-commerce websites, particularly for students who may be more vulnerable to online scams or fraud. E-commerce websites that prioritize trust and security factors, such as secure payment processing and encryption, are more likely to gain students' trust and retain their loyalty.

5. Social connections: E-commerce websites can also facilitate social connections among students, particularly through the provision of user-generated content and reviews. By sharing their experiences and opinions about products and services, students can help each other make informed decisions and build social connections online.

7. FUTURE SCOPE

The proposed e-commerce website for college students has the potential to revolutionize the way students shop for goods and services. To make the website more useful and relevant, the following future scope can be considered:

1. Integration of a virtual marketplace: As e-commerce continues to evolve, the integration of virtual

marketplaces is becoming more popular. The future scope of the proposed e-commerce website for college students should include the integration of a virtual marketplace. This will enable students to purchase goods and services from a wide range of vendors, thereby enhancing the online shopping experience.

2. **Mobile Application:** With the increased use of smartphones and tablets, the development of a mobile application for the proposed e-commerce website for college students should be considered. A mobile application will provide students with an easy and convenient way to shop and make payments using their mobile devices.

3. **Personalization:** The future scope of the website should include the integration of personalization features. Personalization will enable the website to provide tailored recommendations based on students' purchase history and preferences, enhancing the overall user experience.

4. **Social Media Integration:** social media is a vital aspect of the daily lives of college students. Therefore, the future scope of the proposed e-commerce website for college students should include the integration of social media features. This will allow students to share their shopping experiences with their friends, receive feedback, and make informed purchase decisions.

5. **Blockchain Payment Integration:** Using the Ethereum technology stack which mainly consists of Ether.js, Meta Mask wallet, etc. Traditional Payment processing lacks the versatility provided by Blockchain. Moreover, the security and transactional transparency provided by Blockchain is unmatched. Decentralized apps, based on blockchain are the new trend as they render most cybersecurity threats null and void due to the security provided by Blockchain.

8. CONCLUSION

In conclusion, the development of an e-commerce platform tailored for students offers a promising avenue for enhancing their shopping experience. The advantages of such platforms, including time and cost savings alongside access to a diverse array of products, resonate deeply with students facing hectic schedules and financial constraints. However, paramount to the success of these platforms is the assurance of trust, security, and seamless user experience. Given students' susceptibility to online threats, safeguarding their personal and financial data becomes imperative. Moreover, prioritizing user experience fosters satisfaction, loyalty, and positive referrals among student shoppers. Furthermore, fostering social connections through features like user-generated content and reviews can cultivate a sense of community and trust within the student demographic. While e-commerce platforms for students hold immense potential, it's essential to uphold values that resonate with their priorities. Emphasizing convenience, affordability, security, and user experience ensures that these platforms serve as indispensable resources, meeting students' needs while offering a safe and accessible shopping environment. In addition to prioritizing trust, security, and user experience, integrating blockchain payment processing into e-commerce platforms for students holds significant promise. Blockchain technology offers unparalleled security through its decentralized nature, ensuring that transactions are transparent, immutable, and resistant to tampering or fraud. By leveraging blockchain payment processing, e-commerce platforms can provide students with enhanced peace of mind regarding the safety of their financial transactions.

Furthermore, blockchain payment processing offers benefits such as reduced transaction costs and faster settlement times. compared to traditional payment methods. These advantages align closely with students' desire for affordability and efficiency, making blockchain an attractive solution for e-commerce platforms catering to this demographic. Looking ahead, the future scope of blockchain payment processing in e-commerce is promising. As blockchain technology continues to evolve and mature, its integration into e-commerce platforms is expected to become more seamless and widespread. Moreover, innovations such as smart contracts and decentralized finance (DeFi) present exciting opportunities for further enhancing the efficiency and functionality of blockchain-based payment systems. Lastly, the incorporation of blockchain payment processing into e-commerce platforms for students not only strengthens trust and security but also offers tangible benefits such as

cost savings and faster transactions. With ongoing advancements in blockchain technology, the future holds immense potential for further innovation and optimization in this space, making blockchain payment processing a key driver of growth and differentiation in the e-commerce landscape.

REFERENCES

- [1]. GeekforGeeks. 2023. Web development. URL: <https://www.geeksforgeeks.org/webdevelopment>.
- [2]. IBM. 2023. What is an API? URL: <https://www.ibm.com/topics/api>.
- [3]. JavaScript. Info. 2023. Cookies, documents. Cookie. URL: <https://javascript.info/cookie>. McRae, J. 2022.
- [4]. Why You Should Use Next.js and Vercel in 2023. URL: <https://www.stackfive.io/work/nextjs/why-you-should-use-next-js-and-vercel-in-2023>.
- [5]. China online shopping market development scale and user behavior analysis in 2019. Available from: <https://www.iimedia.cn/c1020/66739.html>.
- [6]. Q. Wang, H. Guo, M. Liu. A Study on the Conversion mode of Customer Satisfaction and Customer Loyalty in Online Shopping-Taking Taobao, Tmall, and JD e-commerce sites as Examples.
- [7]. MongoDB. 2023. MongoDB Cloud Services. URL: <https://www.mongodb.com/cloud>.
- [8]. MetaMask. (2023). MetaMask Documentation. Retrieved from <https://metamask.io>
- [9]. Ether.js Documentation (2023). Ether.js Documentation. Retrieved from <https://docs.ethers.io/>