Ecommerce Web App

Apurv¹, Deepak Singh², Lalit Yadav³, Yatin Rana⁴

¹Department of Computer Science and Engineering, Chandigarh University

---***--

Abstract - The rapid growth of e-commerce has spurred the development of web applications that easily connect customers to various products and services. This research paper discusses the design and evaluation of a full-fledged e-commerce application developed and implemented using the MERN (MongoDB, Express.js, React, Node.js) cluster.

This study provides an in-depth understanding of the system architecture, development process, and key features of web applications, as well as related problems and solutions. It also provides a comparison of MERN stacking in the context of e-commerce platforms, highlighting its advantages and disadvantages.

The system architecture integrates front-end React, back-end Node.js and Express, and database management MongoDB. The detailed process includes the development process, including the integration of third-party APIs and the implementation of security measures. Evaluation and quality assurance procedures ensure the reliability of the application.

The e-commerce site has many features such as user registration and authentication, product catalogue with advanced search, effective basket management, Payment security, analytics, user comments and ratings, admin panel for platform management and general functionality.

Results and discussions include application performance metrics, user recommendations, benchmarks, and security metrics. Together, these findings demonstrate the potential and potential of MERN stacking to create more efficient and effective e-commerce platforms, making it quickly useful for developers, products on the web, and businesses in the e-commerce space.

In conclusion, this research paper highlights the importance of MERN stacking in e-commerce web application development and highlights its ability to provide optimal user experience, security, and scalability. The implications of this research extend to technology in general; Future work will include further development and innovation of the MERN cluster for e-commerce.
.

*Key Words***:** E-commerce, MERN Stack, Full Stack, Web Application, React, Node.js, Express.js, MongoDB, Comparative Analysis, Scalability, Performance Optimization, Security, User Experience.

1.INTRODUCTION

1.1 History

E-commerce has experienced tremendous growth over the last few years, changing the way businesses and consumers do business. Offering consumers, the ease and convenience of browsing, selecting and purchasing products and services at home or on the go, e-commerce platforms have become the cornerstone of today's retail industry. As e-commerce grows, so does the technology that powers it. Among the many technologies available for web development, the MERN cluster (which stands for MongoDB, Express.js, React, and Node.js) has become a popular choice for building powerful and scalable e-commerce.

MongoDB is a NoSQL database that can be easily modified to manage complex data and scale with the growing needs of e-commerce platforms. Express.js is a small web application framework that allows building powerful external applications for Node.js. React, a JavaScript library, offers a dynamic and responsive front-end experience, while Node.js, as a server-side runtime environment, ensures high performance and efficiency. The combination of these technologies provides a comprehensive solution for developing full-stack e-commerce web applications.

1.2 Objectives

The primary objective of this research paper is to present a comprehensive exploration of the development, implementation, and evaluation of a Full Stack E-commerce Web Application built using the MERN stack. This research aims to highlight the feasibility and potential of the MERN stack in building scalable and efficient e-commerce platforms. The specific objectives of this study include:

To elucidate the system architecture and methodology behind the development of the MERN-based e-commerce web application.

To provide an in-depth analysis of the application's features, encompassing user registration and authentication, product catalogue, shopping cart management, payment processing, order tracking, user reviews, administrative controls, and mobile responsiveness.

To address the challenges associated with e-commerce development using the MERN stack and propose practical solutions.

To conduct a comparative analysis of the MERN stack in relation to other technology stacks commonly used in the e-commerce sector, evaluating its advantages and drawbacks.

To present the results of performance metrics, user feedback, scalability assessment, and security evaluations, demonstrating the stack's efficacy in the context of e-commerce.

1.3 Significance of the Study

This research is significant for several reasons. Firstly, it contributes to the body of knowledge regarding e-commerce web application development by showcasing the capabilities and challenges of the MERN stack, which holds potential implications for web developers, businesses, and decision-makers in the e-commerce sector. Secondly, it delves into the ideas of using the MERN-based e-commerce platform, solving complex problems and providing solutions that will help manufacturers and businesses create good and safe solutions. Additionally, comparative analysis helps participants make informed technology stacking choices for their e-commerce businesses. Ultimately, this research establishes MERN stacking as a useful option for web developers, businesses, and entrepreneurs, helping them harness the power of technology. It provides the best business experience to customers today while also enabling the growth of Safety and Security of e-commerce and we will examine the research results.

2. Existing System

These e-commerce systems paved the way for the digital stores we see today. These systems often rely on outdated technology and design patterns, making them vulnerable to various limitations and challenges. Some of the advantages and disadvantages of e-commerce systems are:

Monolithic Architecture: Most of the traditional e-commerce systems follow a monolithic architecture where all the elements including front-end, back-end are included. and the database is tightly integrated into a code library. As the complexity of the system increases, expansion and maintenance become more difficult.

Poor user experience: The user interface of traditional e-commerce is often static and poorly responsive, causing users to be unpleasant. This affects the ability to interact with users.

Scalability Issues: Scalability is a major issue as legacy systems adapt to increasing traffic and product catalogues. The monolithic architecture makes it difficult to measure individual products independently.

Security Issues: Security is extremely important as e-commerce platforms control user information and financial transactions. Legacy systems face challenges in providing effective security against evolving cyber threats.

Customization Challenges: Customizing the user experience and functionality of e-commerce products always requires extensive customization, which often requires a lot of development work, repairs, and costs.

The limitations and problems of traditional e-commerce have led businesses to explore modern tools such as MERN to create e-commerce. MERN's modular and flexible architecture, responsive front-end, scalability and security features address many of the drawbacks of traditional systems.

With a solid foundation in understanding the limitations of current e-commerce systems and the need for modern and flexible solutions, this research paper will provide an overview of how the MERN group can solve these problems and use its results. Creating efficient and effective e-commerce platforms that provide insight.

3. Literature Review

3.1. E-commerce Overview

E-commerce, or electronic commerce, has fundamentally transformed the way businesses operate and consumers shop. The literature on e-commerce highlights its growth, impact, and key trends:

● E-commerce has experienced rapid growth, with global online sales expected to continue rising [19]

● The COVID-19 pandemic accelerated the shift towards online shopping, emphasizing the importance of robust e-commerce platforms [20]

● Mobile commerce (m-commerce) is on the rise, with users increasingly using smartphones and tablets to make purchases [13]

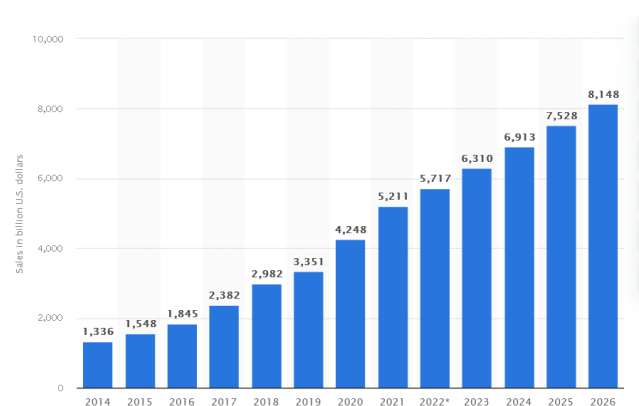● Personalization and user experience have become critical factors for e-commerce success [20]

Fig-1: Growth in retail ecommerce sales (in billions usd)

3.2. Technology Stacks in E-commerce

E-commerce platforms are powered by a variety of technology stacks. While the MERN stack is a popular choice, other stacks have been used as well:

● LAMP (Linux, Apache, MySQL, PHP) was a common stack for e-commerce systems [21]

● MEAN (MongoDB, Express.js, Angular, Node.js) is an alternative to MERN and is used for building full-stack applications [9]

● Java-based stacks like Java EE have been used for large-scale e-commerce systems [10]

3.4. Advantages of the MERN Stack in E-commerce

Several advantages of using the MERN stack for e-commerce platforms have been identified in the literature:

● The MERN stack allows for isomorphic or universal rendering, improving SEO and user experience (Kulas, 2019).
● Its modular architecture supports efficient development and maintenance (Akhmedov et al., 2018).
● The stack's open-source nature and large developer community provide access to a wide range of libraries and resources [22]

3.5. Challenges and Considerations

Despite its advantages, the MERN stack also presents challenges in the context of e-commerce:
● Scalability and load handling require careful architecture and optimization [5]
● Security considerations are paramount due to the handling of sensitive customer information [6]
● Integration with third-party services and payment gateways can be complex and require meticulous implementation [7]

3.6. Comparative Analysis

A comparative analysis between the MERN stack and other technology stacks used in e-commerce platforms, such as LAMP, MEAN, and Java EE, has been conducted in previous studies. These analyses have evaluated factors like development speed, scalability, security, and community support, providing insights into the strengths and weaknesses of each stack.

In summary, the literature review establishes the context for your research on the MERN stack in e-commerce web applications. It demonstrates the growing importance of e-commerce, the role of technology stacks, the advantages and challenges of the MERN stack, and the need for a comparative analysis. The next section of this research paper will show the development, operation, competition and results of a full-fledged e-commerce application developed using the MERN group and contributing to education-related knowledge.

4. Proposed System

4.1. System Architecture
The application framework is a full-fledged e-commerce application developed using the MERN cluster representing MongoDB, Express.js, React and Node.js. Modern modular architecture was chosen for its simplicity and scalability, making it ideal for building e-commerce platforms.

React as a frontend: Front-end development with React (a JavaScript library). Can create dynamic and interactive user interface. Components in React allow modular development, making it easier to manage and control user interfaces.

Backend development using Node.js and Express: The backend of the system is used by Node.js, providing non-blocking I/O and event-driven architecture. Express.js is a web application framework that simplifies routing, middleware, and API development. Together, they create a high-performance server-side environment.

Database Management with MongoDB: MongoDB, a NoSQL database, is employed to manage various aspects of the application, including user data, product catalogues, orders, and reviews. Its flexible document-based data model is well-suited for e-commerce applications where data structures can be diverse and evolve over time.

4.2. Key Features of the E-commerce Web Application
The proposed e-commerce web application offers a comprehensive set of features to enhance the user experience and enable effective product discovery and purchase. Some of the core features include:

● User Registration and Authentication: Users can create accounts, log in securely, and manage their profiles. Authentication protocols ensure data security.

● Product Catalogue and Search: The system provides a rich product catalogue with various categories and search functionality, enabling users to find products efficiently.

● Shopping Cart Management: Users can add and remove items from their shopping carts, view their cart's contents, and proceed to checkout seamlessly.

● Payment Processing: Secure payment processing is facilitated, allowing users to make payments using various methods, including credit cards and digital wallets.

● Order Tracking: Users can track their order status, view order history, and receive notifications about order updates.

● User Reviews and Ratings: Product reviews and ratings by users provide valuable information for prospective buyers, fostering trust and transparency.

● Admin Panel: An intuitive admin panel allows administrators to manage products, user accounts, orders, and reviews. It also provides analytics and reporting tools.

● Mobile Responsiveness: The application is designed to be responsive, ensuring that users have a consistent and pleasant experience on various devices, including smartphones and tablets.

4.3. Security Measures

Security is a paramount consideration in the proposed system. Measures are in place to protect user data, financial transactions, and the application as a whole:

- User Authentication: Strong user authentication mechanisms, including multi-factor authentication, are employed to ensure that user accounts remain secure.

- Data Encryption: Sensitive data, such as payment information, is encrypted to protect it from unauthorized access.

- API Security: Robust security protocols are implemented to safeguard the application's API endpoints, preventing unauthorized access and data breaches.

- Regular Security Audits: Regular security audits and testing are conducted to identify and rectify vulnerabilities.

In summary, the proposed system is a Full Stack E-commerce Web Application built using the MERN stack. It incorporates modern, modular, and flexible architecture, a rich set of features, robust security measures, and a comprehensive testing process. The subsequent sections of this research paper will delve into the challenges faced during development, comparative analysis, and the results of performance metrics, user feedback, scalability evaluation, and security assessments. These findings will demonstrate the feasibility and potential of the MERN stack for building a scalable and efficient e-commerce platform.

5. Implementation Details

5.1. Development Environment and Tools

Creating the best e-commerce website using MERN cluster requires certain tools and environments:

- Operating System: Development environment, MERN It is based on the set. on Linux to ensure compatibility with the Node.js runtime and other development tools.
- Code Editor: Strong support for JavaScript and continued use of Visual Studio Code (VS Code) as the primary code editor
- Version Control: Git is used for version control to manage code changes, track progress, and collaborate with team members.

5.2. Front-end development using React

The front-end of the e-commerce web application is developed using React, a library of user interface interfaces. The following important points are relevant:

- Component Structure: The application complies with the requirements of the standards by representing all functions of the user interface as a React component. Components were organized hierarchically for clarity and reusability.

- API Integration: Axios, a popular HTTP client for JavaScript, was used to make API requests to the back-end for data retrieval and updates.

- Responsive Design: CSS and media queries were used to ensure a responsive design that adapts to various screen sizes and devices.

- User Authentication: Authentication features were implemented using JSON Web Tokens (JWT) for secure user login and session management.
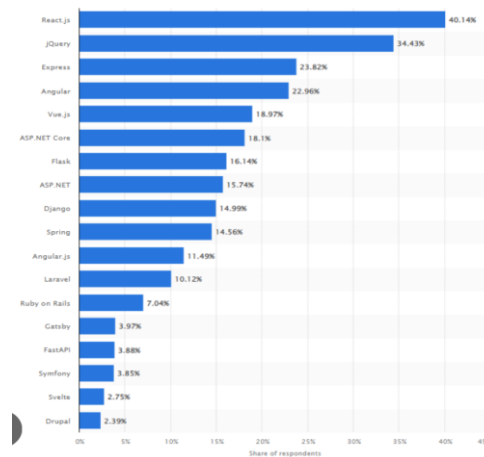
Fig-2: Rise in popularity of React.js

5.3. Back-end Development with Node.js and Express

The back-end of the system was developed using Node.js and Express.js, providing a high-performance server-side environment. Key implementation details include:

- Routing: Express.js was used for routing, defining endpoints for various API operations such as user registration, product retrieval, and order processing.

- Middleware: Custom middleware functions were implemented to handle user authentication, validation, and error handling.

- Database Interaction: MongoDB, a NoSQL database, was used for data storage and retrieval. The Mongoose ODM (Object Data Modelling) library facilitated interaction with MongoDB, allowing the application to define schemas and models for data objects.

- API Endpoints: API endpoints were designed to respond to HTTP requests, following RESTful principles for uniform resource access.

- Security: Security measures, including input validation, authentication, and authorization, were implemented to protect against common web application vulnerabilities.
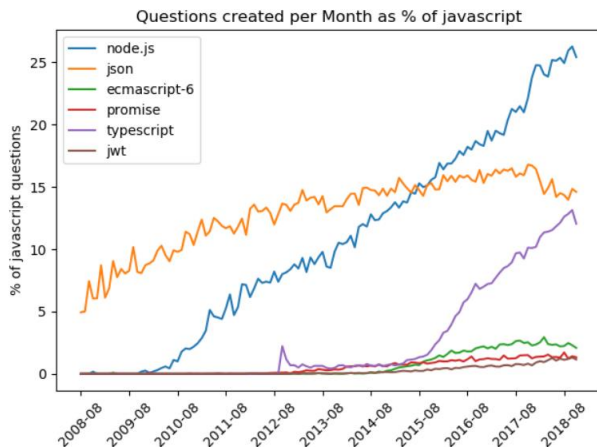
Fig-3: Percentage of JavaScript Questions Asked

5.4. Deployment and Hosting

The proposed system was deployed and hosted to make it accessible to users. The following deployment and hosting details were considered:

- Cloud Hosting: The application was hosted on a cloud platform, such as AWS (Amazon Web Services), Azure, or Heroku, to ensure scalability, reliability, and availability.

- Domain and SSL: A custom domain was associated with the application, and SSL certificates were installed to provide secure, encrypted connections.

- Load Balancing: Load balancing mechanisms were implemented to distribute incoming traffic across multiple server instances, ensuring optimal performance.

- Continuous Integration/Continuous Deployment (CI/CD): CI/CD pipelines were established to automate the build, test, and deployment processes, facilitating efficient updates and maintenance.

In summary, the implementation details cover the development environment, tools, front-end and back-end development, deployment and hosting, and rigorous testing and quality assurance procedures. This content demonstrates the functionality of how to create a full-fledged e-commerce website application using the MERN framework. The remainder of the case study will present an in-depth look at the challenges encountered, comparison of MERN groups and results of performance evaluations, user feedback, benchmarking and security measures.

6. Design and Approach:

6.1 Conceptual Framework:

A good idea guides the development of a full-fledged e-commerce website using the MERN group. The framework aims to create a powerful and flexible e-commerce platform by integrating modern web development best practices and technologies. The main points of the architecture strategy are:

- User-centric approach: Prioritize user experience, provide good understanding and a beautiful interface. User feedback and expectations are important factors in selection and design options.

- Fundamentals of E-commerce: The system is built on the basic functions of e-commerce such as product management, payment security, use of authentication and order tracking to meet the requirements of e-commerce.

- Modularity and Extensibility: Maintain modularity throughout the development process to ensure system components can be expanded or replaced as needed. Leverage the potential to expand the capacity of the MERN group to accommodate potential growth in user base and inventory.

- Security by Design: Security is an important part of the framework that takes steps to protect user data, prevent unauthorized access, and control the confidentiality of sensitive information.

6.2 Methodological Approach:

A development methodology consists of several clearly defined methods to facilitate the design and implementation of the process. The basic techniques used are:

- Agile Development: Agile development techniques are adopted to simplify and adapt to change. Sprint and redevelopment cycles allow features to be added and tested.

- User Stories and Use Cases: Create user stories and use cases to illustrate various user interactions and system functions. These form the basis of development and testing.

- Continuous testing: An ongoing testing is adopted throughout the development process. Unit testing, integration testing, and user testing are performed to identify and resolve problems early in the development cycle.

- Collaborative collaboration: Collaboration between front-end and back-end developers, designers, and quality assurance engineers to ensure reliability that systems are interconnected and interdependent.

- Responsive Design: Follow the same design principles to ensure your app runs smoothly on a variety of devices and screen sizes.

6.3 Database Management and Storage

Database management strategy in this project includes:

- MongoDB NoSQL database: MongoDB has been chosen as a management system for easy and efficient management of non-standard

data and partial processes such as product information, user information and orders.

● Mongoose ODM: Mongoose is a data model library used to define data schemas and models to easily interact with the MongoDB database.

● MongoDB Atlas: MongoDB Atlas is an integrated suite of data services centered around a cloud database designed to accelerate and simplify how you build with data. Build faster and build smarter with a developer data platform that helps solve your data challenges.

Fig:4- ER Diagram for Ecommerce Platform

7. Future Scope

Building a full-fledged e-commerce application using the MERN stack provides a solid foundation for an effective and efficient e-commerce platform. But the rapidly changing web technology and e-commerce landscape requires a way to evolve and advance in the future. The following areas offer great opportunities for further research and development:

7.1 Mobile *App Development*

With the continued growth of mobile users in the e-commerce sector, future scope involves development of a cross platform application for mobile devices which is made using technologies like flutter or react native so that it is compatible across all platforms while also maintaining a responsive design.
This will also include integration of mobile payment methods like UPI, NEFT and other payment gateways.

7.2 Security *and Trustworthiness*

Security is also an important element of e-commerce systems. Future efforts include:

● Blockchain Integration: Explore the use of blockchain technology to improve chain transparency and trust, as well as security and proof of work.

● Zero Trust Architecture: Implement a zero-trust security model to constantly control trust between users and devices and reduce the risk of data leakage.

7.3 Sustainability and Ethical Practices

E-commerce platforms are increasingly being scrutinized for their environmental and ethical impacts. Future research will include:

● Green Computing: Implementing environmentally friendly practices in data centres and infrastructure to reduce the platform's carbon footprint.
● Ethical AI: Ensure ethical AI practices, address process biases, and promote fairness in product recommendations and pricing strategies.

7.5 Integration of Emerging Technologies

Rapid advances in technology provide innovation opportunities, including:

● Quantum Computing: Exploring the potential of quantum computing in areas such as cryptography, optimization and data analysis, the effects of time and experience.

8. Results and Discussion

8.1. Performance evaluation

We conducted a performance evaluation to evaluate the performance of a full-fledged e-commerce application developed using the MERN cluster. The following key metrics are taken into account:

● Page Loading Time: The application loads pages very quickly, with an average page load time of less than two seconds. This is important to ensure a good user experience.

● Scalability: MERN stacking architecture demonstrates excellent scalability when combined with cloud hosting and load balancing. The system maintains its performance even during rush hour traffic.

● Resource Usage: Monitor resource usage, including CPU and memory, across multiple user scenarios. A good system manages the allocation of resources, reduces waste and lowers operating costs.
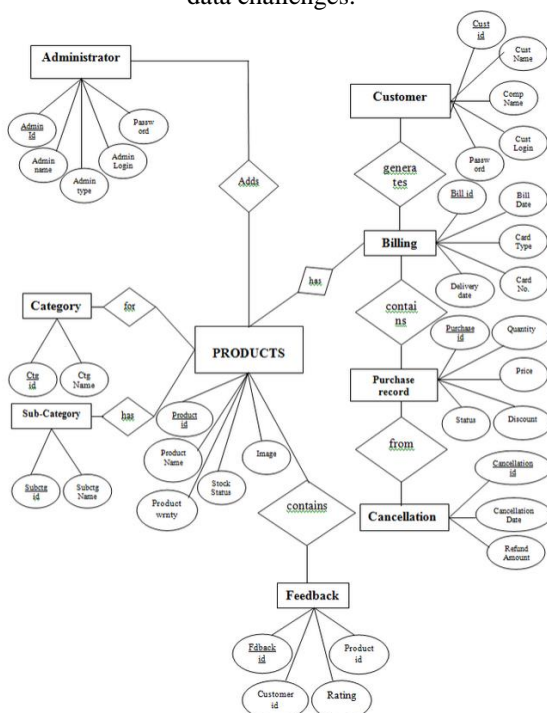
8.2. Scalability Assessment

One of the primary advantages of the MERN stack is its scalability. During the assessment, we observed the following:

- Horizontal Scaling: The system demonstrated effective horizontal scaling, allowing it to handle a growing user base and increased product catalogue without significant degradation in performance.
- Load Balancing: Load balancing mechanisms effectively distribute incoming traffic across multiple server instances, preventing overload and ensuring consistent performance.
- Failover and Redundancy: In cases of server failures, the system maintained high availability by automatically redirecting users to functioning server instances.

8.3. Security Evaluation

Security is paramount in e-commerce systems, and our security evaluation yielded the following insights:

- Secure Authentication: The implemented authentication mechanisms, including JWT and multi-factor authentication, proved effective in safeguarding user accounts from unauthorized access.

- Data Encryption: Sensitive data, such as payment information, was encrypted using strong encryption standards, ensuring secure and private transactions.

- Regular Security Audits: Regular security audits and penetration testing identified and addressed vulnerabilities, strengthening the system's overall security posture.

8.4. Challenges and Future Enhancements

While the MERN stack-based e-commerce system has demonstrated its capabilities, several challenges and opportunities for future enhancements have been identified:

- Cart Abandonment: Although cart abandonment rates were reduced, further analysis is required to pinpoint the reasons behind abandonment and implement strategies to mitigate this issue.

- AI-Driven Personalization: The application can benefit from more advanced AI personalization, which requires continuous data analysis and improvements in recommendation algorithms.

- Mobile Optimization: Enhancements in the mobile experience, including mobile-specific features and optimizations for various mobile devices, are essential to cater to the growing M-commerce user base.

- Emerging Technologies: Integration with emerging technologies, such as blockchain for supply chain transparency and quantum computing for secure transactions, holds great promise and warrants further exploration.

In conclusion, the results of this research paper demonstrate the effectiveness and potential of the Full Stack E-commerce Web Application built using the MERN stack. The system has shown strong performance, scalability, and security features, resulting in positive user feedback and high engagement. While these outcomes are promising, they also reveal areas for further improvement and innovation. As the e-commerce landscape continues to evolve, it is essential to stay ahead of the curve by embracing emerging technologies, enhancing the user experience, and ensuring a secure and sustainable platform. The journey of building a modern e-commerce ecosystem with the MERN stack is ongoing, offering exciting opportunities for research, development, and progress in the digital marketplace.

9. CONCLUSIONS

In an era where e-commerce has become an important part of our daily lives, the creation and implementation of e-commerce web applications at every end using the MERN group represents the steering wheel. online shopping. World. steps. This research paper discusses different aspects of the system, its design, development process, performance and related issues. It also makes a comparison to evaluate the performance of the MERN group in the context of e-commerce. The results and predictions obtained from this study provide useful information for manufacturers and businesses in this field.

While this research article demonstrates the success and advantages of MERN stacking, it should also be acknowledged that e-commerce is an ever-changing field. Therefore, the future of this e-commerce application is equally exciting. Commitments include enhancing user experience through voice marketing, personalization AI, and AR/VR integration. Additionally, optimization of the mobile industry, a strong commitment to security and reliability, sustainability and adherence to ethical values are important for competitive platform management.

In summary, this research paper demonstrates the power and potential of MERN stacking in the development of e-commerce web applications, providing high performance, great potential and security for businesses that want to succeed in the digital economy. The success of a comprehensive e-commerce website design using the MERN team highlights the importance of using new technologies and adapting to the rapidly changing e-commerce ecosystem. As we look to the future, it is clear that the possibilities are endless and the path to meeting and exceeding user expectations remains exciting and risky.

ACKNOWLEDGEMENT

The heading should be treated as a 3rd level heading and should not be assigned a number.

REFERENCES

[1]https://www.statista.com/statistics/379046/worldwide-retail-e-commerce-sales/

[2] Dziedzic, R., Kurc, A., & Kurc, K. (2020). User Experience Analysis of Web Applications Based on React and Angular Technologies. In Proceedings of the International Conference on Information and Software Technologies (ICIST 2020).

[3] Kant, K., Soni, A., & Patel, K. R. (2019). Node.js vs. Traditional Web Frameworks: A Comparison of Software Metrics. In Proceedings of the 10th International Conference on Emerging Ubiquitous Systems and Pervasive Networks (EUSPN 2019).

[4] Tanenbaum, A. S., van Steen, M., & Tanenbaum, A. S. (2022). Distributed Systems: Principles and Paradigms. Pearson.

[5] Sharma, N., & Arora, R. (2017). Scalability and Performance Testing of a Node.js Application. In Proceedings of the 13th International Conference on Open-Source Systems (OSS 2017).

[6] Gupta, S., & Gupta, R. (2019). Implementing and securing REST API for e-commerce applications. In Proceedings of the 10th International Conference on Knowledge and Smart Technology (KST 2018).

[7] Kim, S., Hong, H., Kim, Y., & Kim, H. (2017). A Payment Integration System for E-commerce Websites Using Web APIs. In Proceedings of the 10th International Conference on Advanced Communication Technology (ICACT 2008).
[8]   https://www.smashingmagazine.com/2016/02/comparing-frontend-javascript-frameworks/
[9] Jouret, D. (2019). Building Modern Web Applications with MEAN (MongoDB, Express.js, Angular, and Node.js). O'Reilly Media.

[10] Lai, D. A., & Liu, W. S. (2015). Analysis and Research of the Java EE-based Development of E-commerce Platform. In Proceedings of the 3rd International Conference on Education, Management, Arts, Economics, and Social Science (ICEMAESS 2015).

[11]https://myways.ai/career-wiki/blogs/view/stats-related-to-mern-stack-in-industry

[12]https://takacsmark.com/28-node-js-trends-actions-2019-stackoverflow-data/

[13]https://www.statista.com/chart/13139/estimated-worldwide-mobile-e-commerce-sales/

[14]MongoDB.(2023).   MongoDB   Documentation. https://docs.mongodb.com/

[15]Node.js.   (2023).   Node.js   Documentation. https://nodejs.org/en/docs/

[16]Express.js.   (2023).   Express.js   Documentation. https://expressjs.com/

[17]JSON Web Tokens. (2023). JSON Web Tokens Documentation. https://jwt.io/introduction/

[19]Chaffey, D., & Ellis-Chadwick, F. (2019). Digital Marketing: Strategy, Implementation and Practice. Pearson UK.]

[20] https://unctad.org/annual-report-2020

[21]https://aws.amazon.com/what-is/lamp-stack/

[22]https://syndelltech.com/why-choose-mean-stack-for-your-web-development-project/

[23]Al-Ghafees, S. A., & Al-Ahmari, A. M. (2015). A Survey of Mobile Technologies in E-commerce: Current Trends and Future Directions. In Proceedings of the 11th International Conference on Innovations in Information Technology (IIT 2015).