Case Study of Design and Development of a Web-Based E-Commerce Application Using MERN Stack

Dr. Priya Dilip Chaudhari[1], Prakash D. Dhamdhere[2], Kunal S. Sankpal[3]
[1]*G.H. Raisoni College of Engineering and Management, Wagholi, Pune*
[2,3]*MCA Department, G.H. Raisoni College of Engineering and Management, Wagholi, Pune*
doi.org/10.64643/IJIRTV12I12-200596-459

***Abstract*—With the rapid shift in how consumers shop on the internet and the rapid evolution of the retail industry as an electronic commerce platform, there is an increasing number of businesses developing E-commerce solutions to reach more customers with a more convenient method for them to purchase. The traditional retail system has been largely replaced by the Internet enabled application allowing the consumer to browse products, price comparisons, and place orders from any location utilizing any device that has access to the Internet. This case study report will outline the design and build of an E-commerce web application built with the MERN Stack (MongoDB, Express.js, React.js, and Node.js) that provides scalability and security.**

The new system will include a customer friendly and easy-to-use interface to help customers find products, search and sort products by criteria of interest, add products to a shopping cart, and submit an order in a secure manner. The new system also will include a management section for the administrator who can manage inventory levels of all products, update product information, monitor customer orders, and allow them to be able to perform CRUD (Create, Read, Update, Delete) operations.

The system follows an architecture in which the front-end is built using React to create dynamic user interfaces that can be used by users, with the back-end created using Node.js and Express.js to perform back-end functions and provide API functionality. It utilizes MongoDB to create an efficient means to store all product-related data, user-related data, and order detail-related data.

In addition to providing an efficient means to securely manage user data through the use of JSON Web Tokens (JWT) for authentication purposes and to encrypt passwords for the secure log-in of users, the system also provides a method to safely store user credential information. Additional features, including but not limited to role-based access control and proper management of the database, enhance the reliability and security of the system. This case study illustrates how current web development technologies can be used in a practical sense to create large scale e-commerce applications.

***Index Terms*—E-Commerce, MERN Stack, Web Application Development, React.js, Node.js, MongoDB, Online Shopping System, Case Study.**

I. INTRODUCTION

The growth in Internet-based technological advancements has greatly influenced how a business can interact with its customers. An e-commerce platform allows a business to sell their product or service via an electronic channel (i.e., the Internet), thus offering customers increased convenience and accessibility to those products/services. The traditional retail system is largely based upon a brick-and-mortar store model. This model limits the ability for a retailer to reach customers as well as be efficient operationally. On-line shopping models are free of these constraints since a customer may access products on line from anywhere and at any time. Modern web development tools and technologies have made it possible for developers to create scalable and dynamic applications. A very common full-stack application technology combination that includes four separate technologies is referred to as the MERN stack. Those four separate technologies include MongoDB, Express.js, React.js and Node.js. Some of the many benefits provided by the use of the MERN stack include: JavaScript programming across all layers of an application (unified) Improved efficiency when developing the interface between the client and server (client-server communication) Easier scalability with the database (database scalability) Improved performance of end-user experiences (user interface performance) Through this study, we will design and implement an online e-commerce store utilizing

MERN technologies as an example of how to build a modern full-stack web development application.

II. LITERATURE REVIEW

Many researchers and technology professionals have studied the use of new technologies for developing web-based e-commerce systems.

Turban et al., stated that electronic commerce systems enable the creation of digital markets as well as increase the availability of products and services. The study by Turban et al., also emphasize that modern e-commerce platforms require fast, intuitive user interface designs and secure transaction systems.

In addition to designing user-friendly interfaces and secure transactions, Pressman emphasized that software engineering methodologies are important to developing reliable and scalable web-based applications. According to Pressman, structured development methods help to ensure that software is high-quality and maintainable.

Modern JavaScript frameworks like React.js offer an increase in the speed of user interface creation using reusable components. Using React developers can design and create dynamic, responsive, and high-performance web applications with improved user experiences.

Node.js is rapidly becoming a top choice for the back-end due to its non-blocking I/O and event-driven model which significantly enhances server performance and provides the ability to handle a large number of clients requesting services at the same time.

MongoDB is a NoSQL database that uses flexible document-based storage models (similar to JSON) that allow developers to easily work with their data and make changes to how they store the data to match their needs.

MERN is a combination of MongoDB, Express.js, React.js, and Node.js and offers developers a single environment for building full-stack web applications entirely using JavaScript.

III. PROBLEM STATEMENT

The fact that many small businesses are still relying on the manual method of selling products as well as social media to promote their products and sell them is another example of how rapidly growing online commerce has been for small businesses.

Manual systems used by most small businesses have several drawbacks, including; no structured way of managing products, limited potential for scale (i.e., limited ability to grow), lack of security with regards to authenticating users, and difficulty in tracking inventory levels.

Due to the need to keep track of orders, updates on products and interacting with customers, manual systems require a great deal of time and effort to accomplish.

Therefore, a scalable, secure and web-based e-commerce platform is needed to help reduce the amount of time and effort required to manage products and create a better shopping experience for the customer.

IV. OBJECTIVES OF THE STUDY

The primary goals of the research include:

- Developing a full-stack application using the MERN Stack as a means to develop a web-based e-commerce application
- Creating a web-based platform that allows users to browse and purchase products through an on-line shopping experience
- Implementing secure methods of authentication to allow users to login to the system securely
- Development of an administration interface to manage products within the e-commerce application
- Demonstrating how modern web technologies can be used to create a full-stack web application in development
- Create a safe method of authenticating users so they may safely log into the system.
- Develop an administrative interface in order to handle the management of all products contained in the E-Commerce System.

V. SYSTEM ARCHITECTURE

The proposed system's architecture has three key layers: the frontend layer, the backend layer and the database layer.

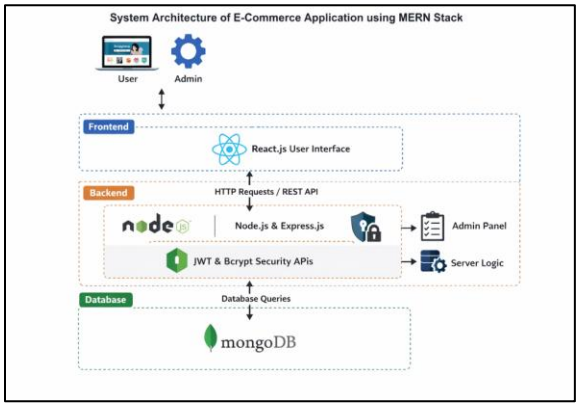
Frontend Layer -

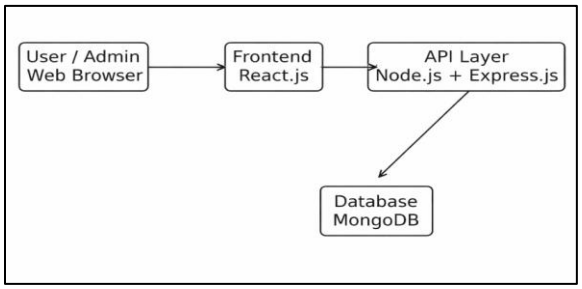
The front end is created with React.js. This creates an interactive and engaging user experience based on the responsiveness provided by React.

Components are also used to create product lists and provide management of user shopping carts and to support user registration and login processes.

Backend Layer -
The back-end was built using Node.js and Express.js. The back-end is responsible for providing the server-side functionality (server-side logic) and developing APIs (application programming interfaces).
APIs (Application Programming Interfaces), which are developed using the RESTful protocol, support communication between the client and server.

Database Layer -
The MongoDB database is used to store the data from the application. All data collected from the application regarding the users, products and orders are stored in flexible document formats in MongoDB.
All three layers communicate through API requests and API responses.





VI. IMPLEMENTATION

Implementation is the next step in developing the web-based e-commerce application and it will involve development of front-end interfaces, back-end API's and database design.

Front-End Development
React.js will be utilized to create reusable front-end components that will include the following:
- Product listing pages
- Shopping Cart Interface
- Login/Registration forms

These components are designed to be both responsive and interactive.

Back-End Development
Node.js and Express.js will be utilized to create back-end APIs for the application that will handle all application logic.

API Endpoints:
- Authentication (login/register)
- Product Management
- Cart Operations

Database Design
MongoDB will be used to store all application data in document format.
There will be three main collections for
- users
- products
- orders.

Security
The following security mechanisms were implemented into this application:
- JSON Web Token (JWT) Authentication
- bcrypt Password Hashing

This will protect the user's information and also provide a secure method for accessing the application.

VII. RESULTS AND DISCUSSION

The system has shown evidence to prove that it is able to successfully implement an e-commerce platform on the web, utilizing MERN technology.
This system has provided the following functions:
- Registration and Login User Functionality
- Functionality to Browse Products
- Functionality to Manage Shopping Cart
- Functionality for Administration Product Management

The responsive user interface has created an easier and better user experience, whereas backend API's have

allowed for faster data transfer from the backend to the frontend database.

The above results provide evidence that the MERN stack creates a fast and flexible environment for the development of web-based applications.

VIII. FUTURE DIRECTIONS

The system will be able to be improved in the future by adding some of the following features:

- Product Recommendation System Using Machine Learning
- Customer Review and Rating Systems
- Functionality to Track Orders
- Development of Mobile Application
- Adding these features would greatly increase the functionality and ease of use of the website.

IX. CONCLUSION

This case study demonstrated the design and build of an e-commerce platform based on a web technology called MERN Stack. The example is designed to show how the combination of modern web technologies are used to create scalable and secure online shopping applications.

As well as demonstrating the basic features that an e-commerce application should have (e.g., product search/browse, shopping cart management, administrative product control) it also shows how the use of MERN based technologies will simplify the development process of the e-commerce platform.

It also provides a solid base upon which further developments may take place to enhance and advance the e-commerce platform.

REFERENCES

[1] E. Turban, D. King, J. K. Lee, T. P. Liang, and D. C. Turban, Eds., *Electronic Commerce: A Managerial and Social Networks Perspective*, 8th ed. Cham, Switzerland: Springer, 2015.

[2] R. S. Pressman and B. R. Maxim, *Software Engineering: A Practitioner's Approach*, 8th ed. New York, NY, USA: McGraw-Hill Education, 2015.

[3] Meta Open Source, "React – A JavaScript library for building user interfaces," *React documentation*. [Online]. Available: https://react.dev

[4] Node.js Foundation, "Node.js JavaScript runtime documentation." [Online]. Available: https://nodejs.org

[5] MongoDB Inc., "MongoDB documentation." [Online]. Available: https://www.mongodb.com

[6] R. T. Fielding, *Architectural styles and the design of network-based software architectures*, Ph.D. dissertation, Univ. California, Irvine, CA, USA, 2000.