A Study on Optimizing an Effective Online Platform to Address Plastic Waste Management in Sri Lanka

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Abstract— **Plastic waste is a severe environmental problem with far-reaching effects on the environment, human health, and the economy. Therefore, sustainable methods for managing plastic waste are essential to protecting the environment and guaranteeing a cleaner, healthier future for the next generations. Unfortunately, Sri Lanka is currently grappling with a serious plastic waste management problem, with plastic waste volumes increasing rapidly over the years. However, the issue extends beyond environmental concerns, permeating social and economic spheres. Rapid urbanization, population growth, and low stakeholder awareness of the problem are some of the contributing factors. This requires introducing an effective and efficient system incorporating technology to improve solutions. The proliferation of technology has significantly impacted the global marketplace, resulting in an expanding customer and vendor base. This development has triggered a departure from traditional buying and selling methods, as digitalized platforms offer an efficient approach to securing ideal consumer products. Although countless online fashion platforms exist, many lack a commitment to environmental sustainability. This paper discusses a web-based application designed to accumulate PET (Plastic Polyethylene Terephthalate) bottles, recycle them, and convert them into clothing products. Web-based PET bottle collection is a new innovative feature that addresses this prominent environmental concern. The process generates various polyester threads by separating and reprocessing plastic waste, which is subsequently used to create desired clothes. The ultimate objective of the application is to establish an online clothing store that efficiently manages the plastic waste in Sri Lanka.**

Keywords— plastic waste management, environment, STG 12, PET bottles, online clothing, fashion

I. INTRODUCTION

Sustainable development is a pressing issue today, with growing concerns over environmental degradation, resource depletion, and social inequality. Responsible consumption and production (SDG 12) are critical sustainable development components. They aim to ensure that our consumption and production patterns are sustainable and do not harm the environment or society. [1] In recent years, there has been an increasing focus on responsible consumption and production as a critical component of sustainable development.

As businesses and individuals become more aware of their actions' environmental and social impacts, there is a growing need for tools and solutions that can help promote responsible consumption and production. [2] Plastic waste management is a multifaceted and intricate issue that calls for adopting sustainable practices to safeguard the environment and tackle the plastic waste predicament. Among the various methods, recycling is the most efficient solution for plastic waste management, owing to its numerous ecological, financial, and societal benefits.

Figure 1: Amount of Plastic import to Sri Lanka during the year

The research "Status of Plastic Waste Generation and Propose a Circular Economy-Based Policy Framework to Manage Plastic Waste in Sri Lanka" highlights the amount of plastic import to Sri Lanka. Figure 1 demonstrates that from 2008 to 2018, plastic imports increased steadily. [3] With the passage of the Environmental Conservation Levy Act No. 26 of 2008 35 in 2008, the government imposed an "Environmental Conservation Levy" with a focus on specific consumer goods, specific goods imported into or produced in Sri Lanka, and particular services offered in Sri Lanka that are likely to harm the environment. Up to 650,000 tons of plastic will be imported annually by 2025, more than twice the amount imported in 2013.

Concurrently, the emergence of the internet has significantly transformed the fashion industry with the advent of online clothing stores. These stores have brought numerous opportunities, such as cost-effectiveness, more comprehensive outreach, increased revenue, agility, and enhanced customer satisfaction. [4] For online clothing stores to thrive and achieve profitability, they must address these challenges and create an end-to-end, seamless experience that inspires customer trust and confidence in the online shopping

environment. [5] This necessitates a keen awareness of customers' changing needs and preferences and an unwavering commitment to continuously tailoring their offerings to meet these demands. Ultimately, the success of an online clothing store relies on its ability to remain aligned with its target audience, foster trust, and deliver excellent customer experiences.

In response to this need, this research paper presents a software web application designed to address specific problems related to responsible consumption and production. The main idea of the software web application is to collect plastic waste materials from outside and recycle them to produce clothes to be sold online. The application is intended to help individuals and businesses make more informed and sustainable choices by providing access to information, resources, and tools that promote responsible consumption and production practices. The paper begins by giving an overview of the developed software web application. It then explains its key features and functionalities.

The application addresses various responsible consumption and production issues, including reducing waste, minimizing environmental impact, and promoting social responsibility. It includes some processes for collecting plastic waste and reducing the environmental pollution. And provide sustainable products and services. The paper also includes a discussion of the potential benefits of the software web application, including its ability to increase awareness and promote behavior change around responsible consumption and production. It highlights future research and development potential and the importance of continued efforts to promote sustainable development through responsible consumption and production.

II. LITERATURE REVIEW

This section is designed to underscore relevant scholarly works interconnected with the research. The discussion will prioritize the most noteworthy and related literature by highlighting how it connects and enhances the present study.

A. Use of online platforms for plastic waste collection

Collecting PET bottles is a critical step toward waste reduction and recycling promotion. According to Plastic Waste Management paper (2019), water bottles, soda bottles, and food packaging are frequently made of the popular plastic PET. [6] Plastic polyethylene terephthalate (PET) is both strong and lightweight. This plastic is commonly used for packaging food, juice, drink, bottled water, and cooking oil. Since this single-use bottle, hot water shouldn't be put in it. Sadly, many of these things wind up in landfills or the ocean, which can take hundreds of years to degrade. Recycling PET bottles also lessens the energy required to create new goods because recycled plastic may be used to build several products, including new bottles, carpeting, and apparel. "PET Plastic Waste" architectural journalism [7] illustrates that recycling PET bottles is a simple and effective strategy to encourage sustainability and support environmental protection.

Utilizing an online platform is essential to effectively managing plastic waste in Sri Lanka. [8] Integrating technology into waste management initiatives can enhance operational efficiency, reduce costs, and promote transparency. [9]

Considering technology's progress, the Internet has become ubiquitous for everyday tasks, including collecting plastic waste. Web applications function to the advantage of their users. However, some of these applications' features prove more advantageous to their owners. Companies that depend on raw materials for production recognize the importance of securing these resources. [10] Thus, the necessity of a web-based system for collecting plastic bottles arises. This approach promises an expedient and efficient process for the initiative.

B. Impact of user behavior on plastic waste collection

Trust plays a critical role in web applications with sales functions, particularly for users concerned about receiving fair compensation for the materials they sell. Such users expect prompt and accurate payments for their collected plastic waste, and their continued patronage of the web application depends significantly on maintaining their trust. Heshan Sun's research on the Sellers' Trust and Continued Use of Online Marketplaces provides valuable insights in this regard. [11] Hence, establishing and fostering trust is significant.

C. Use of plastic waste in manufacturing clothing items

The fashion industry's plastic dependency extends far beyond textiles, highlighting a significant environmental issue. One potential solution to ensure sustainable fashion is recycling plastic waste to create clothing. The article "Sustainable Fashion" highlights that turning plastic waste into clothing leads to a more environmentally friendly manner. [12] Although still in its developmental stages, recycling plastic waste can prevent it from ending up in landfills while preserving natural resources.

This approach can also increase the durability of products and mitigate financial burdens associated with pollution and emissions. [13] By converting plastics into textiles such as polyester, nylon, and fleece through advanced recycling technologies, fashion designers can create a sustainable cycle of product manufacture and recycling. Ultimately, recycling plastic waste in this manner can significantly diminish the environmental impact associated with traditional material production. [14] This approach presents cost-effective, eco-friendly solutions to create stylish and environmentally responsible apparel while resolving a mounting ecological crisis.

D. Impact of customer engagement on online clothing stores

"Customer Engagement in the Online Clothing Industry" journal paper states that customer engagement refers to establishing a business relationship between a customer and an enterprise through various communication channels, including actions, dialogues, results, or general consumer encounters. [15] With the internet's growth, customers can now access a global market. Online apparel retailers are becoming increasingly popular, and it is vital that customers can benefit from novel technological features. [16]

Given that the garments in this clothing business are made from plastic trash, it is typical, and each customer interaction strategy is only practical to specific companies in specific sectors. Online clothing stores provide an excellent shopping experience to customers, who can explore a vast selection of products, read product reviews, and make purchases from the

convenience of their homes. Further, the advantages of affordability, adaptability, reliability, and product quality contribute to the development of this platform. [17] It is well described in Katarzyna Zyminkowska's research (2015).

Online clothes retailers need to use efficient marketing techniques to reach their target demographic. "Influence of Social Media Marketing on Customer Engagement" research shows that social media marketing effectively increases consumer interaction across various industries, including fashion. [18] Online clothing companies also need to offer a smooth experience to boost clients' trust and confidence in the online purchasing experience. Ultimately, the success of an online clothes company depends on its ability to meet the demands and expectations of its target market.

E. Card payment impact on online clothing platforms

In recent years, online shopping has become increasingly popular due to the convenience and accessibility it offers to customers. One of the critical factors in online shopping is the payment section, which plays a crucial role in customers' purchasing decisions. This literature review aims to explore the existing literature on the payment section in online shopping. The payment security of online shopping is one of the significant concerns of customers. The security of payment transactions is the responsibility of the e-commerce platform. According to Al-Somali, Roya Gholami, and Ben Clegg (2009), payment security is one of the critical factors affecting customers' trust in e-commerce. [19] Their study found that the presence of secure payment options positively affects customer trust and intention to purchase.

Payment options are also critical in online shopping. According to Mohamed Hassan and Geunhee Lee, the effect of payment options on consumer perceptions of online stores: An experimental study. International Journal of Retail & Distribution Management, 39(4), 261-277. [20] They found that customers' perception of payment options positively affects their intention to purchase. Therefore, online stores should provide various payment options to meet customers' needs and preferences.

Trust is a significant factor influencing customers' purchasing decisions in online shopping. According to Paul A. Pavlou's research paper (2003), trust is a critical factor in the e-commerce environment, and it is essential to build trust between customers and e-commerce platforms. [21] The payment section is crucial in building trust and providing secure payment options can enhance customers' trust.

III. METHODOLOGY

The software development process for the MERN Stack system has been structured using a three-tier architecture, incorporating four integral technologies that predominantly rely on JavaScript as their base programming language. The four technologies involved in the MERN Stack are Mongo Database, Express.js, React.js, and Node.js. [22] MongoDB is an adaptable and versatile cloud-based NO-SQL database system. The React.js technology is a client-side JavaScript framework, while Express.js is a web framework. The top-tier JavaScript web server Node.js is compatible with multiple platforms. The presentation layer of the system utilizes React.js, while the business layer uses Node.js and Express.js. A visual representation of the relationships between the four technologies is presented in Figure 1.
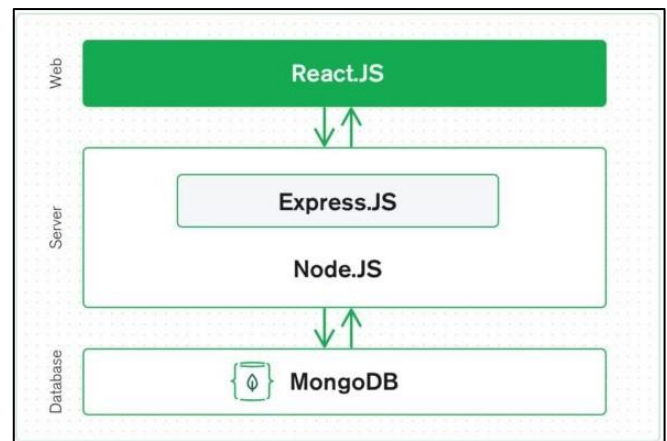

Figure 2: The relationships between the four technologies

An alarming issue prevalent in Sri Lanka is the accumulation of vast quantities of waste PET plastic bottles, which severely impacts the ecology and environment. The slow decomposition rate of these bottles, approximately 1000 years, exacerbates the issue, compounded by the millions of plastic bottles discarded globally every minute, with only 7% recycled. [23] It is evident that this is a problem afflicting various areas. The fashion industry's increasing demand and production costs also pose obstacles due to consumers' economic status. Technology can aid the proposed solution to mitigate these concerns, which will effectively tackle both issues.

A. Collecting plastic waste from the general public.

The proposed web application provides an opportunity for members of the general public who have used PET plastic bottles to dispose of these items profitably. Participation is welcome from a diverse pool of individuals, including hotel owners, pharmacy owners, grocery store owners, local distributors, and homeowners. Interested parties must complete a comprehensive form outlining their relevant information. Once submitted, the administrator will vet the data and send a confirmation message detailing the dates and times when the materials will be collected. Subsequently, all successful collections will be duly recorded and updated within the system for further reference.

B. Units Selling cloth items which are produced by recycling PET plastic bottles

The proposed web application offers clothing items manufactured from recycled PET plastic bottles to the general public. The system provides an intuitive interface for the administrator to update and manage different categories of clothes. Before proceeding with the purchase, the customer can access pertinent details, such as item name, materials used, and unit price. The website incorporates convenient online payment methods to streamline the purchasing process. In addition, the system's availability, fault tolerance, and security features are crucial factors in ensuring an optimal user experience.

The proposed system enables users to perform various functions, such as submitting data and sending requests to the system. The system's front end is designed to transmit submitted data to the backend server and store it in the database's file systems. Similarly, the backend server is responsible for receiving user requests to fetch data and retrieving the requested information from the database before delivering it to the front end for display.

Moreover, to ensure maximum security, the system implements a variety of security mechanisms and employs additional confirmation, validation, and authentication methods in both the frontend and backend.

IV. PROPOSED SYSTEM

The proposed system uses a web-based application to collect waste PET plastic bottles and sell clothes made by recycling them. This web application has four main functions. Those functions are Customer / User Management, Item / Clothing Management, Cart & Payment management, and Plastic Waste Management. Figure 3 illustrates the high-level diagram of the system.
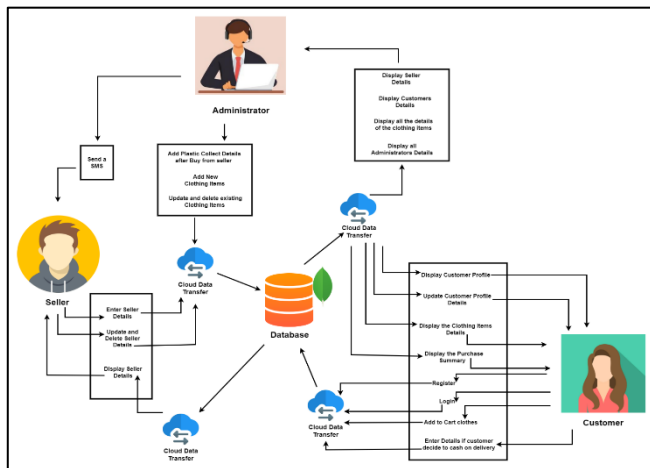
Figure 3: High-level flow diagram of the proposed system

A. Customer Management

The customer and the system administrator can handle different functionalities within the customer management role. The key responsibilities that fall under customer management are listed below.

- Login
- Registration
- Change Passwords
- View/Search Items
- Edit Profile
- Remove Profile
- Add Items to the Cart
- Edit Items in the Cart
- Remove Items from the Cart
- Generate/View Customer Reports
- Filter Customer Details

To access and purchase apparel goods, interested parties must register as a user and establish an account. Creating an account requires the user to submit basic personal information. The consumer can then log into the system by providing their email address or username along with the password. Upon logging in, customers can begin making purchases. Additionally, registered users can access and modify their account information by selecting the profile button. If a registered user forgets their password, they have the option to change it or create a new password, which requires email confirmation.
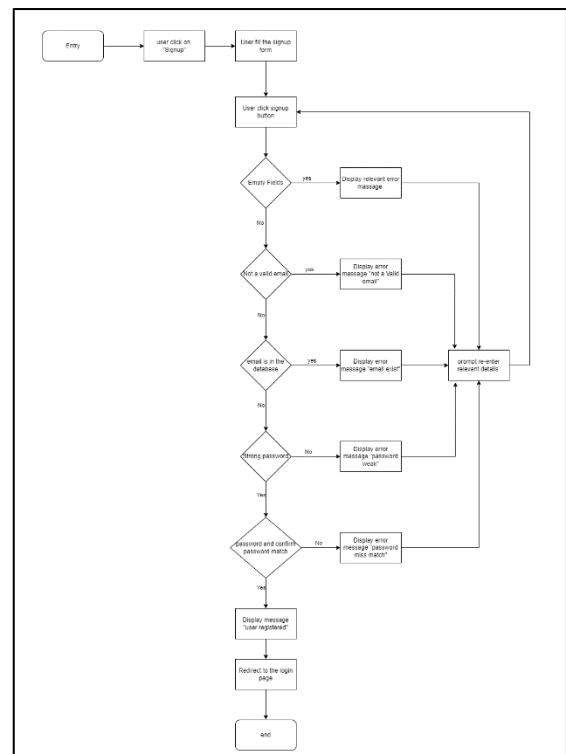

Figure 4: The user flow diagram of Customer Registration

The administrator holds the authority to access the list of customers and their respective information. Using this information, the administrator can generate reports on the customers and examine individual customer profiles. Furthermore, the administrator can modify customer information or remove customer profiles as needed.

B. Clothing / Item Management

The item management function consists of different functionalities which can be performed by both the customer and the system administrator. Below mentioned are the main functions under item/clothing management.

- Add Items
- View/Search Items
- Edit Item Details
- Remove Items
- Generate/View Item Reports
- Filter Item Details

From the home page, customers are provided with the option to navigate to the item page for purchasing clothes. The apparel items are available for purchase can be found on the item page. To facilitate a smooth shopping experience, customers can search for their preferred clothing items by item name, category, or unit code. Customers can access relevant details such as item name, category, unit price, size chart, materials, images, and other pertinent information by selecting an item of interest. Once customers have determined the items they wish to purchase, they can add them to their cart by clicking the "add to cart" button. Figure 4 shows the use case diagram of the customer according to the item management.
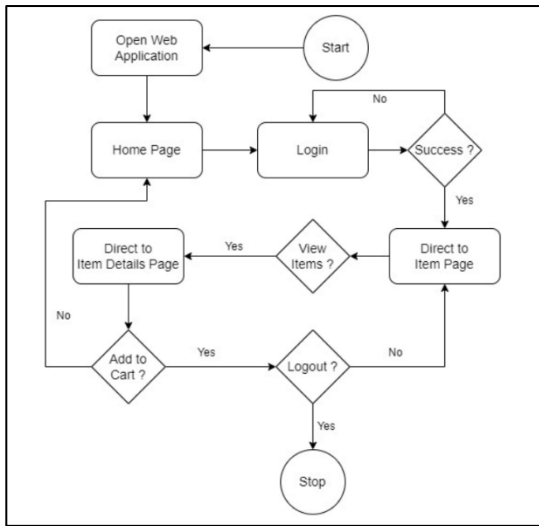
Figure 5: The user flow diagram of adding items to the cart process

The Administrator holds the responsibility for managing the system's clothing items. As such, they can add new items, modify item details, and remove items from the inventory. Additionally, the Administrator is accountable for tracking the status of items. The filter feature is available to the Administrator to create monthly reports filtered by various criteria.

C. Plastic Waste Management

Anyone can sell PET plastic bottles to this company through this web application. Users can initially add their details to the system by filling in the form. After submitting the form, the user can view, update and delete the entered details.
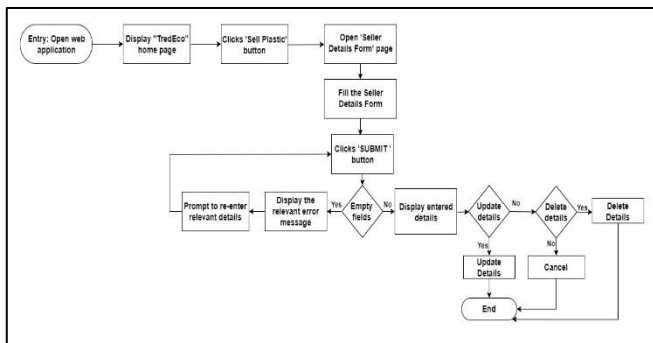
Figure 6: The user flow diagram of adding plastic waste information

Then the administrator checks the user's details and sends a confirmation message. The administrator can filter elements by using the date, time, and district. They can also search user details by name. Moreover, they can generate reports. When it comes to plastic waste collection, the administrator updates the system after buying PET bottles from users. The administrator can filter details by weight, view, edit, and delete information accordingly. Also, the administrator can generate monthly plastic collection reports.

D. Curt and Payement Management

Users can purchase clothes from the shopping page. Users can direct to the checkout payment options page. The system has cash on delivery (COD) and PayPal as their options. If they choose cash on delivery, they must provide some details for a better delivery experience. Once they choose PayPal,

they can access the PayPal page. It will secure a good user experience for the user.
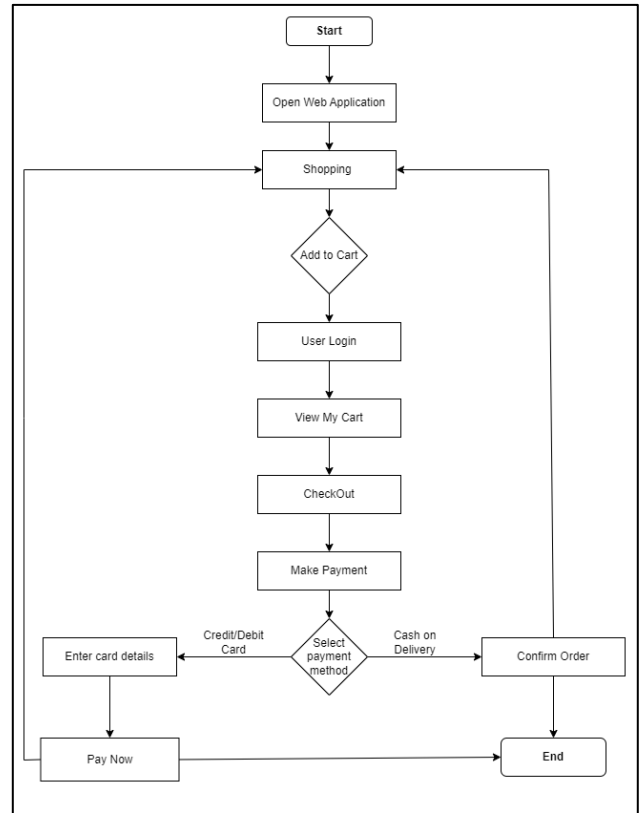

Figure 7: The user flow diagram of checkout process

V. DISCUSSION

The findings of the study underscore the importance of establishing an online platform to address Sri Lanka's plastic waste problem. By incorporating technology, programs aimed at managing plastic waste can become more efficient, cost-effective, and transparent. [24] Plastic pollution in Sri Lanka can be traced to two primary sources: industrial and household. The former stems from manufacturing various plastic products, such as bottles, bags, and packaging, while the latter arises from household waste. Other sources of plastic waste include construction sites, medical facilities, and shipping and transit. Different types of plastic, such as HDPE (high-density polyethylene), PETE (polyethylene terephthalate), PVC (polyvinyl chloride), LDPE (low-density polyethylene), PP (polypropylene), PS (polystyrene) require varying modes of disposal or recycling. [25]

E-commerce has transformed the fashion business and how people purchase clothing. Online clothing retailers offer several advantages: lower costs, more comprehensive coverage, higher sales, flexibility, and improved customer experience. [26] However, challenges include intense competition, logistical issues, trust concerns, product returns, and marketing. To succeed in this highly competitive sector, online clothing companies must provide a seamless experience that meets the needs and expectations of their target market.

The proposed system is expected to yield several significant results, chief among them being the reduction of informal disposal of PET plastic bottles into the environment. This will help to mitigate environmental damage while ensuring a steady supply of materials for the company's

products. The system also provides a solution for the proper disposal of PET plastic waste accumulated in households and companies, promoting cleanliness. These expected outcomes are aligned with the company's objective of transforming environmental concerns into a profitable venture that benefits both the environment and the company.

The proposed web-based approach provides monetary incentives for individuals who bring plastic to encourage participation. The system systematically establishes collection locations and schedules, with funds deposited directly into participants' bank accounts. The collected waste is then transformed into aesthetically pleasing, environmentally friendly clothing. Comprehensive information on the transformation process and the amount of plastic used for each item is provided on the proposed website, which also allows for online purchases.

Comprehensive testing is conducted before the website's launch to ensure the smooth operation of every aspect of the process, from the collection and transportation of plastic to the creation and sale of clothing items.

VI. CONCLUSION

This paper presents an online clothing platform as a viable solution to the plastic pollution challenges in Sri Lanka. The study highlights the grave plastic waste issues in Sri Lanka and proposes a multifaceted system to combat this problem. The proposed approach incorporates features such as collecting PET bottles, recycling them, and transforming them into clothing items. Plastic trash is effectively transformed through this method into sensitive materials that are safe for both people and the environment. A web-based application is introduced to facilitate efficient human interaction and streamline the system's functionality, utilizing modern techniques to address environmental concerns. In the near future, the system will be further refined and adapted to meet the evolving requirements of present and future stakeholders.

VII. FUTURE WORK

The proposed system serves as a paradigm for the future fashion industry, providing a solid foundation for the development of optimized online clothing store platforms. Additionally, this system offers a basis for further research to improve the efficacy and effectiveness of such platforms in the future.

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