Design, Development, and Evaluation of VIRTRON: a Virtual Try-on Application

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***Abstract*—This article presents the development of a Python-based 2D virtual try-on system prototype that leverages real-time video input from a 60fps webcam. The system utilizes the MediaPipe library to track 33 body coordinates, enabling accurate body tracking in real-time. By measuring clothing garments' dimensions and the user's left and right shoulder and hip coordinates, the system calculates the aspect ratio and overlays the dress onto the body. Furthermore, a Flask API is implemented to connect the virtual try-on system with a web app, enhancing the user experience. This article highlights the innovative features and potential applications of the virtual try-on system, showcasing its ability to revolutionize the fashion industry by providing an immersive and realistic shopping experience. Lastly, usability evaluation and SUS evaluation are done to evaluate the system.**

***Index Terms*—Python-based virtual try-on system, MediaPipe library, Flask API, Web app integration.**

I. Introduction

A virtual try-on system is an innovative technology that enables customers to try on a product before purchase. This technology uses augmented reality (AR) [5] and computer vision techniques to accurately simulate how a product looks on a consumer's body without ever having to try it on physically. Virtual try-on system allows shoppers to visualize how they will look in a product while still shopping online, helping them determine if the item would be a good fit or not and ultimately aiding in their purchasing decision.

The virtual try-on technology operates by employing 3D body scanning and various vision technologies to monitor the user's actions. This information is subsequently utilized to create a precise depiction of the user's body form, which can be employed for the virtual trial of apparel and accessories. While the user changes positions, the 3D representation of their body adapts accordingly [2], enabling them to gain a precise perspective of how different clothing items appear on them from various viewpoints.

Virtual try-on software offers a range of advantages for both customers and retailers. It not only enhances the convenience of online shopping but also offers valuable insights into customer preferences. These insights can aid retailers in refining their inventory selection process, enhancing product design, elevating customer satisfaction, and ultimately driving improved sales performance across the board.

Some existing virtual try-on systems make our lives very comfortable. Some of them are given below:

A. Farfetch

In the case of Farfetch, a user simply stands in front of their camera and says, for instance, "Show me a windbreaker jacket with a pattern". The software chooses an appropriate product from the brand's product catalog and it's placed on their body.

B. e.l.f. Cosmetics

There's a button that says "Try It On" on e.l.f cosmetics application. When users tap the button, their camera launches and displays the featured product on them. They can cycle through color and shade options for their desired cosmetics. After trying out the product, users have the option to make a purchase and will be redirected to the relevant product page on the e.l.f. Cosmetics website.

C. Baume and Mercier

Luxury watch company Baume and Mercier partnered with Haptic Media to create an unbelievable virtual try-on experience on their website. The realistic nature of the experience is attributed to the fact that the watches were designed in various wrist sizes and variations, specifically for the virtual try-on.

D. L'Oreal

The social media platform has partnered with L'Oreal's AR and AI company ModiFace to introduce virtual try-ons for makeup companies on Instagram Shopping.

E. Wacoal

Wacoal also uses AR and AI technology to trial undergarments virtually on users.

F. Warby Parker

Warby Parker is an interesting case as one of a small group of e-commerce providers that allows at-home try-ons. Customers are sent five test models of glasses for free to help them decide which to purchase.

Virtual try-on systems also known as virtual dressing rooms, this type of technology has become more popular since the beginning of the COVID-19 pandemic. Clothing products saw a 43.5% decline in retail sales during the pandemic—the most dramatic decline of all sectors. Global lockdowns meant shoppers were unable to buy products in-store. Even when those retail locations opened up again, people were more hesitant to try on clothing items, worried it increased their risk of exposure to the virus. Virtual fitting rooms, however, reduce that risk dramatically.

Firstly, the objective of this paper is to design and develop a usability study of the virtual try-on application, VIRTRON. Secondly, the study aims to gather feedback from participants who will individually interact with the app, with a particular focus on their overall satisfaction and usability using the System Usability Scale (SUS) evaluation technique.

II. Literature Review

Virtual try-on applications have become a ground-breaking technological development that has completely changed how people shop by fusing the physical act of trying on clothing and accessories with the digital world. The combination of machine learning, computer vision, and augmented reality creates these applications. Users can now instantly see how clothes and accessories will fit and look on their bodies.

In [9], a virtual dressing room application that uses the Microsoft Kinect sensor to create a virtual space for trying on clothing is presented. The methodology entails mapping the user's image to a 2D texture and measuring the user's size in real-time to produce an avatar. The application's features, such as the ability to customize the avatar's appearance by changing its appearance and size as well as viewing the avatar from various perspectives, are presented along with the system model. The paper does, however, also acknowledge some application limitations, such as the need for precise measurements and the possibility of mapping errors. The measurement and mapping processes will need to be more precise in the future, and the application may be integrated with other technologies like augmented reality.

The goal of [7] is to create a virtual try-on system that outperforms current virtual fitting techniques at 192 x 256 resolution, generates high-resolution virtualization without pixel disruption, simultaneously warps clothing and generates segmentation while exchanging information. The suggested methodology creates high-quality virtual try-on images in real-time using machine learning algorithms. The system adopts a novel virtual try-on approach that addresses the shortcomings of existing systems and raises the overall level of accuracy and quality of the virtual try-on experience.

The need for a substantial amount of training data to achieve high accuracy is one of the proposed system's limitations. Furthermore, some garment or fabric types might not be accurately represented by the system. Personalized measurements for a better fit, expanding the system's ability to represent a larger variety of garments and fabrics, and investigating the use of augmented reality to improve the virtual try-on experience are some of the future research areas for this technology.

To give users precise outfit recommendations, the goal of [8] is to create a web-based virtual trial room using machine learning techniques. Based on user preferences and clothing characteristics, the methodology combines CNNs and RNNs to forecast outfit combinations. The drawback was evaluating with a single set of metrics and a small amount of data. To evaluate using a wider range of metrics, more study was required. Future work may involve creating a 3-D scanner for clothing, incorporating personalized recommendations and augmented reality to enhance user experience, and investigating additional uses in various fields.

The goal of [10] is to introduce LaDI-VTON, a Latent Diffusion textual Inversion-enhanced model, for the Virtual Try-On task, which creates a brand-new image of a target model sporting a specified in-store item. Experimental findings on the Dress Code and VITON-HD datasets show that LaDI-VTON consistently outperforms rival systems, resulting in appreciable advancements in the Virtual Try-On task.

In [6], the paper suggests an image-based virtual try-on system that can change the size of the clothing based on the measurements of the wearer and the garments. The system measures the distance between the shoulder width and height of the clothing in the person image, and it modifies the size of the clothing area in the segmentation map based on the ratio of the person's and the clothing's sizes. Thifront ends the visual appeal by removing overlapping and collar details. The accuracy of the size adjustment procedure may be impacted by key point detection's dependability with OpenPose, which is not covered in the paper. The lack of a thorough analysis of the system's effectiveness in terms of user satisfaction and clothing size adjustment accuracy in the paper suggests the need for additional validation and user studies.

The research gaps discovered in the literature review of virtual try-on applications are as follows: Firstly, there's a lack of studies that take into account the diverse needs and preferences of users, especially concerning gender-specific aspects and the accuracy of sizing. Second, existing research often doesn't search deeply enough into usability evaluation. Additionally, there's a lack of standardized assessment methods. Lastly, there's a shortage of systematic SUS evaluations, which are crucial for measuring usability and user satisfaction. To address these gaps, our work will involve conducting a thorough usability study and applying the System Usability Scale

(SUS) evaluation technique. This will provide a comprehensive assessment of a virtual try-on application for online clothing shopping and contribute to advancing research in this field.

III. Concept Design and Architecture

A. System Architecture

1) User Interface (UI): This is the front end of the application where users interact with the system. It includes options for users to use a live video feed for the virtual try-on experience. It also provides controls for selecting different clothing items.

2) Mediapipe Model Integration: The core component of the system that integrates the Mediapipe machine learning model. Utilizes computer vision and machine learning techniques to track and identify key human body points and coordinates.

3) Clothing Database: A database containing a collection of clothing items.

4) Matching Engine: Compares the detected human body coordinates from the Mediapipe model with clothing item dimensions from the database.

5) Virtual Try-On Output: Displays the virtual try-on results in real-time on the user interface. The overlaid clothing appears as if it is worn by the user, adjusting to their movements and body shape.

B. Workflow Diagram

In the workflow Diagram, a customer must stand in front of the camera of our system. They can search for their desired clothes through hand gestures. Then according to customers' commands, desired products will be shown to the customers from the product's database to the digital screen. Then if the customer selects the product showing on the screen, two options will appear on the screen. One option is to try the clothes virtually and the second option is to order the desired cloth.

If the customer chooses the first option, then he or she will easily try the clothes virtually. Then, if he or she taps the second button indicating to order, a QR code will appear to the customer.

Then the customer must scan the code with his phone. After scanning the QR code, the mobile application will open on the customer's device. From the mobile application customers will be able to order the desired product. Also from the mobile application, customers can choose other clothing items and buy them through online mobile banking systems like Bkash, Nogod, Rocket, etc.

IV. Methodology

A. Hardware

For developing the Virtual try-on system, we have used the Fifine k420 Web camera and Digital screen(computer screen).

1) Fifine K420 Web Camera: A high-quality webcam, like the Fifine K420, is essential for capturing clear and accurate images of the user. This webcam provides high-definition video with 1080p resolution, which ensures that the user's image is clear and detailed, making it easier to accurately overlay virtual clothing or makeup on the user's image.

2) Digital Screen (Computer Screen): The digital screen is where the virtual try-on system is displayed, and it must be high-quality to provide clear and accurate visuals. A high-resolution computer screen is essential for displaying the virtual clothing or makeup accurately and ensuring that the user can see the details of the virtual items.

Overall, the Fifine K420 Webcam and digital screen are all essential components for developing a high-quality virtual try-on system. They all work together to create an immersive and accurate virtual experience for the user.

B. Software

In our system, there will be mobile application facilities where a customer can order clothes. For developing the mobile application front end, we have used Flutter and for the back-end database, we have used Firebase. For connecting the front end with the back end we have used Cloud Firestore. We have also used the Mediapipe ML model to track a customer's body co-ordinators.

Here are the steps to connect the software and hardware parts of the virtual try-on system:

1) Capture the user's image using the webcam: we have used the webcam to capture the user's image and stream it to the computer. Then we processed the image using Mediapipe algorithms to detect the user's body and hand gestures.

2) Overlay virtual clothing on the user's image: we have overlayed the virtual clothing on the user's image in real-time as the user moves.

3) Display the virtual try-on system on the digital screen: The system will display the virtual try-on system on the digital screen to provide visual feedback to the user. Then we must update the display in real-time as the user interacts with the system.

4) Integrate the hardware and software components: We have connected the webcam to the computer and configured it to work with the virtual try-on software with some Python code. The virtual try-on will be displayed on the digital screen.

V. Experimental Setup

A usability study [1] is like testing a tool or a website to see if it's easy for people to use. We watch how people use it and ask them questions. This helps us make the tool or website better and more user-friendly, so anyone can use it without problems. Conversely, the System Usability Scale (SUS) provides a reliable tool for measuring usability. It consists of a 10-item questionnaire with five response options for respondents; from Strongly disagree to Strongly agree. The detailed usability study and SUS evaluation are described below.

TABLE I
TASK 1 FOR WEB APPLICATION

Evaluator Name	Task Completion Time	Success/ Fail	No. of Click Requires Vs Expected	No. of Attempts	No. of Asking Help
P1	2s	Success	Required:1 Expected:1	1	0
P2	2s	Success	Required:1 Expected:1	1	0
P3	2s	Success	Required:1 Expected:1	1	0
P4	3s	Success	Required:1 Expected:1	1	0
P5	2s	Success	Required:1 Expected:1	1	0
P6	1s	Success	Required:1 Expected:1	1	0
P7	3s	Success	Required:1 Expected:1	1	0
P8	2s	Success	Required:1 Expected:1	1	0
P9	2s	Success	Required:1 Expected:1	1	0
P10	3s	Success	Required:1 Expected:1	1	0

TABLE II
TASK 2 FOR WEB APPLICATION

Evaluator Name	Task Completion Time	Success/ Fail	No. of Click Requires Vs Expected	No. of Attempts	No. of Asking Help
P1	11s	Success	Required:1 Expected:1	2	1
P2	10s	Success	Required:1 Expected:1	2	1
P3	7s	Success	Required:1 Expected:1	1	0
P4	10s	Success	Required:1 Expected:1	2	1
P5	6s	Success	Required:1 Expected:1	2	1
P6	9s	Success	Required:1 Expected:1	1	0
P7	8.5s	Success	Required:1 Expected:1	2	0
P8	9s	Success	Required:1 Expected:1	2	0
P9	6s	Success	Required:1 Expected:1	2	1
P10	9s	Success	Required:1 Expected:1	2	1

Usability Study: For the web application and mobile application, the following tasks are given below which will be performed by the users individually,

1) Task 1: Selecting dresses from the virtual try-on application
2) Task 2: Trying clothes virtually with the hand gesture
3) Task 3: Ordering selected dresses from the application
4) Task 4:Viewing the cart item

TABLE III
TASK 3 FOR WEB APPLICATION

Evaluator Name	Task Completion Time	Success/ Fail	No. of Click Requires Vs Expected	No. of Attempts	No. of Asking Help
P1	-	Fail	-	-	-
P2	-	Fail	-	-	-
P3	-	Fail	-	-	-
P4	-	Fail	-	-	-
P5	-	Fail	-	-	-
P6	-	Fail	-	-	-
P7	-	Fail	-	-	-
P8	-	Fail	-	-	-
P9	-	Fail	-	-	-
P10	-	Fail	-	-	-

TABLE IV
TASK 4 FOR WEB APPLICATION

Evaluator Name	Task Completion Time	Success/ Fail	No. of Click Requires Vs Expected	No. of Attempts	No. of Asking Help
P1	-	Fail	-	-	-
P2	-	Fail	-	-	-
P3	-	Fail	-	-	-
P4	-	Fail	-	-	-
P5	-	Fail	-	-	-
P6	-	Fail	-	-	-
P7	-	Fail	-	-	-
P8	-	Fail	-	-	-
P9	-	Fail	-	-	-
P10	-	Fail	-	-	-

TABLE V
TASK 1 FOR MOBILE APPLICATION

Evaluator Name	Task Completion Time	Success/ Fail	No. of Click Requires Vs Expected	No. of Attempts	No. of Asking Help
P1	2s	Success	Required:1 Expected:1	1	0
P2	3s	Success	Required:1 Expected:1	1	0
P3	1s	Success	Required:1 Expected:1	1	0
P4	1s	Success	Required:1 Expected:1	1	0
P5	1s	Success	Required:1 Expected:1	1	0
P6	3s	Success	Required:1 Expected:1	1	0
P7	3s	Success	Required:1 Expected:1	1	0
P8	2s	Success	Required:1 Expected:1	1	0
P9	1.5s	Success	Required:1 Expected:1	1	0
P10	2s	Success	Required:1 Expected:1	1	0

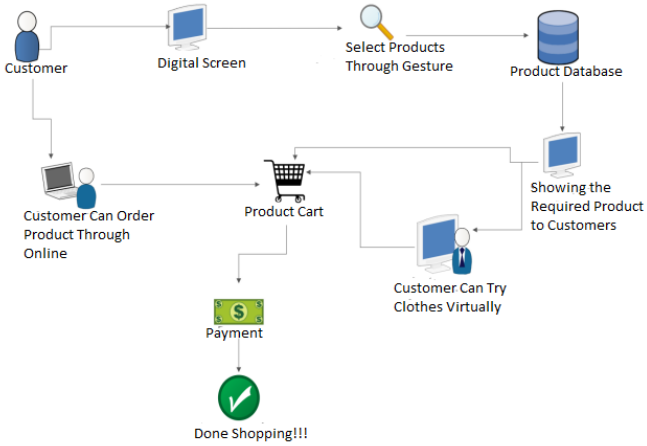

Fig. 1. Workflow Diagram of VIRTRON

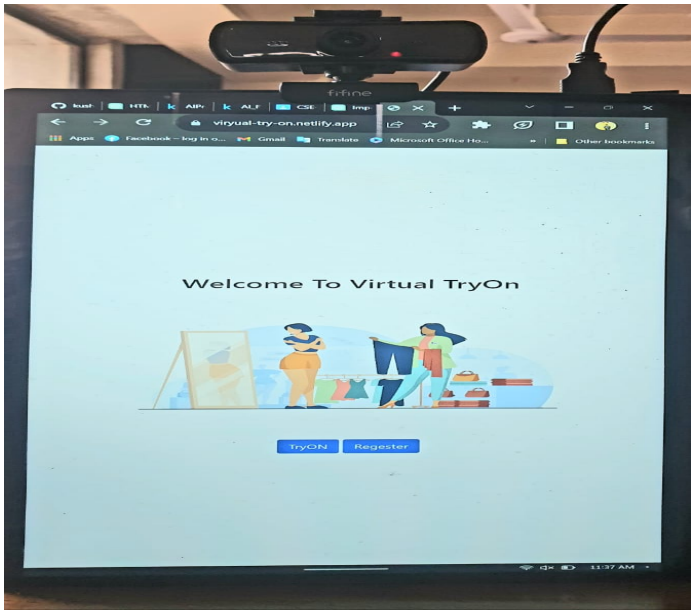

Fig. 2. Landing Page of Virtual Try-on Web Application

TABLE VI
TASK 2 FOR MOBILE APPLICATION

Evaluator Name	Task Completion Time	Success/ Fail	No. of Click Requires Vs Expected	No. of Attempts	No. of Asking Help
P1	-	Fail	-	-	-
P2	-	Fail	-	-	-
P3	-	Fail	-	-	-
P4	-	Fail	-	-	-
P5	-	Fail	-	-	-
P6	-	Fail	-	-	-
P7	-	Fail	-	-	-
P8	-	Fail	-	-	-
P9	-	Fail	-	-	-
P10	-	Fail	-	-	-

TABLE VII
TASK 3 FOR MOBILE APPLICATION

Evaluator Name	Task Completion Time	Success/ Fail	No. of Click Requires Vs Expected	No. of Attempts	No. of Asking Help
P1	2s	Fail	Required:1 Expected:1	1	0
P2	2s	Fail	Required:1 Expected:1	1	0
P3	2s	Fail	Required:1 Expected:1	1	0
P4	3s	Fail	Required:1 Expected:1	1	0
P5	3s	Fail	Required:1 Expected:1	1	0
P6	3s	Fail	Required:1 Expected:1	1	0
P7	2s	Fail	Required:1 Expected:1	1	0
P8	2s	Fail	Required:1 Expected:1	1	0
P9	3s	Fail	Required:1 Expected:1	1	0
P10	3s	Fail	Required:1 Expected:1	1	0

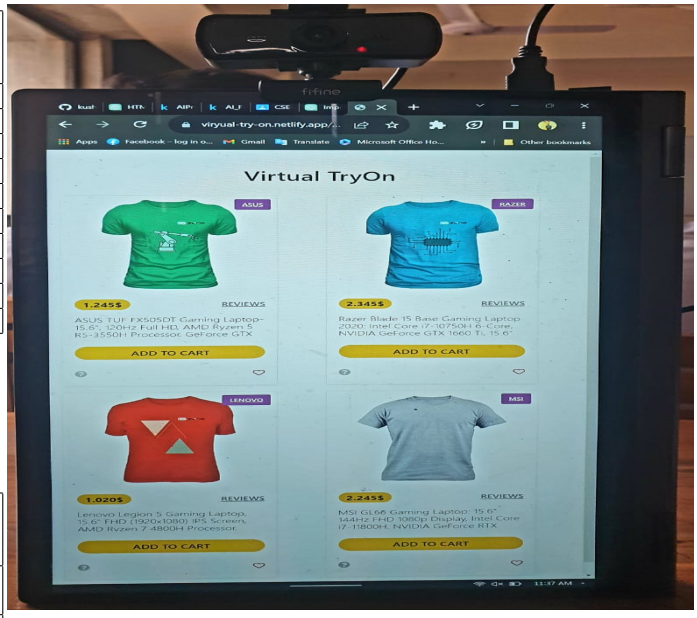

Fig. 3. Product Category Page of Virtual Try-on System

System Usability Scale (SUS) evaluation:

Calculation of SUS Score:

1. For odd items first we have to subtract one from the user response.

2. For even-numbered items we have to subtract the user responses from 5

3. This scales all values from 0 to 4 (with 4 being the most positive response).

4. Then we have to add up the converted responses for each user and multiply that total by 2.5. This converts the range of possible values from 0 to 100 instead of from 0 to 40. [4]

Fig. 4. Virtual Try on

TABLE VIII
TASK 4 FOR MOBILE APPLICATION

Evaluator Name	Task Completion Time	Success/ Fail	No. of Click Requires Vs Expected	No. of Attempts	No. of Asking Help
P1	1s	Success	Required:1 Expected:1	1	0
P2	1s	Success	Required:1 Expected:1	1	0
P3	1s	Success	Required:1 Expected:1	1	0
P4	2s	Success	Required:1 Expected:1	1	0
P5	1s	Success	Required:1 Expected:1	1	0
P6	1s	Success	Required:1 Expected:1	1	0
P7	1s	Success	Required:1 Expected:1	1	0
P8	1.5s	Success	Required:1 Expected:1	1	0
P9	1s	Success	Required:1 Expected:1	1	0
P10	1s	Success	Required:1 Expected:1	1	0

Now for participant number 1, the SUS score will be, (3-1)+(5-2)+(4-1)+(5-2)+(3-1)+(5-2)+(3-1)+(5-2)+(3-1)+(5-3) * 2.5 = 62.5

All the participant's SUS score is given below:

VI. Result Analysis

We have used two evaluation techniques which are usability evaluation and SUS evaluation. In the usability evaluation, 5 female participants and 5 male participants participated. Both male and female participants have performed 4 tasks individually. There is a web application and a mobile application in our system. For the web application, the average time required to complete task 1 which is selecting dresses from the virtual try-on application is around 3 sec and the success rate is 100%. For task 2 which is trying clothes virtually with the hand gesture, the average completion time is approximately 8.55 sec and the success rate is 100%. But task number 3 and 4 which are Ordering selected dresses from the application and Viewing the cart item are unsuccessful tasks. As these tasks are not implemented in the web application.

For the mobile application, the success rate of task 1 is 100%. However, task 2 is incomplete because the selected clothes cannot be tried virtually in the mobile application. Task 3 also can not be done in the mobile and web application which is ordering the selected dresses from the system. Lastly, task 4 can be done through the mobile application and the success rate is 100%.

VII. Future Work and Conclusion

In conclusion, this study highlights the significant advances made in the application and website of VIRTRON, as evidenced by commendable success rates in usability evaluations. Tasks 1 and 2 in the web application can be completed quickly, which is evidence of the effectiveness of the try-on mechanism. But limitations in tasks 3 and 4 point to important areas that require concentrated attention, especially when it comes to web application development. The mobile application encounters difficulties, particularly in tasks 2 and 3, even though it succeeds in some of them. One relevant limitation is that the mobile application does not allow users to virtually try on specific clothes. Despite these limitations, task 4's successful completion highlights the possibility of success with focused improvements for the mobile application. This study emphasizes the need for continued development to address identified limitations while laying the groundwork for the system.

The future work aims to refine and expand the application's functionality, ensuring a comprehensive and satisfying user experience across multiple platforms and thus contributing to the evolution of online shopping in the fashion industry. To improve the application's utility, future development efforts should focus on enhancing its functionality. A greater range of hand gestures could be included for a more interactive virtual try-on experience. To guarantee a smooth transition between web and mobile applications and promote a consistent user experience, cross-platform integration also requires attention. Another essential area for improvement is the addition of features to the ordering system that allow direct purchases within the application. Future development will also require investigating augmented reality technologies and establishing a strong feedback mechanism, which will enable the application to adapt to changing user expectations.

Appendix

Participants:

P1 = Afrin Hafiz Prapty (Occupation: Student, Gender: Female, Age: 23-24)

TABLE IX
SUS EVALUATION

Participants	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Total SUS Score
P1	3	2	4	2	3	2	3	2	3	3	62.5
P2	5	2	5	2	5	2	5	2	5	2	87.5
P3	5	1	5	1	5	1	4	1	5	1	97.5
P4	3	1	4	2	3	2	4	2	4	1	75
P5	3	3	2	2	3	3	2	3	2	3	45
P6	4	2	4	2	4	2	4	4	4	1	72.5
P7	4	1	3	2	3	1	5	2	4	2	77.5
P8	5	1	3	1	5	1	5	1	4	1	92.5
P9	3	2	3	1	4	1	5	1	4	2	80
P10	5	2	3	2	4	1	5	1	5	4	80

P2 = Marzan Samin Ashrafi (Occupation: Student, Gender: Female, Age: 23-24)

P3 = Sinchi Mary Mree (Occupation: Student, Gender: Female, Age: 23-24)

P4 = Chowdhury Farjana Tur Santona (Occupation: Student, Gender: Female, Age: 23-24)

P5 = Mahbuba Tasnim (Occupation: Student, Gender: Female, Age: 23-24)

P6 = Koushik Halder (Occupation: Student, Gender: Male, Age: 23-24)

P7 = Fardin Rahman (Occupation: Student, Gender: Male, Age: 23-24)

P8 = Saidur Rahaman Sagor (Occupation: Student, Gender: Male, Age: 23-24)

P9 = Md Afir Uddin Bhuiyan (Occupation: Student, Gender: Male, Age: 23-24)

P10 = Md Sajid Hossain (Occupation: Student, Gender: Male, Age: 23-24)

The 10 questionnaires are: [3]

1. I think that I would like to use this system frequently

2. I found the system unnecessarily complex.

3. I thought the system was easy to use.

4. I think that I would need the support of a technical person to be able to use this system.

5. I found the various functions in this system were well integrated.

6. I thought there was too much inconsistency in this system.

7. I would imagine that most people would learn to use this system very quickly.

8. I found the system very cumbersome to use.

9. I felt very confident using the system.

10. I needed to learn a lot of things before I could get going with this system.

For SUS scaling, we have used the following score: Score 1 = Strongly Disagree, Score 2 = Disagree, Score 3 = Satisfactory, Score 4 = Agree, Score 5 = Strongly Agree.

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