

IMPROVING THE LOGIN AND NEWS FEATURES WITH FINGERPRINT AND CARD LAYOUT: AN EVALUATION OF CONVERSION RATE AND USABILITY

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Abstract The discipline of human factors or also known as ergonomics focuses on interactions between humans and artifacts. One example of such an artifact is a smartphone. Currently, many smartphones are equipped with various sensors, one example is the fingerprint sensor. Fingerprint sensors offer various conveniences, an example of their use is to simplify the login process. This research uses the Gapura UB application as a case study. Currently the Gapura UB application does not yet implement fingerprint login, so it is not yet known whether Gapura UB users will prefer to log in using the conventional method (email and password) or using a fingerprint. Apart from that, this research also investigated the usability of news features of Gapura UB when implementing a card layout (as a treatment) compared to the original version which uses a list layout (as a control). To answer these research problems, this research uses an experimentation with the research subjects from the students of Teknik Informatika, FILKOM UB and the research objects are conversion rate and usability. The conversion rate measurement involved 30 unmoderated participants, whereas the usability measurement involved 10 moderated within group participants. The results obtained on the fingerprint login conversion rate show that most participants prefer to use fingerprint login ($73\% \pm 17\%$) rather than conventional login methods. Meanwhile, the results of the usability test on the news feature using the card layout showed that there was an increase in retention time (51 ± 15 seconds) compared to the original version which used the list layout (31 ± 14 seconds). The score of measurements using the system usability scale also show an increase in the card layout (90 ± 5) compared to the list layout (65 ± 15).

Keywords: Human factor, Ergonomics, Usability, Fingerprint, Login, Card layout, List layout

1. Introduction

Ergonomics, also commonly referred to as human factors, is an interdisciplinary scientific discipline that is primarily concerned with understanding the dynamics of interactions between humans and other components within various systems [1]. Ergonomics encompasses a broad range of applications, from workplace safety and product design to human-computer interaction, emphasizing the importance of a human-centric approach in the design and evaluation of systems and environments. The Gapura UB application, specifically designed for Universitas Brawijaya students, functions as a mobile gateway to various university-related services and information. Among its

key features are the ability to check class schedules, access study plan cards, view study results, and monitor tuition fee details. Despite its utility, the application is not without its flaws, one of which is notably evident in its login process. Presently, the Gapura UB app requires users to log in every time the application is opened. This process entails repeatedly entering a username and password, which can be cumbersome and time-consuming for frequent users. Worse still, this repetitive process is done almost every day, so optimizing this interaction is very beneficial from an ergonomic standpoint. To address the issue of frequent login requirements in the Gapura UB application, integrating a fingerprint-based login mechanism presents a promising solution [2]. This biometric approach simplifies the login process significantly. Instead of typing in credentials each time, users can simply place their finger

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Cite this Article As Yogastama, Kharisma, and Dharmastiti (2024). Improving the Login and News Features with Fingerprint and Card Layout: An Evaluation of Conversion Rate and Usability. *Journal of Engineering and Management in Industrial System*, 12(2), p98-110

Paper Accepted : October 18th 2024

Paper Published : October 23th 2024

on their smartphone's screen [3]. This not only streamlines the login process but also enhances the overall user experience by providing quicker and more convenient access to the main page of the app. Implementing this feature could greatly improve the usability and appeal of the Gapura UB application.

The news viewing feature of the Gapura UB application, as it currently stands, utilizes a list layout to display news items [4]. In this format, news is presented primarily through titles and publication dates, offering a basic and straightforward approach to information delivery. However, this layout has its limitations, particularly in terms of engaging users and providing a rich, multimedia experience. A shift towards a card layout could significantly enhance the news viewing feature [5]. The card layout is adept at incorporating multimedia elements like images, which adds a visual dimension to the content. Adopting a card layout for presenting content offers distinct advantages in how information is conveyed, and user engagement is fostered [6]. Implementing a card layout in the news viewing interface can offer several advantages. It creates a more organized and user-friendly environment, allowing users to quickly grasp the essence of the news through a combination of headlines and accompanying images. This visually enriched and intuitive format can significantly improve user engagement and satisfaction, making the news browsing experience more enjoyable and efficient. The card layout, therefore, stands as a more ideal choice for the news viewing feature in the Gapura UB application, promising a deeper and more interactive user experience.

This study seeks to evaluate the effectiveness of incorporating a fingerprint login system and to compare the usability and user preferences between card and list layouts in the news viewing feature of the Gapura UB application. To achieve this, the research will employ A/B testing and the System Usability Scale (SUS) as primary methodologies. The A/B testing method will be instrumental in comparing the original interface (control) with the modified interface (treatment) [7]. This approach will enable an objective assessment of which design variant performs better in terms of user engagement and effectiveness. Additionally, the System Usability Scale (SUS)

will be utilized to gauge user satisfaction levels for both the treatment and the control interface [8]. The SUS provides a reliable measure of the usability of different interface designs, offering insights into user preferences and overall user experience. The research problem is articulated through a null hypothesis [9]. The hypothesis that will be tested in this research is:

1. There is no difference in the user conversion rate from the login method using username and password to the login method using fingerprint
2. There is no difference in the average completion rate for the news viewing feature from using the list layout to the card layout
3. There is no difference in the average task time for the news viewing feature from using a list layout to a card layout
4. There is no difference in the average retention time for the news viewing feature from using a list layout to a card layout
5. There is no difference in the average system usability scale score for the news viewing feature from using a list layout to a card layout

This research has a limitation in that its results are confined to the creation of a high-fidelity prototype of the Gapura UB application, specifically for the login and news viewing features using Figma. The scope of this research is in the Informatics Engineering Study Program, Faculty of Computer Science, Universitas Brawijaya class of 2020. Apart from that, the main contribution of this research lies in the empirical data obtained from the testing stage, which includes testing completion rate, task time, retention time, and conversion rate. Additional contribution in the form of design artifacts for the Gapura UB application user interface on the login and news viewing features.

There are several previous studies that were used as references in carrying out this research. The research conducted on the CGV Cinemas website interface employed both the A/B testing method and the System Usability Scale (SUS) to evaluate and compare different design variations of the website [10]. In this research, data collection was conducted through online questionnaires distributed via Google Forms, totaling 30 questionnaires. The

collection was carried out in two iterations, the first iteration was for the CGV Cinemas website interface and the second iteration was for the website interface improvement design created by the researcher. The results of testing using the A/B testing method on the improved interface design with the initial interface design were that the improved design got a higher SUS score than the initial design. In the initial design, the SUS score obtained was 55. Based on the SUS score obtained, the initial interface design of the CGV Cinema website was classified as marginal and less than 68. In the improved design, the SUS score obtained was 90 so it was classified in the acceptable category with a SUS score of more than 80 that showed the interface prototype, they got a good impression from the user's point of view.

The research utilized Usability Testing and A/B testing as key methods for evaluation, effectively blending qualitative and quantitative approaches [11]. Usability Testing was pivotal for gaining insights into the user experience by directly observing how users interacted with the interface. This method allowed for the identification of usability problems in a real-world context. On the other hand, A/B testing served as a valuable tool for a data-driven analysis, comparing two distinct versions of the interface. By doing so, it helped in discerning which version was more effective in terms of user engagement and satisfaction. A/B testing was carried out on the design of the main page interface, interactions for making reports, and choosing application colors. A/B testing is conducted by dividing participants into two groups, with some testing version A and others testing version B. Measurements are carried out using a questionnaire. In this way, the selected design is implemented in a prototype which will be tested in the final evaluation. The result of the interface design chosen based on the user is that the attractiveness and perspicuity scale of the design is in the good category. Apart from that, the efficiency, dependability and stimulation scales are in the excellent category and the novelty scale is in the excellent category. That way, the design produced using the A/B testing method produces a satisfying user experience.

The research focused on the implementation of fingerprint-based login
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methods, highlighting the time-consuming nature of traditional login practices like entering user IDs and passwords [3]. This traditional method requires users to input each piece of login data separately, leading to a longer process. The findings of the research indicated success in implementing a fingerprint login method, which significantly reduced the time required for both registration and logging in. As a result, this biometric approach streamlined the login process, allowing it to be completed in a simple and rapid manner.

The recent research examined the impact of the automated reasoning (AR) feature on the usability of electronic clinical task management systems [12]. This study utilized a Figma prototype for conducting usability testing. The findings indicated that the AR feature holds significant potential to enhance usability in these systems. Additionally, it was noted that user psychological and organizational factors in the feature's design play a crucial role in determining its overall usability. This highlights the importance of considering both technical functionality and human-centered design principles in developing effective user interfaces.

2. Methods

The data collection method used in this test is experimental, involving a control and a treatment interface to test the hypothesis. Data collection related to testing the login feature using fingerprints involved 30 students which was carried out in an unmoderated [13]. The login feature of treatment interface will be given to student test participants. For collecting data related to testing the news viewing feature, moderate testing was conducted and involving 10 students [14]. Testing is also carried out within groups so that each student in testing the news viewing feature will be given a control and treatment interface. Based on Figure 1, the card layout and list layout tests on the news viewing feature use randomization to divide test participants into 2 groups. Each group has a different test scenario sequence. Students will fill out the system usability scale at the end of testing the news viewing feature.

The method used to analyze data obtained from the testing stage is using

average, standard deviation, confidence interval, t-test, and chi-squared test. The average usage is utilized to calculate the conversion rate of users switching from using usernames and passwords to fingerprints for login [15]. Apart from that, the average value is also used to determine the completion rate, task time, and retention time of the news viewing feature and calculate the system usability scale of the control and treatment interface. If the average value has been calculated, the next stage is to find the standard deviation to find out the distribution of the data in the sample and how close the standard deviation is to the average value [16]. The standard deviation will later be used in

calculating the confidence interval [17]. The confidence interval is used to create error bars [18]. The t-test is a statistical method used to test the validity of hypotheses concerning continuous data. It essentially compares the means of two groups or conditions to determine if they are significantly different from each other [19]. By analyzing the means and variances of two datasets, t-test helps in making inferences about whether any observed differences are statistically significant, thereby supporting or refuting a given hypothesis. The chi-squared test, akin to the T-test, is utilized for hypothesis testing, though it is distinctively applied to binary data [20]

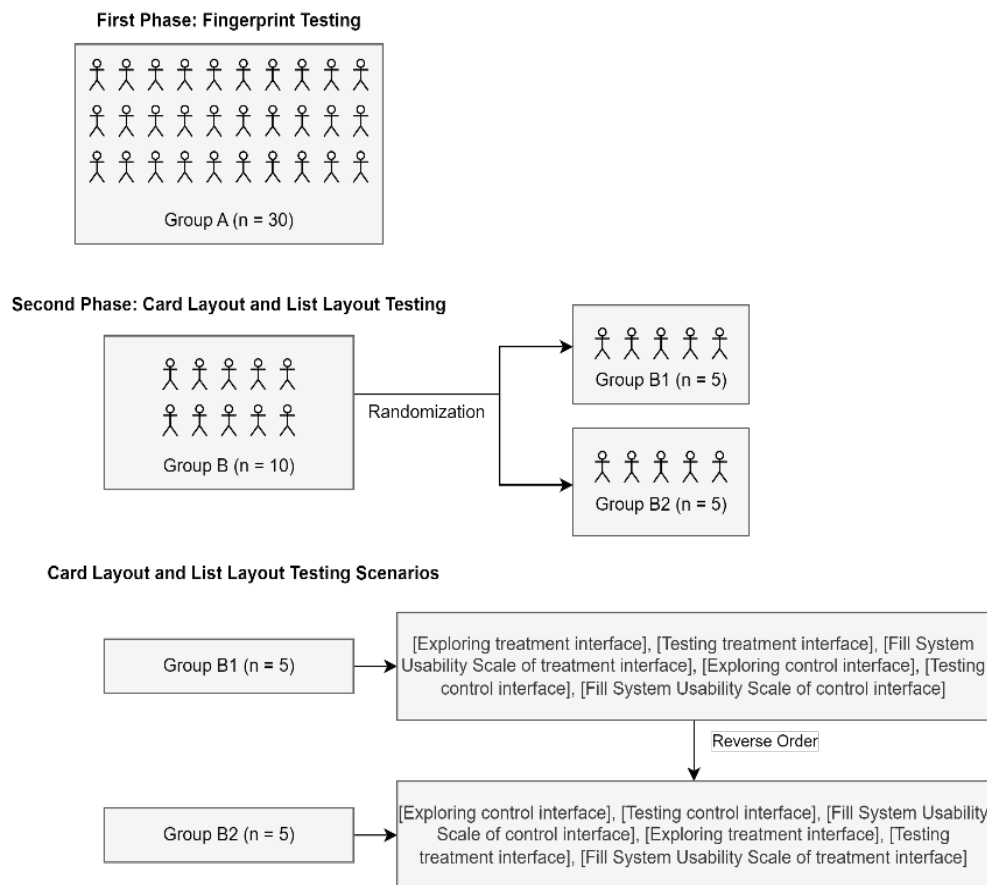


Fig. 1 Method of collecting data

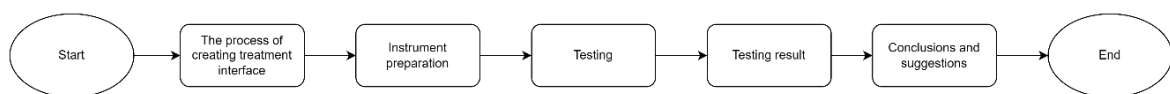


Fig. 2 Research stages

The research stages consist of five stages. The first stage is the process of creating a treatment interface that implements fingerprints when logging in and card layout for the news viewing feature. This stage involves the prototyping process, which aims to enable practical interaction with the near-final design to test its functionality. The next stage is preparing the instrument so that it can be used as an accurate measure of quantitative data. In this research, the instrument used are conversion rate, completion rate, task time, retention time, and the system usability scale (SUS). Basically, this research covers three aspects of usability, namely effectiveness, efficiency, and satisfaction. Data for conversion rate, completion rate, task time, retention time were obtained through direct observation of participants. The SUS contains questions regarding the usability of the Gapura UB application and the SUS will be shared via Google Form. The third stage is the testing stage which consists of testing the control and treatment interface that was created in the previous stage. This test uses the A/B testing method and system usability scale (SUS). The use of A/B testing in testing allows comparison between control and treatment interface. In addition, the use of SUS aims to gain a deeper

understanding of user satisfaction. The fourth stage is the results of testing. At this stage, the results of testing in the previous stage will be calculated to determine the average value. Afterward, the standard deviation of the average value will also be calculated to determine the data distribution around the mean. The standard deviation will be used to calculate the confidence interval value so that error bars can be created. Then, the t-test and chi-squared test will be calculated to accept or reject the hypothesis. The results of the system usability scale will also be compared to determine each usability value of the control and treatment interface of the news viewing feature. The final stage is drawing conclusions and suggestions.

3. Results and discussion

Figure 3 provides a visual comparison of the login feature interface between the control and the treatment within the Gapura UB application. The key difference highlighted in this figure is the introduction of an additional button in the treatment interface, positioned next to the traditional "Sign In" button. This new button offers users the option to log in using their fingerprint.

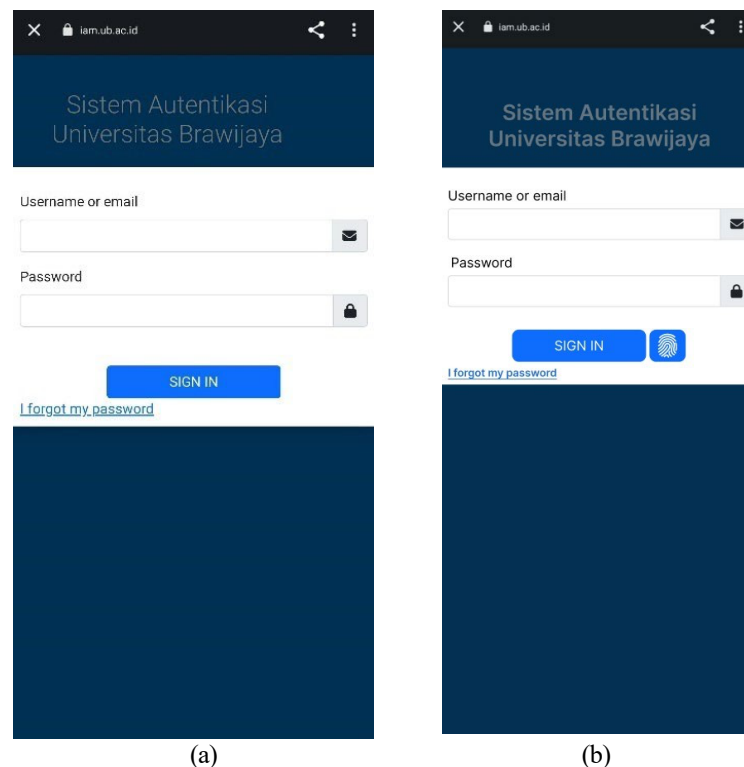


Fig. 3 Login feature in (a) control and (b) treatment interface

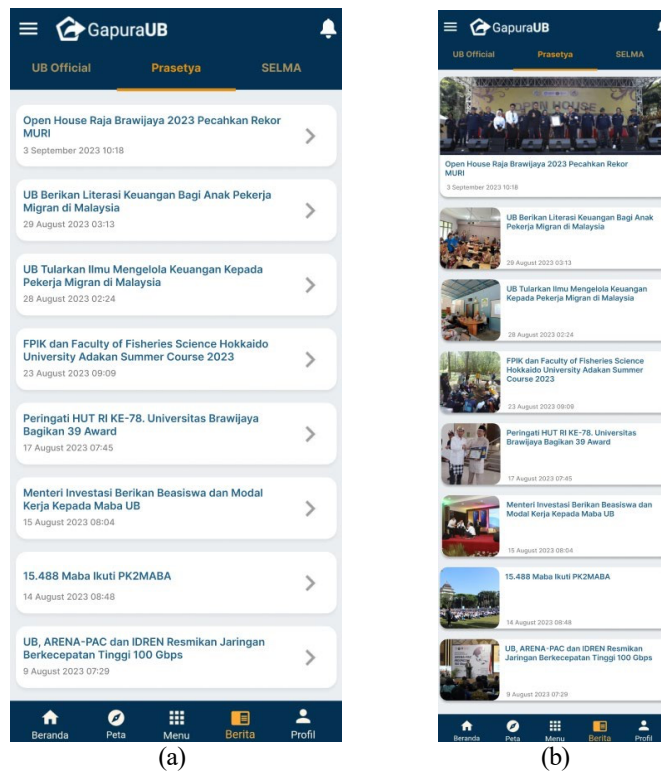


Fig. 4 The news viewing feature at Prasetya news section on (a) control and (b) treatment interface

Table 1. Login feature testing task

Task Name	Task Description
Take attendance on ongoing courses	While attending an Operating Systems class on campus, the lecturer provided information that attendance had been opened. That way, participants will open the Gapura UB application to attend the Operating Systems course.

Table 2. News viewing feature testing task

Task Name	Task Description
View news related to the Raja Brawijaya Open House	This month, Raja Brawijaya are being carried out. Raja Brawijaya is known as an interesting event. That way, participants felt interested in knowing news about the current Raja Brawijaya.

Table 3 Login feature test results

Variable	n	Average ± confidence interval	Chi-squared
Fingerprint login	30	0,73333 ± 0,16791	0,010587137

Figure 4 in the research illustrates the modifications made to the Prasetya news viewing feature in the Gapura UB application, showcasing the differences between control and treatment interface. The most notable

change in the treatment interface is the transition from a list layout to a card layout. Prasetya News, which provides general news about Universitas Brawijaya, is central to this feature. In the card layout of the treatment

interface, images sourced directly from the news content are prominently displayed, with the objective of capturing user interest and motivating them to engage more deeply with the news items. In instances where a specific news item lacks an accompanying image, the Universitas Brawijaya logo is used as a placeholder. This approach not only enhances the visual appeal of the news feed but also makes it more intuitive and engaging for users. To assess the effectiveness of these design changes, a prototype of the interface is used in the testing process. Participants in the test are assigned specific tasks to perform within the application. The evaluation is conducted online using Maze, a platform that facilitates remote user testing. This setup allows for a comprehensive assessment of the user experience, focusing on how the new card layout impacts user interaction and satisfaction compared to the traditional list layout.

In the testing phase for the Gapura UB application's login feature, participants were implicitly instructed to log in as part of their assigned task, a prerequisite for participating in the study. Upon reaching the login page, participants were presented with the autonomy to choose their preferred method of logging in: either using a username and password, as per the traditional approach, or opting for the newly introduced fingerprint login. By giving participants the freedom to select their preferred login method without explicit guidance, researchers aimed to gather authentic data on user inclination towards either the conventional or the biometric login option. The testing process for this feature was conducted in an unmoderated environment. This approach allows participants to interact with the application in a more natural and unguided manner, closely mimicking real-world usage scenarios.

In the task designed to evaluate the news viewing feature of the Gapura UB application, researchers provided participants with a specific objective: to find news related to the Raja Brawijaya Open House. This task required participants to navigate through different sections of the news viewing page, including UB Official, Prasetya, or SELMA.

This targeted task approach was chosen to effectively gauge key metrics such as completion rate, task time, and retention time, in relation to the two different layouts – a list layout and a card layout. By directing participants to search for a particular piece of news, researchers could precisely measure how quickly and successfully users could locate the information using the different layouts. This also allowed for the observation of how long users engaged with the content, providing data on retention time. Unlike the testing for the login feature, the assessment of the news viewing feature was conducted in a moderated setting. This means that during the testing process, participants were overseen by a facilitator or researcher. Such a moderated approach is beneficial for a more controlled evaluation, allowing for immediate feedback and the ability to observe user behavior in real-time. It also enables researchers to understand the user's thought processes and experiences while interacting with the different layouts, thereby offering deeper insights into the effectiveness and user-friendliness of the list and card layouts in the application's news viewing feature.

As depicted in Figure 5, the user conversion rate from traditional username and password authentication to fingerprint login is examined. Among the 30 participants in the study, a significant majority (73%) favored fingerprint login. The associated error bars, indicating variability, range from 56% to 90%, as per the confidence interval detailed in table 3. Further analysis using the chi-squared test with a calculated value of 0,010587137. This study adheres to a 95% confidence level, corresponding to a 5% significance level (0,05). The chi-squared value, being lower than the significance level, leads to the rejection of the null hypothesis, which is "There is no difference in the user conversion rate from the login method using username and password to the login method using fingerprint". Consequently, the alternative hypothesis "There is a difference in the user conversion rate from the login method using username and password to the login using fingerprint" is accepted.

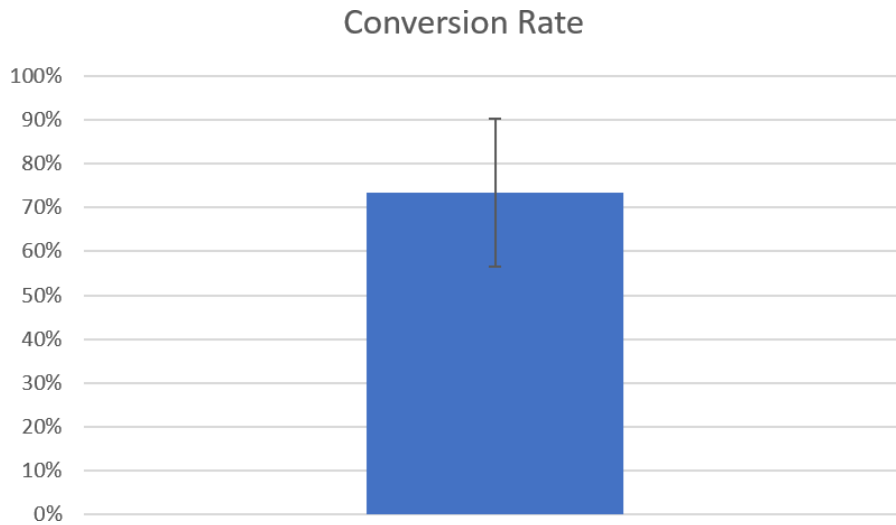


Fig. 5 Conversion rate graph

Table 4 Test results of the news viewing feature

Variable	n	Average completion rate ± confidence interval	Average task time ± confidence interval	Average retention time ± confidence interval
List layout	10	1 ± 0	35,7 ± 9,78414	31,398 ± 13,57523
Card layout	10	1 ± 0	18,72 ± 10,66557	51,041 ± 14,76217

Table 5 Calculation of the t-test and chi-squared test for news viewing feature testing

Chi-squared test completion rate	T-test task time	T-test retention time
1	0,084534499	0,003265278

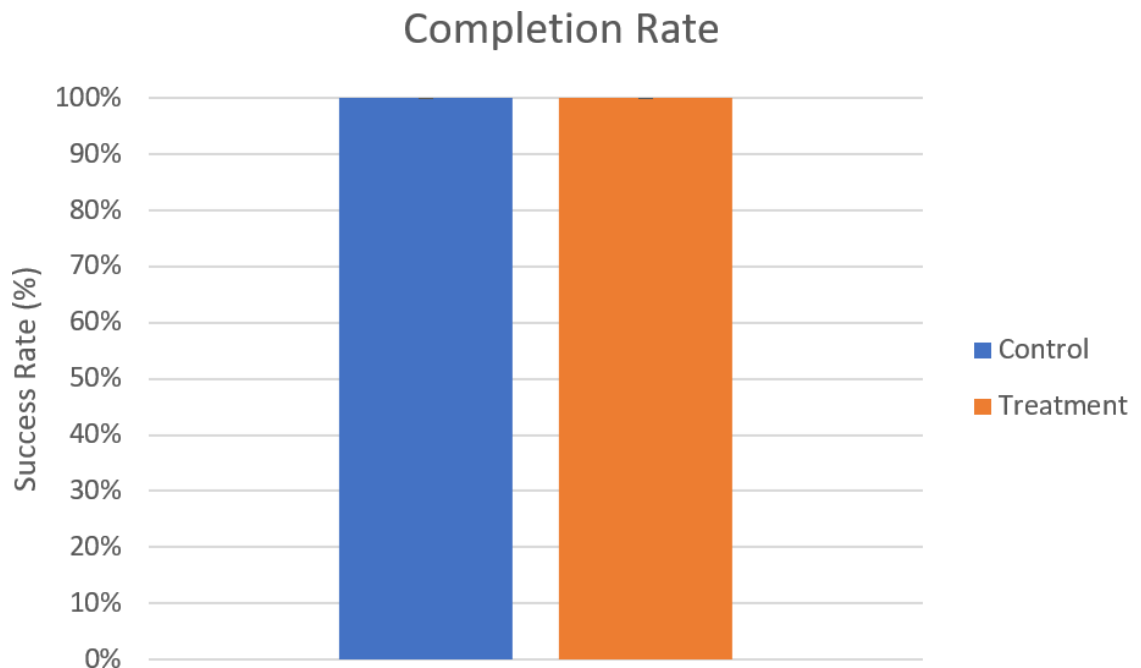


Fig. 6 Completion rate graph

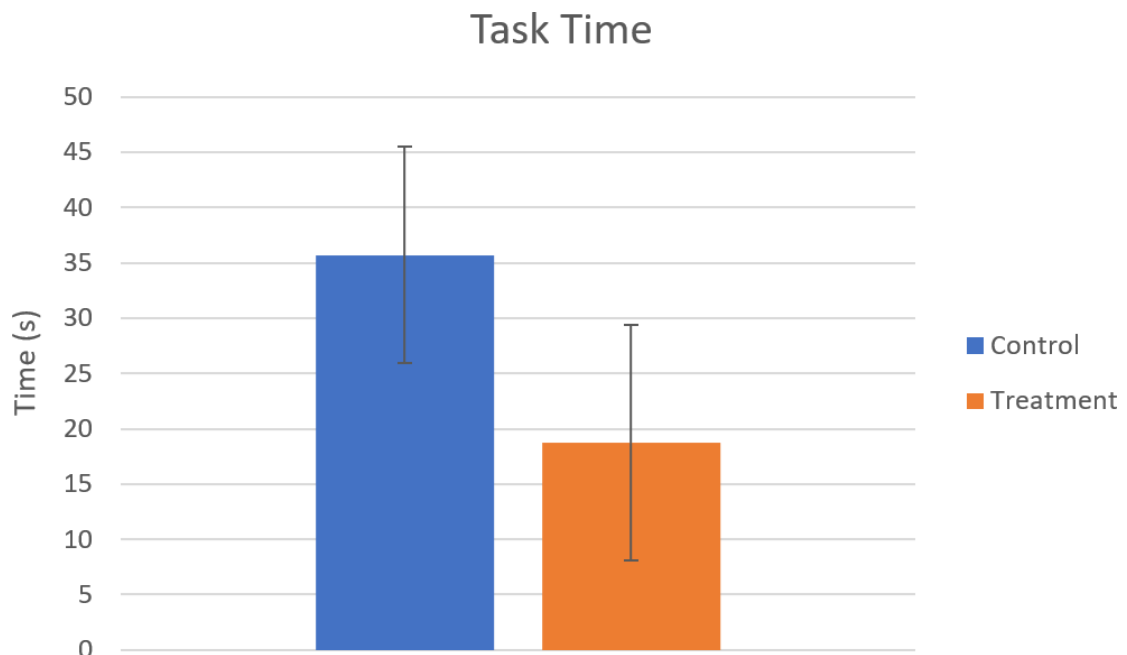


Fig. 7 Task time graph

Figure 6 delineates a comparative analysis concerning the task success rates associated with two distinct interface approaches. The first is a control interface employing a list layout, represented in the blue section of the figure. In contrast, the orange section is a treatment interface, which utilizes a card layout. Remarkably, both sections report a 100% task success rate. This uniformity is visually represented by error bars located at the uppermost point in both the control and treatment sections, based on confidence interval values referenced in table 4. Further statistical validation is provided through a chi-squared test, with results detailed in table 5. The test yields a value of 1, surpassing the threshold of 0,05. This outcome supports the acceptance of the hypothesis stating, “There is no difference in the average completion rate for the news viewing feature from using the list layout to the card layout”.

Figure 7 provides a visual representation of the comparative analysis focusing on the average time needed to complete a particular task under two distinct interfaces. The control interface which employs a list layout is depicted in the blue segment of the figure. Conversely, the treatment interface utilizing a card layout is represented in the orange segment. The blue segment indicates an average task completion time of 35,7 seconds using list layout. In contrast, the orange section, which employs card layout, shows a

more efficient average time of 18,72 seconds. The variability in these times is represented by error bars in both sections. For the control, the error bars range from 25 to 45 seconds, while the treatment span from 8 to 29 seconds. These error bars are based on the confidence interval values provided in table 4. The statistical analysis, using a t-test as detailed in table 5, results in a value of 0,084534499 for the task time. This value exceeds the confidence level threshold of 0,05. Consequently, the hypothesis stating "There is no difference in the average task time for the news viewing feature from using a list layout to a card layout" is accepted.

Figure 8 presents a detailed analysis of retention times associated with two distinct interfaces. The control interface, employing a list layout, is indicated by the blue section of the figure. In contrast, the treatment interface, which utilizes a card layout, is highlighted in the orange section. Retention time, defined as the duration for which test participants engage with the interface, varied between the two layouts. List layout, depicted in blue, showed an average retention time of precisely 31,398 seconds (approximately 31 seconds). In contrast, card layout, represented in orange, demonstrated a longer average engagement time of 51,041 seconds (about 51 seconds). To illustrate the variability in these measurements, error bars are included in both sections of the graph. For list layout, the error

bars range from 17 to 44 seconds, while card layout extend from 36 to 65 seconds. These error bars are based on confidence interval values derived from table 4. The statistical significance of the observed differences in retention time was assessed using a t-test, as detailed in table 5. The resulting t-test value for retention time is 0,003265278, which is below the set confidence level of 0,05. This finding leads to the rejection of the initial hypothesis

that stating “There is no difference in the average retention time for the news viewing feature from using a list layout to a card layout”. Consequently, a new alternative hypothesis is formed, stating “There is a difference in the average retention time for the news viewing feature from using a list layout to a card layout”.

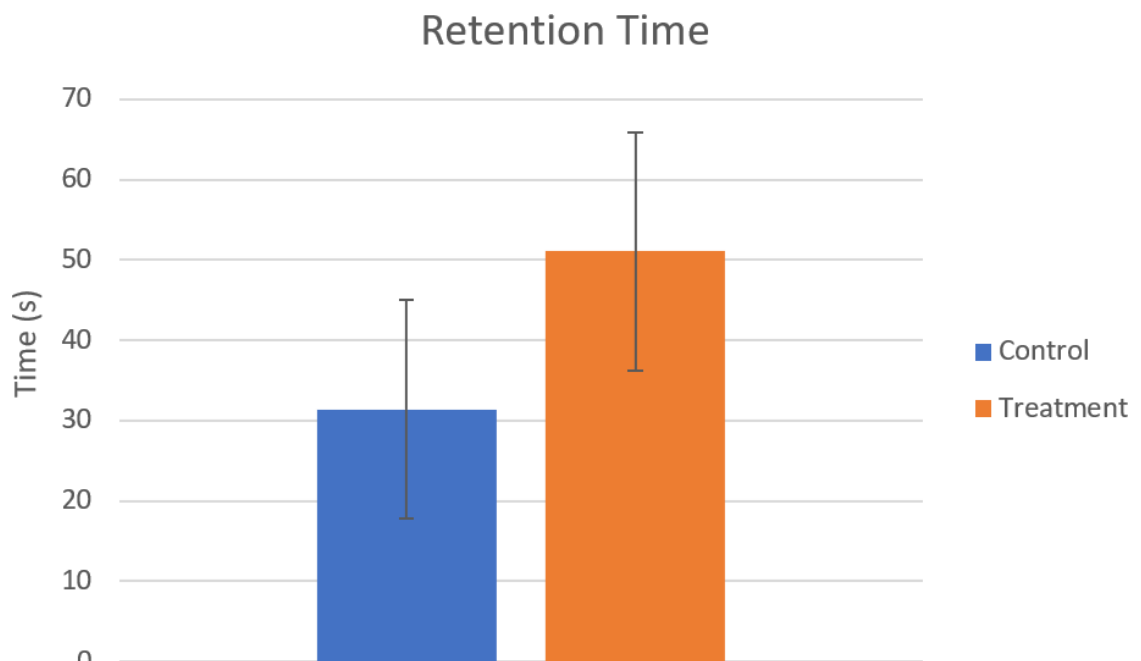


Fig. 8 Retention time graph

Table 6 System usability scale result

Variable	n	Average system usability scale score ± confidence interval
Control using list layout	10	64,75 ± 14,87719
Treatment using card layout	10	90,25 ± 4,65178

Table 7 T-test value of system usability scale score

T-test
0,005037242

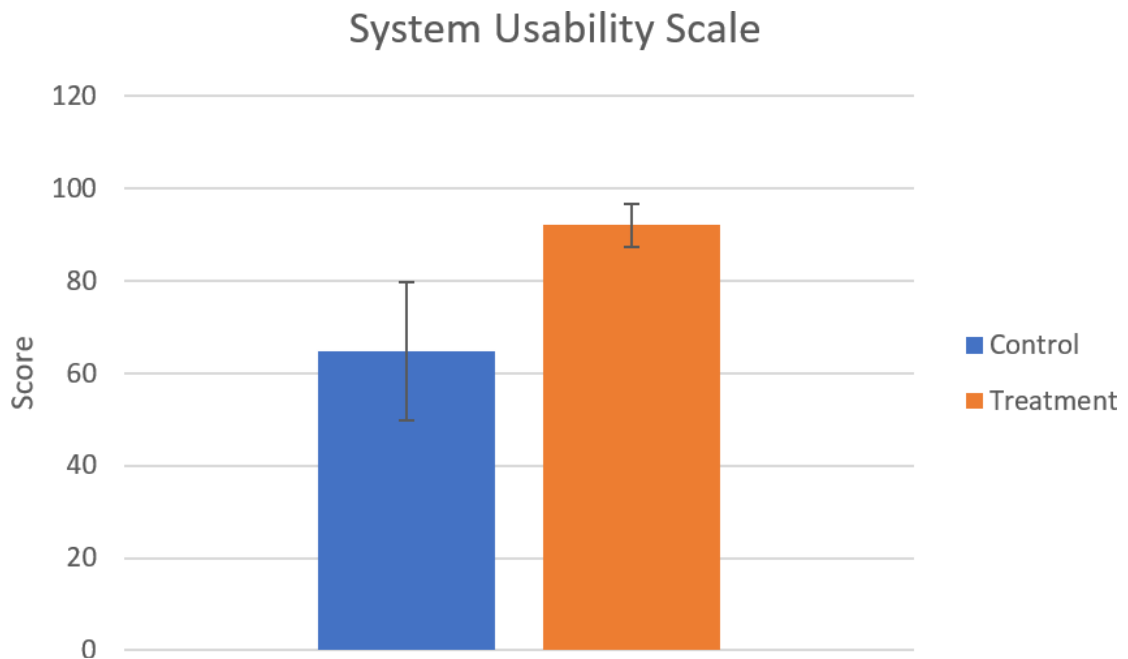


Fig. 9 System usability scale graph

Figure 9 provides a visual representation of the comparative analysis focusing on the average score of system usability scale on two distinct interfaces. The control interface which employs a list layout is depicted in the blue segment of the figure. Conversely, the treatment interface utilizing a card layout is represented in the orange segment. List layout depicted in blue showed an average score of precisely 64,75. In contrast, card layout represented in orange demonstrated a bigger average system usability scale score of 90,25. To illustrate the variability in these measurements, error bars are included in both sections of the graph. For list layout, the error bars range from 50 to 80, while card layout extend from 85 to 95. These error bars are based on confidence interval values derived from table 6. The statistical significance of the observed differences in retention time was assessed using a t-test, as detailed in table 7. The resulting t-test value is 0,005037242, which is lower than confidence level of 0,05. This finding leads to the rejection of the initial hypothesis that stating “There is no difference in the average system usability scale score for the news viewing feature from using a list layout to a card layout”. Thus, a new alternative hypothesis is formed, stating “There is a difference in the average system usability scale score for the news viewing

feature from using a list layout to a card layout”.

4. Limitations

This research has potential limitations. Participants were recruited considering representativeness, but all participants recruited were students. We believe that by recruiting more participants and more diverse participants, the results obtained will be more convincing. One of the anticipations we made regarding this issue is to conduct a within group experimental design.

5. Tips for Usability Practitioner

When designing a mobile application similar to this study:

- Still provide several alternative methods that users can use to log in, such as email and password methods and fingerprint methods.
- Users tend to choose the fingerprint method for frequent and repeated login processes
- To increase user retention when viewing a list, do not use a list layout that only contains text, but use a card layout that is accompanied by illustrative images of the content to be displayed. this study revealed that there was a fairly large difference in retention time.

6. Conclusion

The research conducted on the Gapura UB application yielded several key insights. The introduction of a fingerprint login option was well-received, as evidenced by 22 out of 30 participants opting for this method. The chi-squared test result is 0.010587137 leading to the rejection of the hypothesis "There is no difference in the user conversion rate from the login method using username and password to the login method using fingerprint". Therefore, the new/alternative hypothesis "There is a difference in the user conversion rate from the login method using username and password to the login using fingerprint" is obtained with an effect size conversion rate of 0.73333 ± 0.16791 or $73\% \pm 17\%$. The study found no significant difference in task completion rates between card and list layouts in the news viewing feature. All participants successfully completed their tasks using both layouts, supporting the hypothesis "There is no difference in the average completion rate for the news viewing feature from using the list layout to the card layout".

The t-test for task time in news viewing feature is 0.084534499, indicating that the layout type does not substantially affect task completion time. Thus, the hypothesis "There is no difference in the average task time for the news viewing feature from using a list layout to a card layout" can be accepted with the effect size of the average task time on the card layout being 18.72 ± 10.66557 seconds and 35.7 ± 9.78414 seconds in the list layout. The research showed a significant preference for the card layout over the list layout in terms of user engagement. Participants spent more time exploring the interface with card layouts (51.041 ± 14.76217 seconds) compared to list layouts (31.398 ± 13.57523 seconds). The t-test result is 0.003265278 led to the rejection of the hypothesis stating "There is no difference in the average retention time for the news viewing feature from using a list layout to a card layout". Therefore, a new/alternative hypothesis "There is a difference in the average retention time for the news viewing feature from using a list layout to a card layout" is obtained.

Lastly, the t-test for system usability score in news viewing feature is 0,005037242, indicating that the layout type does substantially enhanced usability. Therefore,

the hypothesis "There is no difference in the average system usability scale score for the news viewing feature from using a list layout to a card layout" can be rejected. Thus, a new/alternative hypothesis "There is a difference in the average system usability scale score for the news viewing feature from using a list layout to a card layout" is obtained with the effect size of the average system usability scale score of list layout being $64,75 \pm 14,87719$ and $90,25 \pm 4,65178$ in the card layout.

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