

was then conducted using questionnaires built based on the identified features. The research referenced to Macefield (2009) in determining the number of participants, who suggested that for tests investigating problem discovery, a group size of 3-20 participants is typically valid, with 5-10 participants being a reasonable baseline range. He also suggested that group size should be increased in proportion to the study's complexity and the importance of its setting. According to Sauro & Lewis (2016), group size is determined by the desired level of confidence and determining the level of confidence is problematic because measurement data are not normally distributed.

Users who have had experience making online purchases were asked to participate in this study by completing a survey. A total of 62 users responded to the survey. The survey questions (Q) ask:

Q1: Experience problems when choosing size and fit?

Q2: Difficult to make size conversions between the US, UK, and Euro?

Q3: Experience receiving the wrong size and fit?

Q4: Method for size conversion?

Q5: Experience with shoe size recommendation systems?

Q6: Convenient to have a shoe size and fit recommendation system?

Q7: Size conversion improve the shopping experience?

Q8: Confusing shoe brand experience?

Q9: Will creative storing and access using QR code be useful?

Q10: Animation for size and fit?

The results from the survey were used to confirm gaps, and as functional and non-functional requirements for the intended mobile application for shoe size recommendation. User satisfaction tests were then conducted on the developed application to obtain user feedback and assess the level of satisfaction. The participants were selected among online shoppers. Prior to beginning the evaluation work, a pre-test demographic background was surveyed. Participants were chosen among the earlier respondents based on the following criteria: mobile phone owner with prior intention of buying shoes online.

The respondents (n=50) were given a total of nine task scenarios in which they were requested to experience the application on their mobile phone, before they took the satisfaction test. Table 1 demonstrates the tasks and scenarios.

TABLE 1. User Task Scenario

Task	Scenario
Authentication	The user clicks the Register/login button to register/login to the system.
Search	The user clicks the Search button to search for the shoe type and brand for size conversion and fit.
Update	The user clicks the Update button to update their profile details including foot size.
Recommendation	The user clicks the Search button for shoe size recommendation based on type.
Save size conversion	The user clicks the Save History button to save the result of shoe size and fit conversion and generate a QR code.
Delete	The user clicks the Delete button to remove the result of the shoe size conversion in the history section.
QR code	The user clicks the QR code button to view the result of the shoe size conversion and fit.
Scan QR code	The user scans the QR code using their phone's camera and views the result of shoe size conversion and fit.
Security	The user clicks the Forgot password button to reset their password.

TABLE 2. Requirements Cross-tabulation (in %)

Gender	Age	Job	Q1		Q2		Q3		Q4		Q5		Q6		Q7		Q8		Q9		Q10			
			No	Yes	No	Yes	No	Yes	No	Yes	Ask friend	Ask agent	Search internet	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Female	18 - 22	student	0	32	3	29	2	31	2	16	15	5	6	26	5	27	15	2	16	0	2	31	5	27
		unemployed	0	2	0	2	0	2	0	0	0	2	2	0	0	0	2	0	0	2	0	0	2	0
	23 - 27	employed	2	23	2	23	2	23	2	0	23	3	0	24	0	24	15	3	6	0	0	24	2	23
		student	5	6	2	10	2	10	0	5	6	5	0	11	0	11	6	0	5	0	0	11	0	11
Male	18 - 22	unemployed	0	2	0	2	0	2	0	0	2	0	0	2	0	2	0	0	2	0	0	2	2	0
		employed	0	6	0	6	0	6	0	3	3	0	0	6	0	6	3	0	3	0	0	6	0	6
	23 - 27	employed	2	2	2	2	0	3	0	3	0	2	2	2	2	2	2	2	2	0	0	3	0	3
		unemployed	2	2	2	2	0	3	0	3	0	3	0	3	0	3	3	2	0	2	0	3	0	3
28 - 32	18 - 22	student	0	5	3	2	0	5	0	0	5	0	0	5	0	5	5	0	0	0	3	2	0	5
		employed	2	5	2	5	0	6	2	2	3	2	0	6	0	6	3	0	2	2	0	6	2	5
	23 - 27	student	0	2	0	2	0	2	0	0	2	0	0	2	0	2	0	0	2	0	0	2	0	2
		employed	0	2	0	2	0	2	0	0	2	0	2	0	2	0	2	2	0	0	0	2	0	2
28 - 32	employed	0	2	0	2	0	2	0	0	2	0	2	0	2	0	2	2	0	0	0	2	0	2	
	unemployed	0	2	0	2	0	2	0	2	0	2	0	2	0	2	2	0	2	0	0	2	0	2	
Total			11	89	15	85	5	95	5	34	61	82	18	89	6	94	52	40	2	5	95	10	90	

After completing the tasks, the respondents were then asked to answer a 15-question post-testing questionnaire, adopted from (Nik Ahmad et al. 2021). The questionnaire was arranged on a 5-point semantic differential scale, from strongly disagree to strongly agree, to assess the user's experience of using the application. The questions assessed the following components:

1. Ease of use.
2. Easy to find the information needed.
3. Pleasant interface.
4. Pleasant font.
5. Speed up task completion.
6. Error and guide to solve the error.
7. Simple steps to execute tasks.
8. Clear and descriptive information.
9. Ease of navigation.
10. Broken link/menu/page.
11. Contain expected features.
12. Require improvement.
13. Have intention to use.
14. Will recommend the application to others.
15. Satisfied with the overall application.

The quantitative results obtained were then analyzed descriptively to determine the user satisfaction level. A post interview was then conducted to the same respondents to obtain deeper assessment from the users. Interview results were analyzed to discover points for future improvements.

RESULT AND DISCUSSION

The requirements study was conducted with 62 participants to confirm the gap and determine functional and non-functional requirements for the shoe size recommender mobile application. Table 2 shows the cross-tabulation analysis results in percentage (%).

The majority of respondents were female students with an age range of 18-22, and young working women with an age range of 23-27 years old. It can be seen from the table that the majority of respondents (89%) across gender, age, and job agree that they had problems when estimating shoe size and fit online. Similarly, 85% agree that they faced difficulties making size conversions to the US, UK and Euro scales, which are used as the standard size reference across the world.

These provide evidence that users face problems with shoe size and fitting when buying online, and a good application must provide a good size and fit reference. 95% of respondents across demographic groups also agree that they have experienced receiving the wrong shoe size after an online purchase. During the shoe selection process, most respondents will take additional steps to refer to either a salesperson/agent or search for internet size conversion

tools. This is due to the lack of a shoe size recommendation feature on the online shopping platform, as evidenced in Q5, in which 82% of respondents said they did not have prior experience with the feature. 94% of users also supported that the shoe size conversion feature will improve the user's shopping experience.

Brands A and N received nearly identical scores when asked which brand generated the most uncertainty regarding shoe size and fit, which may also indicate that they are the most popular brands among online customers. In addition, 95% of respondents demand a QR code to be incorporated, and 90% prefer an animated feature for shoe fit.

The above results have provided design clues for the intended size conversion and size and fit recommendation mobile application. A mobile application was then developed based on the survey results. Figure 1 shows instances of the mobile application.

The mobile application allows users to create user profile including shoe/foot size details. The information will be used to recommend shoe size and fit according to type and brand as well as when generating a QR code. It also allows users to save their search history to keep track of their favourite sizes, types, and brands, which can be used to generate future recommendations. A reference for size conversion is displayed, and users can choose their preferred shoe size based on US, UK, or Euro size reading. Upon selection, an animated GIF appears to help visualize the user's foot shape and size fitting in the shoes according to the selected size reference. The animated GIF will demonstrate whether the selected shoe size will be too tight, too loose, or perfectly fit the user's foot.

The application will also suggest similar shoe types and sizes in other product lines from other brands. The user can then save the preferred size and fit upon confirmation, and a QR code will be generated. The QR code stores information about the user's shoe size and fit profile based on brand and type, enabling quick and easy reference for users and sales agents, saving time, and potentially eliminating physical contact during future buying process. The QR code can then be shared to online stores alike as well as to other parties that require similar information.

The study then conducted 15 satisfaction tests with n=50 respondents who were required to experience the application using 9 task scenarios before answering the 15 usability test questions. Majority of the respondents were male followed by female in their 21-26 years old. (Refer Figure 2). It then followed by female in their 27-34 years of age, and male of 15-20 years old. Respondents for both genders above 35 years old were less than 10% each and can be considered minimal.

A questionnaire comprising of 15 usability tests was used to assess the level of satisfaction. The questionnaire was set to rate a five-point Likert scale, from strongly disagree to strongly agree.

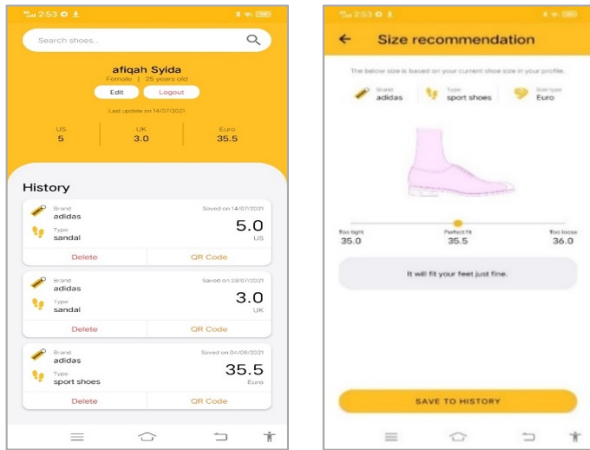


FIGURE 1. Instances of the application

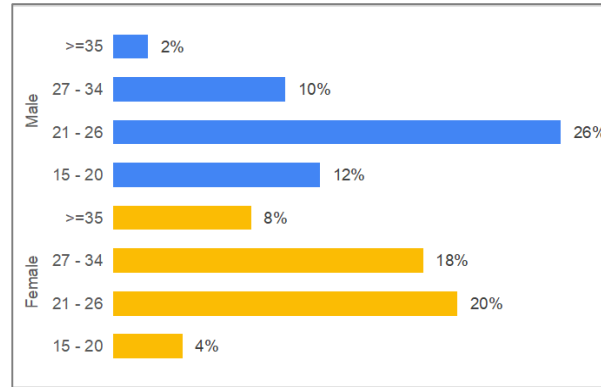


FIGURE 2. Test respondent's background

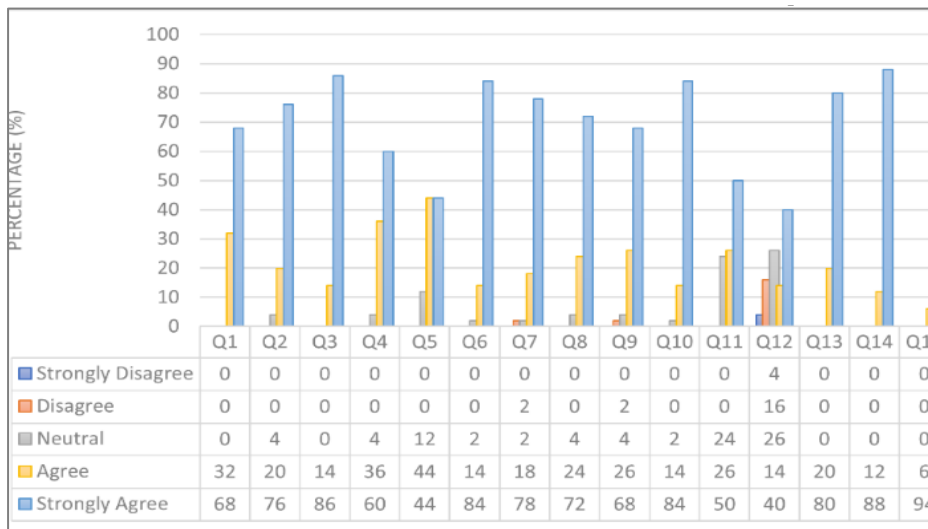


FIGURE 3. Satisfaction result

Figure 3 shows the evaluation results. The result shows that more than 80% of users agreed that they were satisfied with the application in 13 out of 15 tests. 100% of users agree to 5 tests, which indicates that the users think that the application is easy to use and has a pleasant interface, have the intention of using the application soon, will recommend the application to others, and are overall satisfied with the application.

More than 90% of users agree that the application allows them to find information easily, the font used is pleasant, it has an error message and a guide to solve the error, simple steps to execute tasks, and no broken links. 88% of users agree that the application can speed up task completion. Nonetheless, two tests earned less than 70%, which suggests that respondents expect more features but does not necessarily indicate that the application has to be improved.

The research concludes that the majority of respondents are satisfied with the application. Nevertheless, some concern is evident from the data, since it indicates that respondents expected the mobile application to have additional functions. This provides a hint for future application enhancements in the form of additional research and demand determination.

The research conducted mean analysis as shown in Figure 4 to analyze overall satisfaction. The result shows that most of the tests received scores above 4, and this indicates that most of the participants were satisfied with the application. This is further supported by the average mean with a score of 4.6. Although Q5 and Q11 scores below the average mean, they scored above 4, and thus considered as good assessment results. The mean analysis shows a score below average for test 12, which addresses whether the application needs to be improved. This score suggests that the application needs to be improved further.

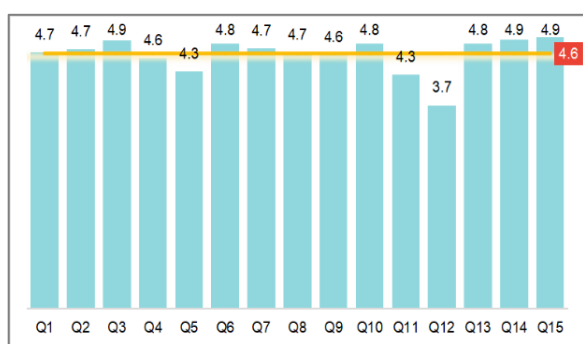


FIGURE 4. Overall mean analysis

Overall, the findings are consistent with those of Nik Ahmad et al. (2021), who employed similar satisfaction tests for web-based and mobile-based pet boarder systems and found that 70% of participants were happy with both platforms. The results add to the discussion on the importance of usability and user satisfaction, motivation and enjoyment which affect the quality of user experience in mobile applications (Juhari & Abu Bakar, 2020).

This study shows higher ratings on ease of use, has a pleasant interface, has the intention of using the application soon, will recommend the application to others, and is overall satisfied with the application, compared to their highest scores on ease of use and speedy task completion. The previous study has revealed a mean score of 3.86, indicating that the majority of respondents were satisfied with the system. This supports the conclusion reached by this study, which had a higher mean score of 4.6, indicating that the application has a high level of satisfaction.

The research then conducted interviews with respondents to obtain further information and feedback from the user experience. The result could be a good starting point for future enhancements to improve user satisfaction. Table 3 shows the consolidated results from the interview session. Overall, the respondents gave good feedback and were satisfied with the application. Although the satisfaction test shows encouraging results, a few suggestions for improvement were suggested, providing a clue for further improvement of the application to meet the user's demand and extend the quality of the shoe size and fit recommendation system.

TABLE 3. The Interview Result

Comments/Errors	Suggestions/recommendations
<ul style="list-style-type: none"> The recommendation feature in this app is very helpful. Nice to have the recommendation feature in this application. The app is easy to use. The flow of the application is quite easy to understand. The app is simple and easy to use. The design is nice. The interface is easy to understand. The application is quite user-friendly. Well designed and the interface is not crowded. 	<p>Search feature</p> <ul style="list-style-type: none"> Add more type of shoes in search button. Add more brand in the application. <p>Recommendation feature</p> <ul style="list-style-type: none"> Add shoe size for children in the application. Add customize features for children.

As can be seen from Table 3, the more types and brands are desirable, and the features could be extended to cater for consumer age group customization.

CONCLUSION

The study has successfully identified required features to be included in a mobile application for shoe size and fit recommendation. The application was developed based on a review of past literature as well as a review of similar existing applications. It includes user profile registration, shoe brand and type search, size conversion, animated GIF for shoe fit based on size options, and QR code generation for future reference and sharing during the buying process.

A 15-user satisfaction test was conducted with n=50 respondents to determine the level of user satisfaction and assess the quality of the application. The test was conducted after the respondents went through 9 task scenarios. The analysis showed that, overall, users were satisfied with the application and evaluated it as easy to use, had a pleasant interface, had the intention of using it, would recommend it to others, and were satisfied with the overall application.

Additionally, the system is evaluated as easy to find information, the font used is pleasant, it has error messages and a guide to solve the errors, simple steps to execute tasks, no broken links, and speeds up task completion. There was one concern where more features were expected by the users. The interview session helped to further understand the concerns, which more types and brands were expected by the users, and the desire to have customized features for children's shoe size and fit recommendation. These provide encouraging clues that the application is well accepted and gains users' interest in using it.

The shoe size and fit recommendation mobile application could assist users to find their right shoe size and fit easily using their smartphone. It will also let users discover the right fit based on shoe brand and type. The QR code stores information on a user's shoe size and fit profile based on brand and type, thus assisting easy reference for buyers and sellers, saving time and potentially eliminating physical contact in future buying process. This will avoid confusion and frustration, and ultimately lead to a reduction in product returns.

Although the assessment result is very encouraging, it was developed based on a specific scope and hence has

limits in its current form. The application was developed on an Android based platform and uses the English language. The application was also built to cater to two brands, brand N and brand A, identified based on the user requirement study. Thus, the respondents were selected among young adults, as they are the interest group for the two brands. These limitations provide opportunities for future work, including enhancement of the application as well as further investigation using wider scope and population size to extend the generalizability of the application design.

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DECLARATION OF COMPETING INTEREST

None

REFERENCES

- Alcacer, A., Apifano, I, Valero, J. & Ballester, A. 2021. Combining classification and user-based collaborative filtering for matching footwear size. *Mathematics* 9(71): 771.
- Bartling, M., Robinson, A. C., Resch, B., Eitzinger, A. & Atzmanstorfer, K. 2021. The role of user context in the design of mobile map applications. *Cartography and Geographic Information Science* 48(5): 432-448.
- Darshan University. 2018. Shoe Size Converter (Version 1.1) [Mobile app]. Google Play Store. https://play.google.com/store/apps/details?id=com.aswdc_shoesizeconverter&hl=en&gl=US
- Demir, S., Kaynak, R., & Demir, K. A. 2015. Usage Level and Future Intent of Use of Quick Response (QR) Codes for Mobile Marketing among College Students in Turkey. *Procedia - Social and Behavioral Sciences* 181: 405–413.
- Egea App Design. 2020. Shoe Size Converter. (Version 1.11) [Mobile app]. Google Play Store. <https://play.google.com/store/apps/details?id=com.mascarphone.shoesize&hl=en&gl=US>
- Huang, S., Wang, Z. & Jiang, Y. 2018. Guess your size: A hybrid model for footwear size recommendation. *Advanced Engineering Informatics* 36: 64-75.
- Juhari, A. N., & Abu Bakar, M. H. 2020. Popular Game Elements Used in Designing Game-Based Learning STEM Application for School Students – A Review. *Jurnal Kejuruteraan*. 32(4): 1-10.
- Jurca, A., & Dzeroski, S. 2021. Fit consistency of men's running shoes. *Footwear Science* 13(1): S63-S65.
- Kabir, M. A., Rahman, S. S., Islam, M. M., Ahmed, S., & Laird, C. 2021. Mobile Apps for Foot Measurement in Podiatric Practice: Scoping Review. *JMIR mHealth and uHealth* 9(3): e24202.
- Khalaf, O. A., & Ja'afar, N. H. 2020. User-friendly Streets for a Walkable, Liveable and Sustainable Environment: A Review. *Jurnal Kejuruteraan* 32(2): 409-414.
- Lindsey, B. 2021. Shoe Size Converter (Version 2.0.2) [Mobile app]. Google Play Store. <https://play.google.com/store/apps/details?id=com.blindsey.ShoeSizeConverter&hl=en&gl=US>
- Macefield, R. 2009. How To Specify the Participant Group Size for Usability Studies: A Practitioner's Guide. *Journal of User Experience* 5(1).
- Mai, C. 2020. My Shoe Size (Version 1.3) [Mobile app]. Google Play Store. <https://play.google.com/store/apps/details?id=net.cuongmai.myshoesize&hl=en&gl=US>
- Nik Ahmad, N. A., Hamid, N. I. M., & Lokman, A. M. 2021. Performing Usability Evaluation on Multi-Platform Based Application for Efficiency, Effectiveness, and Satisfaction Enhancement. *International Journal of Interactive Mobile Technologies* 15(10): 103-117.
- Sauro, J. & Lewis, J. R. 2016. Quantifying the User Experience (Second Edition). Elsevier.
- Sembium, V., Rastogi, R., Saroop, A., & Merugu, S. 2017. Recommending Product Sizes to Customers. Proceedings of the Eleventh ACM Conference on Recommender Systems.
- Singh, S., & Arora, S. 2018. Footwear Size Recommendation System <https://arxiv.org/pdf/1806.11423.pdf>
- Toastguyz. 2021. Shoe Size Converter (Version 2.0.0) [Mobile app]. Google Play Store. <https://play.google.com/store/apps/details?id=com.toastguyz.shoesizeconverter&hl=en&gl=US>
- annop, . ., Stefanyshyn, . ., Anderson, R. ., o gh in, . . & ent, R. 201 . eve opment of a footwear sizing system in the ationa Foot a eage e. *Sports Health* .
- Yuan, Y., Park, M., & Huh, J. (2021). A Proposal for Clothing Size Recommendation System using Chinese Online Shopping Malls: The New Era of Data. *Applied Sciences* 11(23): 11215
- Zainal, S. K., & Ismail, A. 2019. Assessment of Factors Affecting Student's Satisfaction and Loyalty on the Crossed Parking System at Residential Colleges of Universiti Kebangsaan Malaysia. *Jurnal Kejuruteraan* 31(1): 123-129.