A Solution for the Educated Cosmetic Choice to Reduce Cosmetics Waste and Replacement Cycle

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Abstract
There are increasing international concerns in reducing plastic waste. Although cosmetic companies proclaim environment-friendly marketing strategies, it seems to be still hard to replace the plastic cosmetic containers with dissolvable materials. Also if the purchased cosmetics do not fit for customer's demands, they are likely to be thrown away. Eventually it causes significantly shorter life cycle of cosmetics and plastic wastes. This study intends to prolong the life cycle of cosmetics by exactly informing consumers what their skin conditions are, thereby what cosmetics they should select. Therefore, this study introduces an application that accurately diagnose the skin condition by Big Data analysis, and also helps customers select the right cosmetics. First of all, a device with diagnosing functions periodically measure customers' skin conditions, and then the measured data are analyzed to search for appropriate chemicals and ingredients. Based on the analytics, customers are eventually educated concerning the cosmetics appropriate for my skin type among numerous types of cosmetics. The more the customer accumulate historical skin data and their purchase, the more refined choices of cosmetics would be recommended. Additionally, when customers purchase cosmetics, the application indicates whether or not the cosmetics of interest fit for customer's skin condition intuitively and quickly using the AR (Augmented Reality) based ingredient analytics. In short, this paper purpose to promote the educated choice of cosmetics with which customers are satisfied for a long term and reduce the plastic wastes due to the wrong choice of the cosmetics.

Keywords: Augmented Reality (AR), Cosmetics, Personal, UI/UX, Service design

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Introduction

Today's cosmetics have become fundamental consumer goods for modern people. So, the cosmetics market is growing explosively every year. However, due to the contents, containers, etc. of cosmetics that are discarded each day, the current environmental pollution is getting worse. It has been changed to not an eco-friendly era, in which we just need to keep our existing environment, but a Green Survival which is necessary for us to survive. Efforts to reduce the amount of plastics being discarded globally are evident throughout the world, and moreover, there are movements like ''Not Using Plastics'', etc. The cosmetics industry is also pursuing its eco-friendly marketing strategy in keeping with such trends, but actually it is not easy to lower the disposal rate of cosmetics.

Users need to use all the contents of cosmetics to reduce the disposal rate of cosmetics a little, but they have difficulty in finding cosmetics that fit their skin condition. Chloromethylisothiazolinone (CMIT) and Methylisothiazolinone (MIT) ingredients have been detected in the humidifier disinfectant which has become a social issue in recent years, so it sent shock waves through the nation. In addition, the news that household items, such as sanitary pads, wet wipes, toothpastes, etc., contain ingredients similar to those mentioned earlier have impacted the society greatly. At the same time, Chemophobia is spreading gradually, a phobia of chemicals detected in everyday goods, including cosmetics.

As a result, consumers' needs for safety of ingredients of cosmetics have been increasing recently. Famous cosmetic brands are launching their products with the title of 'good cosmetics' with good ingredients. The number of consumers who buy cosmetics is increasing after searching for information about their ingredients. Also, books covering cosmetic ingredients are being published, consumers can search for cosmetic ingredients on the Internet website, and a variety of online services are widely provided so that consumers can register the information they know online to share it with others. It can be said that consumers' needs wanting to know cosmetic ingredients appear in various places.

In fact, the point of view of consumers who are going to purchase cosmetics is simple and clear. It is a question of 'what products are best for my skin' among a number of cosmetics in the world. It is common for people to purchase certain products by sticking to famous brands, but put cosmetics on their vanity tables or eventually throw them away without using them a few times due to skin problems after use. According to actual surveys, there were 92% of people who had cosmetics that were only partially used on their vanity tables. The reason was that the cosmetics had not been suitable for their skin, seasons had changed, or the expiration date had passed. Consumers are constantly worrying about 'what ingredients in cosmetics are adequate to and safe for their skin'. However, all ingredients marked in cosmetics are difficult for consumers to understand because of the low readability and understanding of them.

Therefore, the purpose of this study is to provide consumers with mobile applications that allow them to purchase the best cosmetics for them intuitively through a design that fuses applications and devices that help them purchase the cosmetics intuitively by utilizing data on their respective skin conditions and augmented reality technology and to ultimately help them consume all the cosmetics they purchased while reducing

cosmetic containers or contents, which are waste materials that are discarded due to a wrong choice in selecting the cosmetics. And furthermore, it aimed at organizing a platform optimized for the cosmetics business.

Relevant studies

It is now easy to check information on cosmetic ingredients with the recent appearance of mobile applications that can easily identify them with smartphones in order to solve such problems. The representative application is 'HWAHAE' meaning 'interpreting cosmetics', which provides 20 essential ingredients, EWG(Environmental Working Group) Grade,[1] skin type-specific ingredients, etc. by searching for consumers' desired cosmetic ingredients. However, there are various limitations that it is not able to absolutely have blind faith in the safety of the EWG's green grade along with the cumbersome of searching the cosmetic ingredients every time consumers buy cosmetics.

It is due to the fact that the EWG grade is determined by the number of articles. For the green grade, if there is no study result of the harmfulness of any ingredient in the paper, it is regarded as a safe one. Despite the fact that there is no study to test for the harmfulness of ingredients, they are considered as ingredients with safe grade 1, that is to say a 'green grade'. Rather, substitute ingredients are used to avoid substances widely known as harmful ingredients of cosmetics, but they can be more dangerous to consumers because they have not been tested yet. In addition, ingredients that need users' attention, among cosmetic ingredients, are in an obscure category called not an ingredient that does not fit each individual but 'dangerous for most people', so there are many people throwing away cosmetics or storing them on the vanity table because their ingredients are not actually suitable for their skin although they have purchased them with the idea that they are the right ingredients for them. To put it more simply, 'bad ingredients for most people' can be identified through Internet search or apps, but there is no recommendation for cosmetics appropriate for each person's skin, or a way to intuitively purchase them suitable for each individual, which causes the repetition of buying and then discarding cosmetics, and more seriously, some people have skin diseases such as folliculitis, contact dermatitis, skin troubles, etc. which results in economic loss.

Therefore, in order to go a step further from existing services, this paper had a purpose of identifying the skin environment with a device accurately and then trying to show the ingredients that are appropriate or not for each user's skin as an indicator. In addition, it was intended to help consumers increase the success rate of their cosmetics purchase intuitively, quickly and accurately through 'Augmented Reality-based cosmetic recommendation mode' at the moment of purchasing the cosmetics. Moreover, it tried to proceed with this study while focusing on accurate skin diagnosis, big data, and proper purchasing to improve the technical usefulness of the mobile application covered in this study. Eventually, it is expected that it will realize a sustainable convergence design that will help reduce the number of cosmetics discarded due to wrong choice of cosmetics and completely consume all purchased cosmetics and, by extension, that it will also give consumers economic advantages.

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[1] Environmental Working Group. https://www.ewg.org/ewgverified/about-the-mark.php.

The purpose of the study

The purpose of this study is to make it easier for consumers to purchase cosmetics suitable for them when they purchase cosmetics by proposing augmented reality-based cosmetic application and device after investigating and analyzing the skin care methods and the process of selecting cosmetics for women in their 20s and 30s who are familiar with the application. As an experimental method, it was carried out through quantitative research, an online questionnaire on behavior when purchasing existing cosmetics, and qualitative evaluation, an in-depth interview. And, it will be performed with literature review, definition of research scope, user research, UI (User Interface) prototype design for the mobile app, and usability evaluation in order.

First, through the literature review, it analyzed the perception level of cosmetic ingredients at home and abroad, the importance of cosmetic ingredients, and the symptoms of using cosmetics that are not suitable for one's own skin and investigated the applications and services with regard to cosmetics that are being operated based on prior researches. In addition, it will apply user experience design and service design process and methodology to UI design by collecting recent data.

Second, it will derive the need and considerations of the mobile interface by comparing and analyzing the examples of mobile apps that are currently in operation.

Third, it will conduct a survey of women in their 20s and 30s, targets for this study, by preparing questionnaires about the behavior of purchasing cosmetics, based on the above research methods.

Fourth, in order to refine a survey and understand users' exact needs, it will analyze their current awareness of cosmetic ingredients, skin care, the way they purchase the cosmetics, and difficulties and derive features to meet their requirements by conducting in-depth interviews.

Fifth, it will suggest the final design with the supplemented prototype reflecting improvements in qualitative and quantitative assessments. Finally, this research will be done with the suggestion of significance and use possibility of the application and product that will help users purchase cosmetics that fit their skin intuitively, quickly and accurately while describing the conclusion and future task.

Research results

1) Literature review and evaluation of prior research

As a result of conducting literature reviews and analyzing prior researches, it was found that the patent data were more dominant than the paper. There is 'HWAHAE(interpreting cosmetics)' that is most preferred by people while currently helping to buy cosmetics in Korea. The HWAHAE is an application that is favored by users in a short time and analyzes cosmetic ingredients, launched in 2013, developed by a domestic developer, and it is currently ranked No. 1 in cosmetics-related applications in Korea and is extending its sales channel worldwide. In the beginning, Korean Dermatological Association and EWG(Environmental Working Group) of the U.S. nonprofit organization related to cosmetics, which give the criteria for cosmetic

ingredients marked, analyzed cosmetic ingredients based on EWG grades, but in recent years, it is creating a community with the users of the application while offering consumer review service and ranking, followed by a commerce service in which users can purchase cosmetics on the spot with viewing reviews.

Its advantage not only makes it easier for us to understand unfamiliar chemical terminologies, but also allows us to know what factors are dangerous in cosmetics at a glance. It explains cosmetic ingredients minutely and easily so that consumers, who do not know what is in cosmetics even though they try to analyze cosmetics ingredients, can understand the unfamiliar things easily. Previously, users were able to find harmful ingredients of cosmetics through Korea Cosmetics Association(KCA) and Food and Drug Association(FDA), but the process was cumbersome and difficult to understand, so there was a limit to the user's understanding of cosmetic ingredients. The HWAHAE also added a function to review used cosmetics and a commerce service. It has created a structure where users are asked to write reviews on the advantages and disadvantages of the cosmetics, and they need to write their own reviews first to see other people's ones to filter out commercial reviews and less reliable reviews. Along with those two guidelines, it has created not advertising but an information community that consumers can trust, having the great advantage of making it available for the consumers to buy their favorite products immediately after reviewing them.

However, the HWAHAE is still inconvenient in that consumers have to search for cosmetics one by one when purchasing them offline. Furthermore, it provides information on the harmful ingredients of cosmetics, which have been settled only by the labeling system of all ingredients carried out by the government and by groups such as Korean Dermatological Association and EWG(Environmental Working Group) of the U.S. nonprofit organization, so it does not tell users about harmful ingredients of cosmetics that are not suitable for each of them although their skin conditions are all different.

2) Evaluation of currently used devices for measuring the skin

2-1) Purpose of the survey

This study had a purpose to develop a service that can measure users' skin and help them to buy cosmetics that are effective on their skin. Devices that measure skin conditions are not popular now, but a service that analyzes skin conditions and then recommend cosmetics for the analysis result is being offered to consumers to sell specific company's cosmetics at several cosmetics shops.

2-2) Survey method

The measurement method is to select whether to use cosmetics or not first, to choose the type of cosmetics in use, worries about the skin, etc., to take a picture of the skin with the camera equipped with the device, and to measure moisture, elasticity, pores, freckles, and sensitivity. After that, it recommends the cosmetics suitable for the skin condition and sends the measured information to the users' cell phone by a text message. Town Watching performed the task of measure the skin of five graduate

students while asking them to visit the cosmetics store four times between the 15th and the 20th.

Figure 1 : Town watching. (Source: Gayoung Kang, 2018)

2-3) Results

The measurement results showed that measuring the skin only with the device was less accurate. In fact, all five subjects had different skin types from what they knew, the results also changed dramatically depending on the area to be measured, and the measured values changed greatly each time they visit, so recommended products also changed each time. As shown in Figure 2, the figure of freckles was 1 on September 15, but 68 on November 6. It exceeded the average value of 35 in about two months, confirming that the skin was in a very bad condition. Then, it was measured again after 13 days from the original measurement, and it appeared 32 slightly lower than the average value. It has been evaluated that the device alone was not sufficient to exactly measure the skin because it was confusing users' skin types. It was concluded that users are more likely to get more objective information about their skin if they use the device at the same time with self-survey and making data about their cosmetics after surveying themselves for their skin, such as cosmetics currently in use, etc.
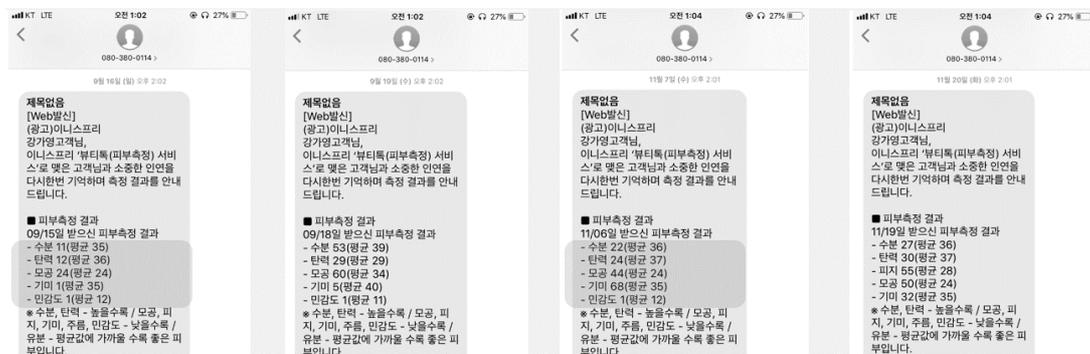

Figure 2 : Text messages sent for 'measurement results'

3) Online survey on cosmetics purchase by users

3-1) Purpose of the survey

It was intended to understand behaviors at the time of purchasing cosmetics for women in their 20s and 30s, who are skilled in using smartphones and applications, by analyzing the perception level of cosmetic ingredients, the importance of cosmetic ingredients, and the symptoms of using cosmetics that are not suitable for their skin.

3-2) Survey method

The questionnaire was created on Google, the gender of all subjects is female, and 51 people, including 30 people in their 20s and 21 people in their 30s, responded to the questionnaire. It consisted of 13 questions in total, including the understanding of their skin and propensity to purchase cosmetics(7 questions), the perception level of cosmetic ingredients(3 questions), and the experience of using cosmetics that do not fit their skin(3 questions).

Table 1 : List of questions in the online survey

Item	Question
Understanding of one's skin and propensity to purchase cosmetics	o Do you think you know about your skin type well? o When you buy cosmetics, do you usually search for what you want to buy in advance? o How many fundamental cosmetics do you use? o Have you ever purchased cosmetics after being recommended by a sales staff? o If so, Did the cosmetics work for you? o Do you see the ingredients of cosmetics when you buy them? o How much do you usually spend on cosmetics each month? o Where do you buy cosmetics, offline and online?
Perception level of cosmetic ingredients	o Do you now how cosmetic ingredients affect your skin? o Do you know what cosmetic ingredients are good or bad for your skin? o Do you use an application that analyses cosmetic ingredients? (or do you search for cosmetic ingredients?)
Experience of using cosmetics that are not suitable for one's skin	o Have you ever been fooled by false advertising about cosmetics? o Have you ever had skin troubles or other skin problems when using cosmetics that are not suitable for your skin? o Do you have experience of throwing away or leaving cosmetics somewhere even though you used them a little after the purchase? o If yes, what did you do with the cosmetics?

3-3) Results

For the question of 'Do you think about your skin type well?', 45% of the respondents answered, 'I know it well', and on the other hand, 55% of them answered, 'I am not sure', meaning that their understanding of the skin was generally low. There were more people to search for the cosmetics in advance before the purchase. In addition, 85% of the respondents have ever purchased cosmetics after being recommended by a sales staff, but there were more people who answered, 'I am not sure about the effect of cosmetics on my skin that I bought by being recommended from sales staffs'. For the confirmation of all ingredients of cosmetics when purchasing them, there were 13.3% for Yes and 20% for Normal, confirming that the positive and negative responses were 33.3% and 66.7%, respectively. Based on the results of the in-depth interviews conducted after the online survey, it was confirmed that many people have purchased cosmetics due to the reviews and word-of-mouth of actual buyers, and advertisements, rather than confirmation of their all ingredients. In addition, the number of users knowing what cosmetic ingredients are good or bad for their skin was 40%, which was a low portion, and that of users knowing how cosmetic ingredients affect their skin was 45%, meaning that there were many people with a low perception of cosmetic ingredients. And, the number of users who have ever had skin troubles or other skin problems when using cosmetics that are not suitable for their skin was 80%, confirming that most of them have experienced them. In addition, 73.3% of users answered that they have ever been fooled by false advertising about cosmetics, showing that most of them have purchased the cosmetics while seeing the advertisements. Also, from an environmental point of view, 80% of users have had experiences of throwing away or leaving cosmetics somewhere even though they used the cosmetics a little after the purchase, meaning that the disposal rate of the contents and containers of the cosmetics is quite high. Users' perception of harmful ingredients was low, but most of them have had skin-related experience with cosmetic ingredients, such as stacking cosmetics somewhere by skin troubles or other skin problems due to their harmful ingredients, etc.

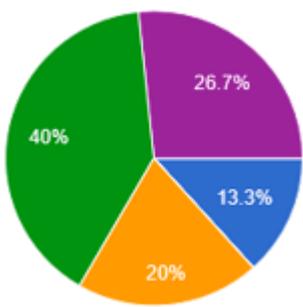Table 2 : Responses to confirmation of ingredients of cosmetics

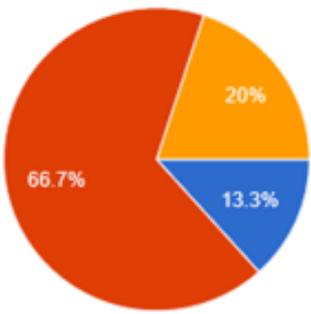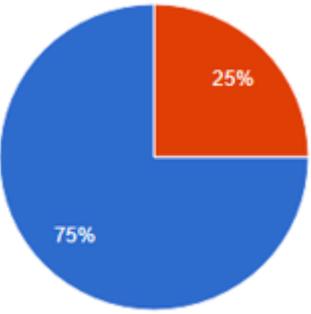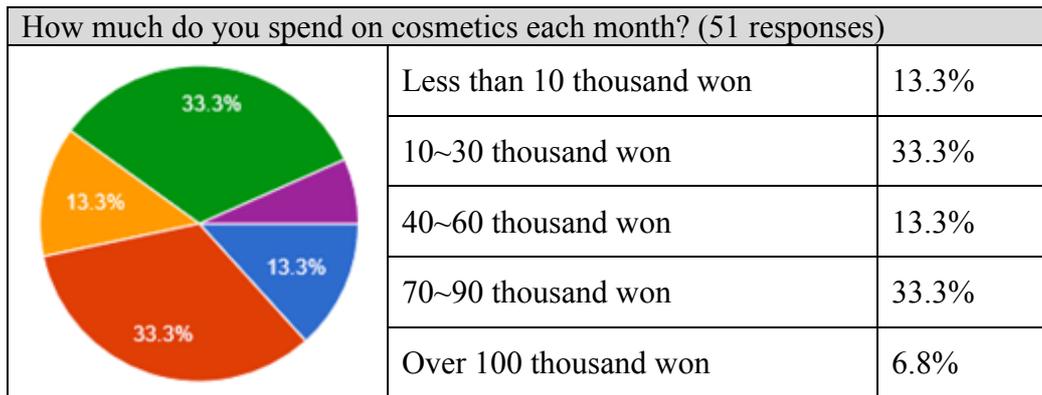| Do you see the ingredients of cosmetics when you buy them? (51 responses)		
	Very likely	13.3%
	Likely	0.0%
	Normal	20.0%
	Unlikely	40.0%
	Very unlikely	26.7%

Table 3 : Responses to the occurrence of troubles caused by cosmetics

Have you ever had skin troubles or other skin problems when using cosmetics that are not suitable for your skin? (51 responses)		
	So often	13.3%
	Yes	66.7%
	Not really	20.0%

Table 4 : Responses to disposal of cosmetics

Do you have experience of throwing away or leaving cosmetics somewhere even though you used them a little after the purchase? (51 responses)		
	Yes	75%
	No	25%

In addition, with regard to monthly average cost for the purchase of cosmetics, there were 33% for 10 to 30 thousand won and 33% for 70 to 90 thousand won, which both were the same. Users who buy 10~30 thousand won worth of cosmetics each month mainly buy them at the road shops, and on the other hand, those who buy 70~90 thousand won worth of cosmetics each month mainly buy them at the department stores or skin care shops. These are the users who responded to the question 'Throw away cosmetics if they do not fit your skin' of the above-mentioned questions, indicating that they already spend a lot of money on cosmetics. There were also users who answered, 'I would like to find cosmetics suitable for my skin and then use only them to the end, rather a variety of cosmetics' in an in-depth interview after the online survey.

Table 5 : Responses to monthly average cost for the purchase of cosmetics

How much do you spend on cosmetics each month? (51 responses)		
	Less than 10 thousand won	13.3%
	10~30 thousand won	33.3%
	40~60 thousand won	13.3%
	70~90 thousand won	33.3%
	Over 100 thousand won	6.8%

4) In-depth interviews

4-1) Purpose of the survey

In order to refine a survey and understand users' exact needs, it analyzed their current awareness of cosmetic ingredients, skin care, the way they purchase the cosmetics, and difficulties and derived functions to meet their requirements by conducting in-depth interviews.

4-2) Survey method

In-depth interviews were carried out for each of five women in their 20s, who responded to the above questionnaire, during about one hour. The interviews began after explaining them enough in advance about what will be covered in the interviews, such as what devices and applications will be created, etc. To be as objective as possible, two graduate students and one professor selected interview questions that they thought were important. The survey was organized with the addition of the intensified questions shown in Table 1 and the survey results. It asked them various questions while focusing on the difficulties in purchasing cosmetics and then derived functions that meet their requirements.

4-3) Results

As a result of the interviews, all respondents said they rarely see all ingredients of cosmetics because they do not know what they mean by looking at them. They said it is not only time consuming to search one by one, but also difficult. They also said that they have ever bought the cosmetics after searching their ingredients, but eventually threw them away as they did not fit their skin conditions after use. In addition, they answered that when purchasing cosmetics, they usually found and then purchased the cosmetics that became famous through word-of-mouth, rather than looking at ingredients difficult for them to understand. So, there were many responses that I had been pooled by false advertising regarding cosmetics and then abandoned them due to skin troubles.

Also, some respondents said they felt uncomfortable because they did not know what cosmetics are appropriate for their skin, whether or not cosmetics are famous. The

cost of purchasing cosmetics was the largest among the criteria for selecting the cosmetics. All of the interviewees answered the monthly average cost for cosmetics was 70,000 to 100,000 won. In fact, some people answered that they have ever abandoned or put cosmetics on other parts of the body, except for the face, when they proved to be unsuitable for their skin, showing that cosmetic disposal is serious. In addition, in case of the response to the skin measuring device, it was able to find the needs of users who said they would be happy to be able to easily observe changes in their skin by constantly measuring their skin at home because it is actually wonderful and good to be able to know their skin type at cosmetic shops, but there are a lot of pressure for product recommendations from sales staffs, and time restrictions for them to visit the stores continuously.

Discussion, implication, and future research

Based on the above results, it was able to analyze the awareness of cosmetic ingredients, skin care, the way they purchase the cosmetics, and the resulting difficulties of women in their 20s and 30s. In fact, it has been more than 10 years since cosmetics sold on the market were prescribed by law to include all ingredients in containers. The purpose of the 'labeling system of all ingredients of cosmetics' is to allow consumers to choose the right cosmetics for their skin condition by displaying all the ingredients used in the manufacture of the cosmetics and to respond promptly with any side effects on their skin, but unfortunately, it is still not well utilized. The biggest problem, among the reasons for not confirming all ingredients of cosmetics, was the low readability and understanding of them. Therefore, it tried to create a device that can measure skin every day when consumers buy cosmetics and an application that can connect to it through the results of the above-mentioned literature review, questionnaires and in-depth interviews. The biggest function of the application is a service that helps intuitive purchasing of cosmetics suitable for consumers' skin through 'augmented reality'. It was intended to focus on the function.

The future research is to create a user scenario based on the above results, organize the menu according to the preliminary analysis results, design UI prototypes that meet consumers' needs, based on augmented reality and form the workflow diagram by combining the results obtained by understanding the usage by the user environment and the networks and technologies studied. Then, it has a plan to conduct a prototype evaluation by grouping the users who received the in-depth interviews conducted earlier after designing the UI prototypes.

It will suggest the final design with the supplemented prototype reflecting improvements in qualitative and quantitative assessments. Finally, this research will be done with the suggestion of significance and use possibility of the application and product that will help users purchase cosmetics that fit their skin intuitively, quickly and accurately while describing the conclusion and future task.

Conclusions

There is a growing international interest in reducing the amount of plastic that is discarded. The cosmetics industry is also actively promoting eco-friendly marketing, but it is practically impossible to lower the disposal rate of cosmetics. In addition, if the cosmetic is not suitable for the type of skin after purchasing it, it is left as it is and

eventually abandoned, which not only shortens the life cycle of the product, but also increases industrial wastes such as plastics.

In order to solve the problem, it aimed to conduct a study for increases in the replacement cycle of cosmetics as much as possible by making it available for users to accurately identity their own skin environment and choose the cosmetics suitable for them. The process should be carried out intuitively. It is because consumers do not want to purchase products while studying them inconveniently. If consumers have no choice but to connect to the Internet website with a computer as in the past, enter the ingredient information as keywords, and then check the alternative product one by one, it is undesirable because it actually means that they have to study to purchase a product that fit their needs.

This study aims to develop products focusing on the cosmetics purchase service based on the cosmetics market, which is attracting much attention now, and the usability of UI design of the application applying augmented reality that is rapidly emerging as a core technology. It also aimed to proceed with research on accurate skin diagnosis, big data, and appropriate purchase. First, users are required to measure their skin periodically with a device that can accurately diagnose the skin, and the measured data is transmitted to the application. The application measures how cosmetics are making changes to the skin. And, it determines which ingredients of cosmetics are suitable for each user through long-term accumulated data. This recommends cosmetics suitable for the user's skin for each type of them, ultimately increasing the success rate. The more users use the device and application, the more sophisticated it will be. Also, when they purchase products at the cosmetics store, it will be available to increase the purchase success rate intuitively and promptly with AR(Augmented Reality)-based cosmetics recommendation mode. In addition, this study will suggest methods to effectively offer a variety of information for the enhancement of the mobile application's technical usefulness.

Eventually, it is expected that it will realize a sustainable design that will help reduce the number of cosmetics discarded due to wrong choice of cosmetics and completely consume all purchased cosmetics and, thereby giving consumers economic advantages.

Acknowledgements

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