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MOBILE SKINCARE INGREDIENTS CHECKER FOR ECZEMA USING BARCODE AND RULE-BASED TECHNIQUE

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Abstract*: Eczema, a chronic skin condition characterized by inflammation and irritation, is often exacerbated by certain ingredients found in skincare products. This paper presents the development of a novel mobile application designed to help individuals with eczema avoid products containing harmful ingredients. Utilizing barcode scanning and rule-based techniques, the EczyCode mobile application provides an efficient method for users to identify potentially harmful substances in skincare products. The core of the application is a comprehensive ingredient database, that enables continuous updates with the latest dermatological research. By scanning product barcodes, users receive immediate feedback on ingredient safety, categorized as harmful or safe. The application also fosters greater awareness of ingredient safety, empowering users to make informed decisions. This study underscores the potential of combining barcode technology with rule-based analysis to improve eczema management, offering a practical tool for millions affected by this condition. Future work will focus on expanding the database and incorporating personalized recommendations to enhance the user experience further.*

Keywords*: Eczema, Skincare, Ingredients, Barcode, Rule-based*

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Introduction

Eczema is a skin disease that often occurs in infancy, children, and adults. It is also known as Atopic Dermatitis (AD), is one of the most common not transmissible skin diseases, it affects up to 20% of children and 2-8% of adults worldwide (Wollenberg et al., 2018). A dysfunctional immune system, an imbalanced skin micro-biome, and a poor skin barrier are the major characteristics of AD (Damour et al., 2019). Eczema is a complex and multifactorial condition that has been the focus of extensive research in recent years. Itch is the most important symptom of eczema, as it has a major impact on health-related quality of life.

The limited availability of digital tools addressing eczema-specific ingredient concerns impacts user confidence in skincare choices (Aziz et al., 2021). This lack of real-time ingredient analysis delays the result, leading to frustration and uncertainty for individuals with eczema who need to find compatible products quickly. According to a current study, the market value of cosmetic and personal care goods in Western Europe reached around 84 billion euros in 2018, and it is predicted that this value will rise by about 6% by the end of 2020. Given the huge annual spending on cosmetics and personal care items, as well as the fact that many of their formulations contain chemical surfactants, many of these substances have the potential to have negative effects on individuals, including allergic reactions and skin irritations (Adu et al., 2020).

As a result, an eczema skincare ingredient checker mobile application named *EczyCode* using barcode and rule-based techniques is developed. The mobile application can be used by eczema sufferers. The users will know which product is safe to use or harmful after they scan the barcode label on their skincare product.

The study is organized as follows. Section 2 discussed the related works. Section 3 presents the methodology for the Eczema Skincare Ingredient Checker mobile application. The results are discussed in section 4. The paper finishes with the conclusion and future work in section 5.

Literature Review

The human body's largest organ is the skin, it is made up of three layers. The uppermost layer, the epidermis, is made up of keratinocytes while the middle layer, the dermis, is made up of fibroblasts, and the outermost layer, the hypodermis, is mostly made up of connective tissue and fat (Susano et al., 2022). Its main purpose is to act as a barrier, limiting excessive moisture loss from the body while also keeping infections and harmful substances from entering from the outside (Adu et al., 2020). Numerous problems with the skin include dryness, eczema, and more (Happy et al., 2021). Chemicals in skincare products are extremely important since they affect not only how safe cosmetics are but also every part of the human body and existence. It is important to assess the toxic and protective mechanisms of products using scientific methods for sensitive skin, a kind of skin that should avoid cosmetics containing harmful ingredients (Liang, 2020).

Before this, natural raw materials (such as plant and rock substances) were mainly used in skincare products for people. However, the petroleum sector has significantly evolved during the 20th century, and petrochemical raw materials are now widely used in our everyday lives. For instance, the majority of cosmetics and daily requirements are made of petrochemical raw materials (Liang, 2020). There are a few skincare ingredients that should be avoided in skincare products for people who suffer from eczema. The ingredients are fragrance, urea, methylisothiazolinone and ethanol.

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Fragrances are used widely in scented products used in daily life. Studies have revealed that using fragrances often causes runny noses and skin irritation and it is one of the biggest allergens (Liang, 2020). Cosmetics also make use of fragrances. There are 3,000 or so compounds used in perfumes. In colognes, deodorants, and perfumes, fragrance is a key component. Perfumes can be found in almost all cosmetic products. These products may include fragrance elements in the form of masking agents that stop the brain from detecting their odour, even if they are promoted as "fragrance-free" or "unscented" (Khan et al., 2019). The primary ingredient itself is a combination of synthetic or natural spices as well as a range of chemical ingredients, some of which are primarily carcinogens and allergies (Liang, 2020).

On top of that, the skincare ingredient that should not be in skincare products is urea. Eczema sufferers may find urea irritable, and it may also harm the skin's acid layer. Even though it may be specially designed for eczema sufferers, it is usually best avoided until necessary. 41 out of the 77 studies found evidence of the harmful effects of moisturizers. In comparison to the sample, patients using creams containing urea reported higher negative side effects after a month. Some negative consequences were odour, pain or burning experiences or skin irritation (Qiu, 2018).

Another skincare ingredient that should not be in skincare products is sodium laureth sulfte (SLS). It often referred to as sodium laureth sulfate or sodium dodecyl sulfate, is an anionic surfactant that is frequently utilized in home cleaning products, such as spray cleansers, laundry detergents, and personal care products (Bondi et al., 2015; Leoty-Okombi et al., 2015). According to autoradiographic investigations, strong surfactant deposition was seen on the skin's surface and in the hair follicles of rats treated with radiolabeled sodium lauryl sulfate. This deposition may have caused damage to the hair follicle (Bondi et al. 2015). Lastly, a human technological study revealed that exposure to hard water both promotes and facilitates the surfactant sodium lauryl sulfate's deposition on the skin, which impairs the epidermal barrier's ability to function and increases transepidermal water loss, TEWL, especially in patients with atopic dermatitis who have filaggrin and FLG mutations (Debinska et al., 2023).

Additionally, methylisothiazolinone is one ingredient that should not be in every skincare product. Methylisothiazolinone (MI) is a typical preservative used in water-based personal care products. A serious case of allergic reaction skin has been caused by increases in the maximum amount of MI that may be found in these items (Reeder et al., 2019). Other than that, with a recorded positive response rate of 13.4%, MI has the highest significance-prevalence index number (SPIN), a measure that evaluates an allergen's relative importance by taking into consideration both clinical relevance and reaction frequency. MI has a positive response rate of 7.3% and is ranked number 4 on the North American Contact Dermatitis Group SPIN rating for 2015–2016 (Comstock et al., 2020). In 2010, a case series showing the early occurrence of MI contact allergy linked to personal care items was reported. The authors detailed how people with AD were exposed to MI using wet wipes and a makeup remover.

Lastly, the skincare ingredient that needs to be cautious is ethanol or it is known as alcohol. Ethanol can damage the skin barrier function and remove natural oils from the skin, which is already damaged in people with eczema. Increased skin sensitivity, redness, and itching could result from this. Ethanol is widely used as a disinfectant and alcoholic beverage. The use of ethanol on damaged skin is discouraged in the cosmetics industry as well. Regular exposure to ethanol can result in eye irritation, skin dryness, cracking, redness, itching, and eczema (Prajapati et al., 2022).

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Similar Applications

There are several existing applications similar to the Mobile Application of Skincare Ingredients Checker for Eczema. The related applications are Cosmily Skincare Ingredient Checker, INCIDecoder Skincare Ingredient Checker, and Think Dirty.

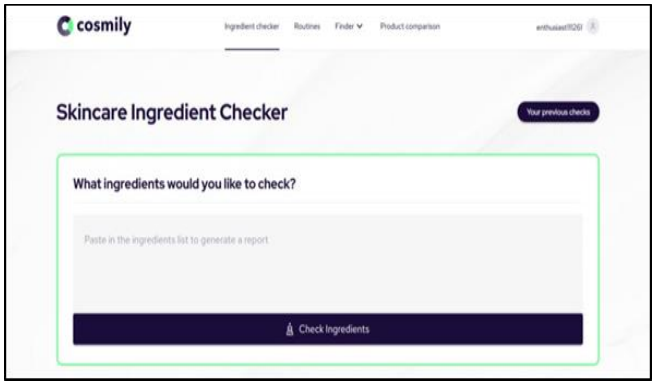

Figure 1: Cosmily Skincare Ingredient Checker Interface

Source: Cosmily - Skincare Ingredient Checker, n.d.

Cosmily Skincare Ingredient Checker (Cosmily - Skincare Ingredient Checker, n.d.) is a free online tool that helps to learn more about the components of skincare products. It examines the list of contents in any cosmetic or skincare product and gives a thorough analysis of each ingredient's safety, effectiveness, and negative effects. The study also discusses the relationship between the ingredients and if the skin type is compatible with them. To use Cosmily Skincare Ingredient Checker, users need to manually copy and paste the ingredients list of the product (Cosmily - Skincare Ingredient Checker, n.d.) as shown in Figure 1.

INCIDecoder Skincare Ingredient Checker (INCIDecoder - Decode Your Skincare Ingredients, n.d.) is a free online tool that can examine the ingredients in skincare products. Users may submit an image of the product's ingredients list or search for a product by name, brand, or category as shown in Figure 2. Then, INCIDecoder will provide a thorough explanation of the chemicals, including their function, level of safety, and any possible adverse effects. According to a recent study, the INCI Decoder website was used to find a list of skincare products that included perfluoro nonyl ethyl carbocycle PEG-10 dimethicone.

Figure 2: INCIDecoder Skincare Ingredient Checker Interface

Source: INCIDecoder - Decode Your Skincare Ingredients, n.d.

Think Dirty (Think Dirty® Shop Clean - Clean Beauty App - Shop Clean Products - Think Dirty® Shop Clean, n.d.) is a free app that allows users to scan the barcode of beauty, personal

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care, or household product to learn about its ingredients and potential health risks. The app interface is shown in Figure 3. The app uses a proprietary scoring system to rate products on a scale of 0 to 10, with 10 being the cleanest.

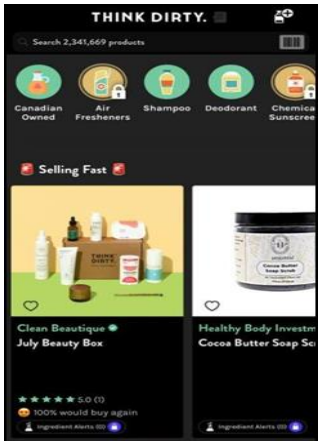

Figure 3: Think Dirty Interface

Source: Think Dirty® Shop Clean - Clean Beauty App - Shop Clean Products - Think Dirty® Shop Clean., n.d.

Think Dirty also provides information on the ingredients in each product, including their potential health effects. The app is available for iOS and Android devices. Think Dirty's goal is to empower consumers to understand the ingredients in their personal care products better and make more informed decisions about what they use on their bodies. By providing transparency and easy-to-understand information, the app aims to promote healthier and safer choices in personal care product selection (Think Dirty® Shop Clean - Clean Beauty App - Shop Clean Products - Think Dirty® Shop Clean., n.d.).

Methodology

Creating a mobile application to check for harmful eczema ingredients involves several steps. The methodologies can be broken down into the following key components as shown in Figure 4.

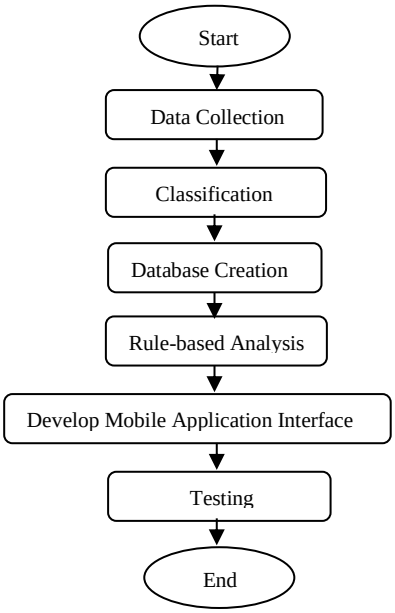

Figure 4: Eczema Skincare Ingredient Checker Mobile Application Methodology

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Data Collection

The datasets were collected by the California Safe Cosmetics Program (CSCP) in the California Department of Public Health [19]. The CSCP's main objective is to gather data on potentially dangerous and harmful substances found in cosmetics sold in California and make that data available to the public. The total number of datasets is 1473. The attributes for each product are labels, brands, names, prices, ranks, and ingredients as shown below in Figure 5.

	A	B	C	D	E	
1	Label	Brand	Name	Price	Rank	Ingredients
2	Moisturize	LA MER	Crème de la Mer	175	4.1	Algae (Seaweed) Extract, Mineral Oil, Petrolatum, Glycerin, Isohexadecane, Microcrystalline Wax, Lanol
3	Moisturize	SK-II	Facial Treatment Essen	179	4.1	Galactomyces Ferment Filtrate (Pitera), Butylene Glycol, Pentylene Glycol, Water, Sodium Benzoate, Me
4	Moisturize	DRUNK EL	Protini™ Polypeptide Cr	68	4.4	Water, Dicaprylyl Carbonate, Glycerin, Cetearyl Alcohol, Cetearyl Olivate, Sorbitan Olivate, Sclerocarya
5	Moisturize	LA MER	The Moisturizing Soft C	175	3.8	Algae (Seaweed) Extract, Cyclopentasiloxane, Petrolatum, Glyceryl Distearate, Phenyl Trimethicone, But
6	Moisturize	IT COSME	Your Skin But Better™ C	38	4.1	Water, Snail Secretion Filtrate, Phenyl Trimethicone, Dimethicone, Butylene Glycol, Butylene Glycol Dica
7	Moisturize	TATCHA	The Water Cream	68	4.2	Water, Saccharomyces/Camellia Sinensis Leaf/Cladosiphon Okamuranus/Rice Ferment Filtrate*, Dimeth
8	Moisturize	DRUNK EL	Lala Retro™ Whipped C	60	4.2	Water, Glycerin, Caprylic/ Capric Triglyceride, Isopropyl Isostearate, Pseudozyma Epicola/Camellia Sine
9	Moisturize	DRUNK EL	Virgin Marula Luxury Fa	72	4.4	100% Unrefined Sclerocraya Birrea (Marula) Kernel Oil.
10	Moisturize	KIEHL'S SI	Ultra Facial Cream	29	4.4	Water, Glycerin, Cyclohexasiloxane, Squalane, Bis-Peg-18 Methyl Ether Dimethyl Silane, Sucrose Stearat
11	Moisturize	LA MER	Little Miss Miracle Limit	325	5	Algae (Seaweed) Extract, Mineral Oil, Petrolatum, Glycerin, Isohexadecane, Microcrystalline Wax, Lanol
12	Moisturize	FRESH	Lotus Youth Preserve N	45	4.3	Water, Glycerin, Propylene Glycol Dicaprylate/Dicaprate, Pentylene Glycol, Cetearyl Alcohol, Caprylic/C
13	Moisturize	KIEHL'S SI	Midnight Recovery Con	47	4.4	Caprylic/Capric Triglyceride Dicaprylyl Carbonate Squalane Rosa Canina Fruit Oil Oenothera Biennis Oil,
14	Moisturize	BELIF	The True Cream Aqua B	38	4.5	Water, Dipropylene Glycol, Glycerin, Methl Trimethicone, Alcohol Denat, Dimethicone, Cyclopentasiloxa
15	Moisturize	SUNDAY R	Luna Sleeping Night Oil	105	4.1	Persea Gratissima (Extra Virgin, Cold Pressed Avocado) Oil, Vitis Vinifera (Organic, Cold Pressed Concor
16	Moisturize	FARMACY	Honeymoon Glow AHA	58	4.6	Water, Lactic Acid, Propanediol, Jojoba Esters, Glycolic Acid, Potassium Hydroxide, Salix Alba (Willow) B
17	Moisturize	DRUNK EL	The Littles™	90	4.4	Beste™ No.9 Jelly Cleanser: Water, Sodium Lauroyl Methyl Isethionate, Glycerin, Cocamidopropyl Betain

Figure 5: Datasets by California Safe Cosmetics Program (CSCP) in the California Department of Public Health (CDPH)

Classification

The skincare products that contain Fragrance, Methylisothiazolinone, Ethanol, Urea, and Sodium Laureth Sulfate are extracted from the dataset and stored in an Excel document. 40 products that consist of 20 harmful ingredients and 20 safe ingredients are collected. A barcode is generated for each of the products using Excel. Figure 6 below depicts the information on some of the products after pre-processing.

	A	B	C	D	E	F	G	H
1	LABEL	BRANDS	DESCRIPTION	INGREDIENTS		EAN-13	BARCODE	PICTURE
2								
3	Moisturizer	ORIGINS	GinZing™ Energy-Boo	Water, Methyl Trimethicone, Butylene Glyco		0 717334 228184		
4	Moisturizer	AMOREPACIFIC	Vintage Single Extra	Water, Propanediol, Glycerin, Camellia Sine		8 809685 751007		
5	Moisturizer	FARMACY	Sleep Tight Firming I	Prunus Amygdalus Dulcis (Sweet Almond) O		0 689533 412308		
6	Cleanser	BOSCIA	Clear Complexion Cl	Water, Hydrogenated Starch Hydrolysate, D		0 808144 121076		
7	Cleanser	SIMPLE	Kind To Skin Refresh	Aqua, Cocamidopropyl Betaine, Propylene G		5 011451 103863		
8	Cleanser	FIRST AID BEAUTY	FAB Skin Lab Resurfa	Water, Polysorbate 80, Glycolic Acid, Butyle		0 815517 020232		

HARMFUL INGREDIENTS | GOOD INGREDIENTS

Figure 6: Product Information

Database Creation

A Firebase database is used to store the data involved in the Mobile Application of Skincare Ingredients Checker for Eczema. Figure 7 shows the screenshot taken from the Cloud Firestore that contains all data of skincare products. In the figure, it is shown that there are seven elements

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for each of the products which are approved, brand, description, eanCode, imageUrl, ingredients, and label. Apart from the product information, the database also stores the application administrators' and user information including the username and password. The administrator will be able to add new products or ingredients in the future.

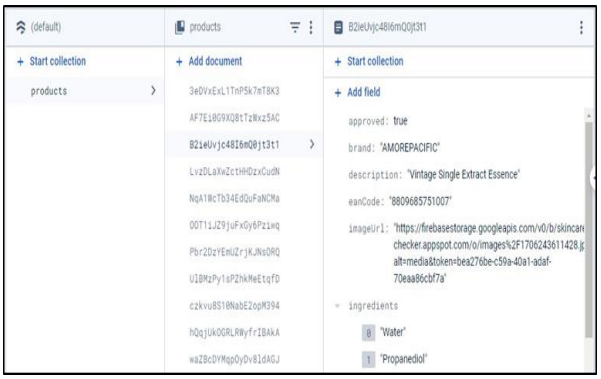

Figure 7: Product information stored in Firebase

Rule-Based Analysis

In this phase, rules are defined based on the ingredient's classification as in Figure 8. By using if-else statements, these rule-based techniques enable the mobile application to analyze and provide insights into skincare products based on their ingredients, ensuring that users can make informed decisions to manage their eczema effectively.

```
Extract product ingredients from a barcode
If the ingredient is harmful
    Display the ingredients and display the product is not safe for eczema
Else
    Display product is safe
```

Figure 8: Pseudocode for Checking Skincare Ingredients using Rule-Based Technique

Develop Mobile Application Interface

In this phase, firstly the wireframes and mock-ups are designed to visualize the application user interface and experience. The design focuses on ease of use, readability, and clear navigation to accommodate users with eczema. Barcode scanning is implemented next, allowing users to scan product barcodes, check the ingredients classification whether harmful or safe, and retrieve the product ingredient information from the database. This involves writing both Flutter code for the interface and platform-specific code for Android to handle camera access and barcode processing.

Testing

The testing phase is important to ensure the functionality of the mobile application. It is considered a crucial component as it tests the functionality of every system component. In addition, any errors or bugs found during this period will be fixed. The testing is performed for this mobile application to evaluate the user interface and experience to ensure ease of use. The test includes sign-in, user registration, editing profiles, adding new products, scanning products, and product details functionalities.

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Results

The application processes barcode scans and returns results within 2-3 seconds, ensuring a smooth and efficient user experience. Figure 9 shows the result after a product barcode is scanned. It shows that the product contains harmful ingredients to eczema users.

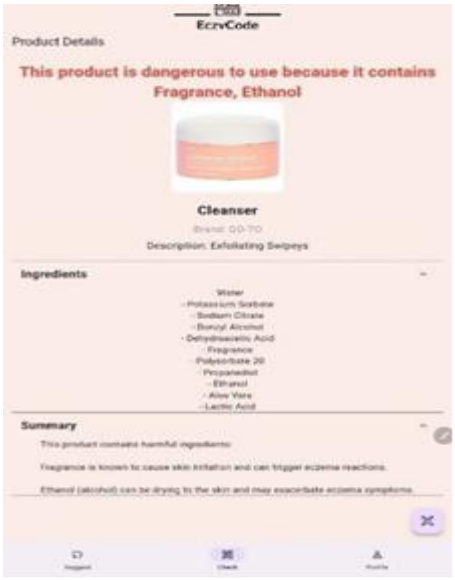

Figure 9: Result of Barcode Reading

In addition, the database can be updated regularly by the administrator using the interface shown in Figure 10 to incorporate the latest research to maintain data accuracy.

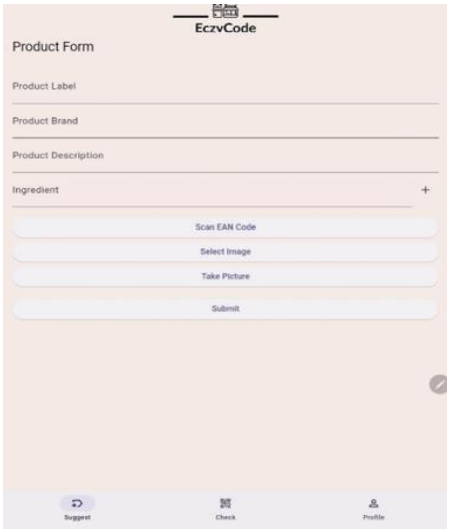

Figure 10: Add new product interface

To make sure the system functions behaviorally, each use case for the user is thoroughly evaluated in this phase. Table 1 shows the result of test cases for the application functionality testing. Every test case is passed and it shows the application's reliability and effectiveness.

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Table 1: Test Cases Result

No	Test Case	Expected Result	Actual Result	Result
1.	The user or administrator input the username and password.	The user or administrator successfully entered the application.	The user or administrator successfully entered the application.	Pass
2.	The user clicks the barcode button.	The phone camera is open and ready to scan the product barcode.	The application successfully scans the barcode and displays product information and whether the product is harmful or contains safe ingredients.	Pass
3.	The administrator adds a new product.	The new product is added successfully, and the product list is updated.	The new product is added successfully, and the product list is updated.	Pass
4.	The administrator adds a new ingredient to the database.	The new ingredient is added successfully, and the ingredient list is updated	The new ingredient is added successfully, and the ingredient list is updated.	Pass
5.	The administrator edits the details of an existing ingredient.	The ingredient details are updated successfully.	The ingredient details are updated successfully.	Pass
6.	The administrator deletes an existing ingredient from the database.	The ingredient is deleted successfully, and the ingredient list is updated.	The ingredient is deleted successfully, and the ingredient list is updated.	Pass

Conclusion

A rule-based barcode mobile application for checking harmful eczema ingredients provides an innovative solution for individuals with eczema to avoid products that may trigger flare-ups. This application integrates a database of ingredients classified as harmful or safe based on literature. By scanning product barcodes, users can quickly retrieve ingredient lists and receive immediate feedback on potential eczema triggers. This tool empowers users with eczema to make better decisions, reducing flare-ups and increasing awareness about ingredient safety in everyday products.

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