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Information System For Calculating Daily Sugar Limit In Packaged Beverages With Prototype Method

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Abstract – Excess sugar consumption is a global concern as it plays an active role in increasing the risk of non-communicable diseases (NCDs) such as obesity, type 2 diabetes and heart disease. In Indonesia, intense consumption of sugary packaged drinks is influenced by lifestyle changes and low public awareness of its impact. This study develops a web-based system to help users determine the safe limit of consumption of packaged sugary drinks, based on daily calorie needs calculated using the Mifflin-St Jeor formula. the application was designed using the prototype method to ensure interactive and user-oriented development. Assessment conducted through the System Usability Scale (SUS) method indicated that the prototype achieved an average score of 76.6, placing it in the 'Good' classification with a Grade B rating. This finding proves that the system has a good level of usability and is acceptable to users. This system has the potential to become an educational media that supports increasing public awareness of the dangers of excessive sugar consumption, through providing information that is easily accessible and easy to understand, and is expected to contribute to efforts to prevent non-communicable diseases (NCDs) in Indonesia.

Keywords – Sugar, Packaged Beverages, Non-Communicable Diseases, Prototype

I. INTRODUCTION

Excessive sugar consumption has become a global concern in recent years. Sugar, which is commonly used as an added sweetener in a wide variety of beverages and food products, can have adverse health effects if consumed in excess. World Health Organization (WHO) has warned that sugar consumption beyond safe limits can lead to an increased risk of obesity, type 2 diabetes and coronary heart disease. [1]. This warning is all more serious because people's diets tend to change, with the consumption of foods and beverages containing high sugar content becoming more prevalent. [2].

This phenomenon is of concern in Indonesia. Non-communicable diseases (NCDs) such as obesity and diabetes mellitus, which were once more common in developed countries, are now rising sharply in developing countries such as Indonesia. [3]. According to data from Global Burden of Disease 2019 and Injuries Collaborators 2020, NCD are the cause of 80% of death cases in Indonesia in just five years [4], One of factors for high number of NCD is pattern of public consumption, particularly the high consumption sugar-sweetened packaged beverages (SSB). Based on research, Indonesia ranks third in Southeast Asia with consumption of packaged sweetened drinks of 20.23 liters per person [5].

This problem is driven by the increasing consumption of sugar-rich packaged beverages, which have become an easily accessible option for people of all ages and socioeconomic backgrounds. [6], which makes it one of the main causes of the high rate of diabetes in society, this can worsen the health situation, resulting in a variety of diseases associated with excess sugar consumption.

Several previous studies have developed various applications to help calculate daily calorie needs and healthy diet planning. OnTrack [7] using CNN and UCD methods with food recognition features, gamification, and meal plan recommendations for teenagers aged 17-21 years, with excellent usability test results (score 79.5).[8] designed an R&D-based android application that provides clear calorie information and received a positive user response. [9] uses fuzzy logic to provide menu suggestions based on an individual's nutritional status based on anthropometric and daily activity inputs. [10] developed the prototype-based Go Healthy Life, with features of calorie calculation, BMI, and online nutrition consultation, which proved to be effective and accurate with a 92% success rate. Meanwhile, the Bowll application [11] It is built using the waterfall method, provides calorie estimation as well as BMI calculation, and the application can show a positive response to user needs.

From various previous studies have developed applications to support a healthy lifestyle, but no one has specifically discussed related to the daily sugar intake limit in consuming packaged beverages based on user characteristics, using calorie calculations. Previous studies have tended to focus on food in general or calorie counting without highlighting the specific impact of sugar consumption in sugary drinks, which is a contributor to health risks such as obesity and diabetes.

This research aims to develop a web-based application designed to help people calculate the safe limit of consuming packaged sugary drinks based on user characteristics. In addition, this research also focuses on evaluating the effectiveness of the application, as well as increasing public awareness about the dangers of excessive sugar consumption and helping to manage daily sugar intake more wisely. This application is equipped with education to provide a deeper understanding of the health impacts of excessive sugar consumption.

Web application was developed using the prototype method, which allows developers and users to interact continuously during the development process, resulting in a more organized application [12]. Through this strategy, application development can be more flexible and responsive to user feedback at every stage. For calorie calculations using the Mifflin-St Jeor formula, which considers aspects such as age, gender, weight, height, and level of physical activity [13]. In addition, to assess the level of user usability of the developed application, the

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System Usability Scale (SUS) evaluation method was used. This method was chosen because it has been proven as a reliable and simple measuring tool in evaluating user perceptions of the ease of use of the system, as well as providing a quantitative description of the usability quality of the resulting prototype [14].

II. RESEARCH METHODOLOGY

in development of web applications, using prototype method. In this process, a design flow is needed to explain each component and process involved to provide a clear picture of how the system is designed and implemented.

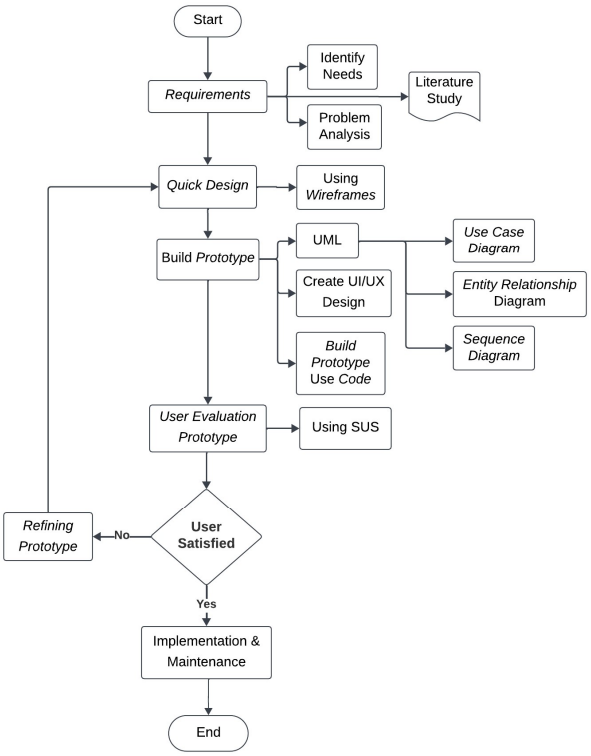

Fig 1. Research flow

A. Requirement

Identification of needs is carried out to determine and ensure that all components, both hardware and software, are available and according to the specifications needed so that the research process can run smoothly.

In this research, using literature study as a collection of needs, this is done by searching various sources such as journals, where the collected literature material is evaluated to ensure its suitability for the ideas and hypotheses developed [15].

Next, a problem analysis is conducted as a way to understand and identify the problem. purpose of the analysis is to find the root of the problem, assess its impact, and formulate an effective solution. This process is according to the results of literature study, which is then processed to identify knowledge gaps or certain aspects that have not been implemented in previous research [16].

B. Quick Design

At the design stage, wireframes are used to design user interface. Wireframes provide the basic structure and main elements of application page without paying attention to visual details such as color or typography [17]. use of wireframes helps in visualizing the page layout and information structure, thus facilitating the design validation process before entering UI/UX design stage.

C. Build Prototype

In making prototype, using Unified Modeling Language (UML) to visualize the system created. author uses three types of UML diagrams, namely:

- Use Case Diagram, is utilized to illustrate how actors interact with the primary functions offered by the system.
- Entity Relationship Diagram (ERD), serves to model data structure and relationships among the entities within the system.
- Sequence Diagram, this diagram is used to show interactions between objects in the system according to time sequence. This diagram will help model interactions between the user, web interface, and database.

The process of creating UI/UX to provide a clearer picture of the final appearance of the web application. UI/UX implementation will focus on principles such as, design consistency, accessibility, and simplicity.

in making this prototype, the author uses coding to design system, which has been made previously. in its implementation, the author utilizes Tailwind CSS as a CSS framework to speed up the interface design process. also, author also uses Next.js as a JavaScript framework that helps develop web applications with high performance.

D. User Evaluation prototype

Prototype evaluation is carried out to assess the quality of prototype based on level of usability. This evaluation is to identify strengths and weaknesses of prototype based on user feedback.

In usability assessment using the System Usability Scale (SUS), this method consists of ten statements that are assessed after user uses the system using a Likert scale from 1 which means strongly disagree to 5 which indicates strongly agree [18], With questions like these.

Table 1. SUS question

No	Questions	Reference Source
1	I would be happy to use this system again.	[19]
2	I feel the system is complicated to use.	[19]
3	I find this system easy to use.	[19]
4	I need help from other people or technicians in using this system.	[19]
5	I feel that the features of this system are working properly.	[19]
6	I feel that there are many inconsistencies (mismatches in this system).	[19]
7	I feel others will understand how to use this system quickly.	[19]
8	I find this system confusing.	[19]
9	I feel no obstacles in using this system.	[19]
10	I need to familiarize myself first before using this system.	[19]

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as illustrated by the questions listed above. Subsequent section outlines the SUS score adjustment process:

- For odd numbered questions (positive questions), score is reduced by 1.
- For even numbered questions (negative questions), score minus 5.
- Total scores are then summed, converted to a 0-100 scale, and result is multiplied by 2.5.

Then to determine the category of system, a sus assessment is used as shown in the following figure.

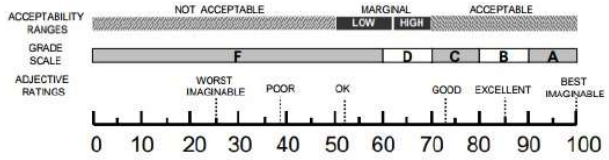

Fig 2. SUS score

For prototype assessment, we will select age group under 17 years old. based on Yayasan Lembaga Konsumen Indonesia (YLKI) in June 2023 in 10 cities in Indonesia, it was found that 25.9% of children under 17 years old consume sugar-sweetened packaged beverages (SSB) every day. In addition, 31.6% of children in this age group consume SSB 2 to 6 times a week. This shows that age group under 17 years old is a suitable segment to be targeted in the prototype assessment.

E. Refining Prototype

After SUS evaluation is conducted, the results will determine whether prototype gets a C or D grade, which states that prototype needs improvement. These improvements include feature enhancements, or interface design, and then will be re-evaluated so that the results show improvement [20]. if prototype meets specified usability standards such as getting grade A or B which indicates prototype is feasible to use, then the next step can be done.

F. Implementation & Maintenance

After prototype has passed the evaluation, prototype is considered ready to be implemented into the full development stage. for this stage, author will host the results of this prototype to the website publicly so that it can be used directly by users. hosting is done to ensure the application can be accessed by users.

III. RESULTS AND DISCUSSION

Research findings obtained based on the methods previously described in making, Information System for Calculating Daily Sugar Limit in Packaged Beverages with Prototype Method.

A. Requirement

Based on the results of literature study, previously developed applications focus on calculating total calories of food and beverages, without paying special attention to the impact of sugar consumption in packaged sweet drinks. in addition, in terms of education, there are not many applications that present information about the dangers of sugar consumption, either in the form of articles or videos.

Therefore, author proposes several solutions, by developing a web-based application that can calculate safe limit of daily sugar consumption, providing educational content in the form of online articles and videos, focusing information on sugar content in various types of packaged sweet drinks, and providing recommendations for drinks that are suitable and safe for consumption based on the needs of each individual.

B. Quick Design

Design drawings of the proposed system. following is a complete description of the system design based on wireframe images that have been made.

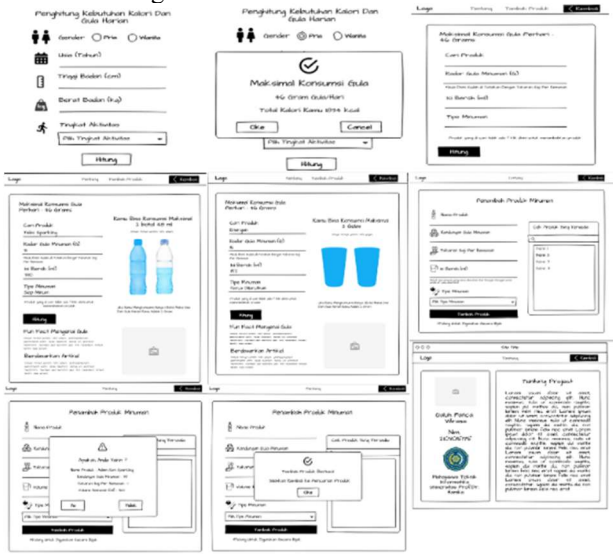

Fig.3 Wireframe

Input page is designed to be simple, consisting of columns such as gender with radio button options for “Male” or “Female”, age, height, weight, and physical activity level selected through a dropdown menu, the system will display the calculation results of the amount of daily sugar consumption and daily calories based on these data.

After user obtains calculation result, user selects the beverage product. system will display results of calculation amount sugar consumption product, complete with visual illustrations in the form the number of bottles or cups that illustrate maximum consumption limit. It is also equipped with educational information related to sugar, such as fun facts, online articles, and videos.

In addition, users can also add beverage product data through input form, and on the right side, there is a search panel, helping users to view and search list of beverage products that already exist in database system.

about page, contains application developer information as well as project objectives. on the left, there is a photo of creator, name, student number, and identity information. on the right, there is a project description, which explains background and purpose of creating a web.

C. Build Prototype

in this prototyping stage, using 3 stages, namely making UML, making UI/UX design and implementation using code, here are the results.

1. UML (Unified Modelling Language)

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a. Use Case Diagram

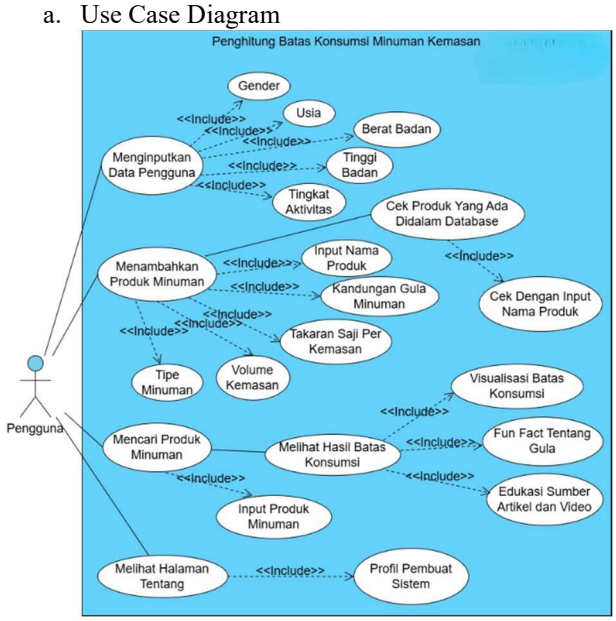

Fig. 4 use case diagram

on this diagram, users can perform various activities, such as entering personal data (gender, age, weight, height, and activity level) to calculate daily calorie and sugar requirements. In addition, users can search and add beverage products. system also offers features such as checking available products in database, visualization of consumption limits, presentation of interesting facts about sugar, and education through articles and videos. there is also an about page, to view profile of system creator.

b. Entity Relationship Diagram (ERD)

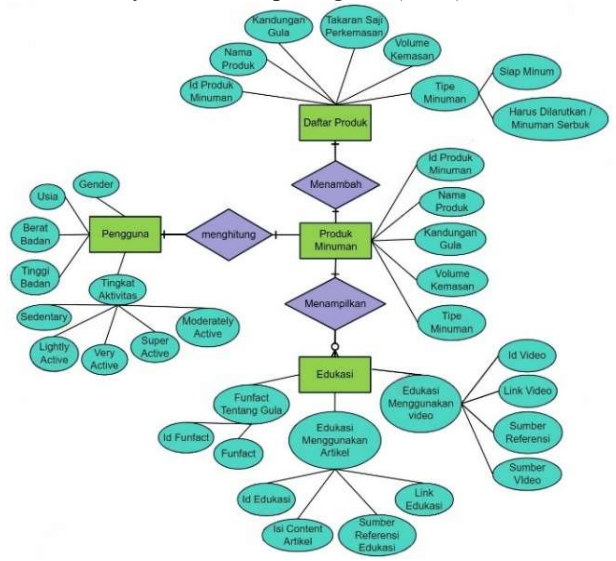

Fig. 5 entity relationship diagram

This ERD illustrates relationship between main entities in the system, namely Users, Product List, Beverage Products, and Education. each entity has a certain role in helping overall usability of the system.

User entity is the main actor who interacts with system, which has attribute to calculate calorie requirement and daily sugar limit for certain beverage products through calculation relationship process.

Product List entity contains information related to beverage products, such as product name, sugar content, serving size per package, package volume, and beverage type, which are related to Beverage Products through the process of adding, where the product list becomes data source in product recording.

Beverage Product is related to Education through the display process, which indicates that after beverage product is calculated, system will provide educational information related to sugar consumption, either through articles, videos, or fun facts, complete with source references.

c. Sequence Diagram

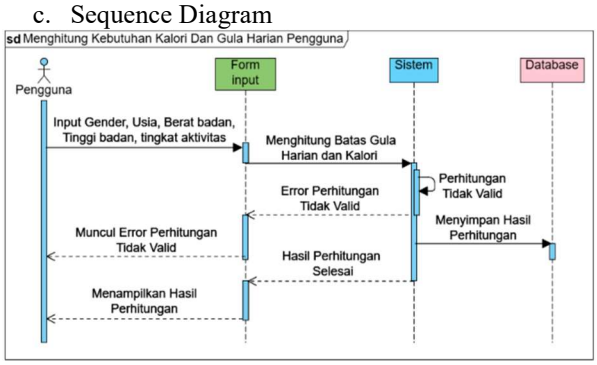

Fig. 6 calculate user daily calorie and sugar

Page calculates the user's daily calorie and sugar needs, this sequence diagram shows flow of interactions between user, input form, system, and database in process of calculating daily sugar and calorie consumption limits. data entered by user is processed by system, then results are stored in database and displayed. if data is invalid, system will display an error message for correction.

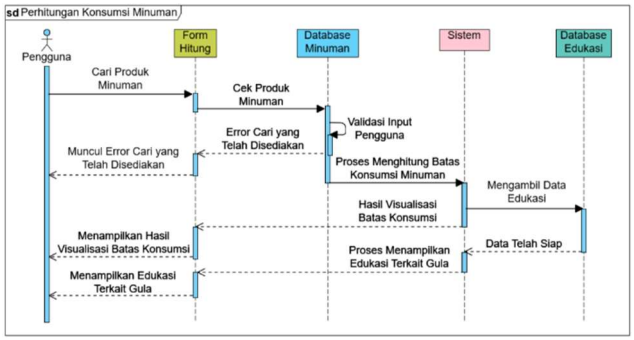

Fig. 7 determining bottled consumption and education

Calculation page to determine the consumption of bottled and educational drinks, this Sequence diagram is interaction between user, calculation form, system, and database. user searches for beverage products, then system verifies through database. if the product is not found, an error message appears. if available, system processes data and calculates consumption limit based on user input. calculation results are displayed in form of a visualization of a bottle or cups, accompanied by educational information related to sugar.

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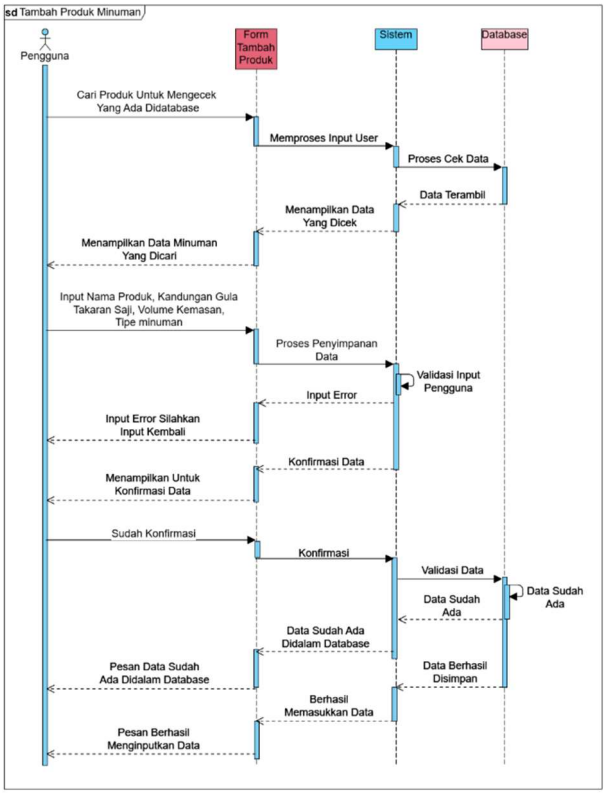

Fig. 8 add beverage products

Add beverage product page, illustrates flow of adding beverage products. user can check availability of product in database. system validates input, displays an error message if an error occurs, and requests a correction. Once valid, system displays a confirmation and again checks for data duplication. if data does not exist, system saves information and provides a success message. This process ensures data validity, prevents duplication, and provides feedback to user.

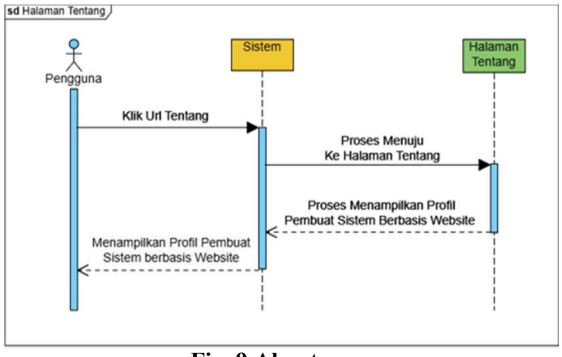

Fig. 9 About page

About Page, this sequence diagram shows interaction when a user accesses profile page. It starts when user clicks URL to about page, system processes request, then displays profile information in user interface.

2. Create UI/UX Design

UI/UX design is focused on aspects of visual consistency, accessibility, and interface simplicity to support improved user experience. Following are the results of UI/UX design that has been made.

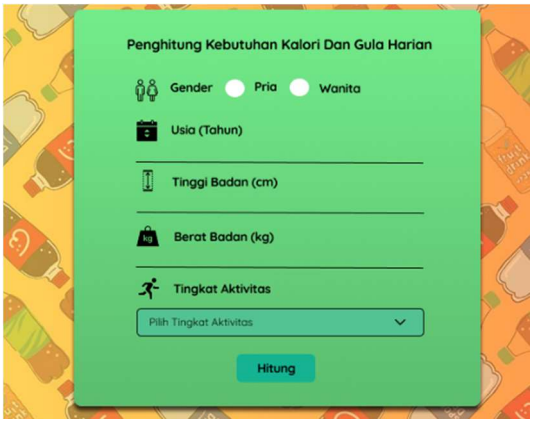

Fig. 10 calculate user daily calorie and sugar

Interface of this daily calorie and sugar requirement is designed simply, with the use of green gradation colors, supported by icons that clarify each input such as age, height, and weight, with elements arranged vertically. selection of elements such as radio buttons and dropdowns to facilitate interaction.

Fig. 11 calculation result

Calculation result display, presents information with the use of green color. Important numbers such as sugar consumption and calories are displayed to stand out with different colors. messages are displayed in an easy-to-understand manner, with buttons to continue interaction.

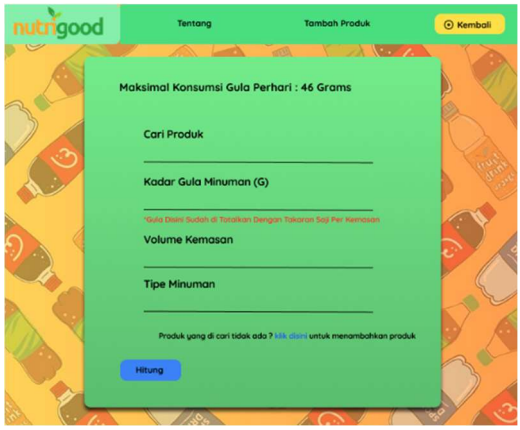

Fig. 12 Find Beverage Products

A form for calculating beverage consumption, a beverage search feature with a sequential layout, for users

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to fill in information such as sugar content, package volume, and beverage type. a consistent green color maintains visual continuity, with red text emphasis to warn users of serving sizes. daily sugar consumption limit information is displayed at the top, and there is also an option to add products.

Fig .13 Ready to Drink Type Calculation Result

This view presents beverage consumption results with a two-column structure. The left side contains input data, while right side displays visual results of number of bottles that can be consumed, complete with illustrations that facilitate understanding. use of the right color and text size helps to highlight important information. It is also equipped with fun facts, education through articles and videos about sugar.

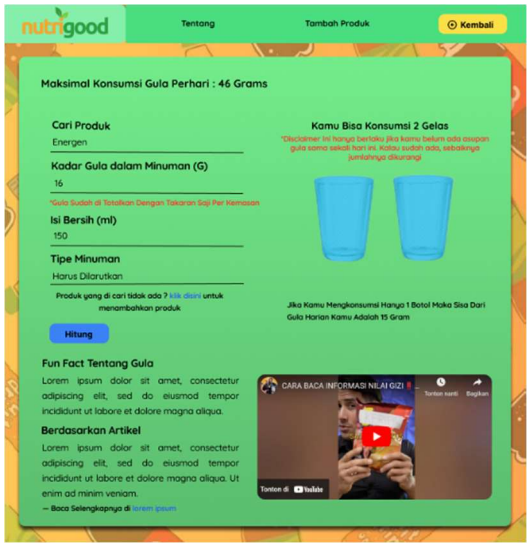

Fig. 14 Type Calculation Result Must be Dissolved

This display is same for presenting the results of beverage consumption, difference being type of beverage that "must be dissolved" or powdered beverages. displays the visual results of the number of cups that can be consumed.

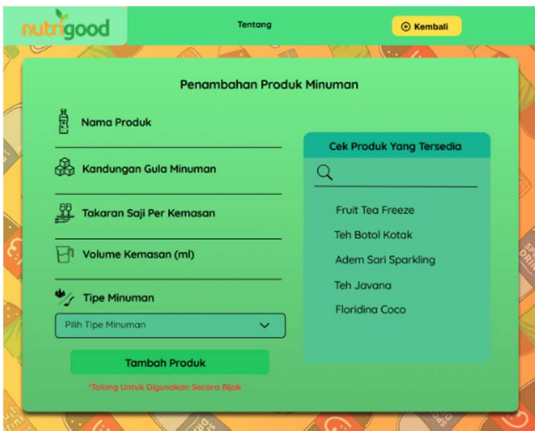

Fig.15 Add beverage products

This view was created to add beverage product data. Icons on each field help clarify the input function. the right side displays a list of available products with a search feature. this design supports data completeness and ease of user navigation.

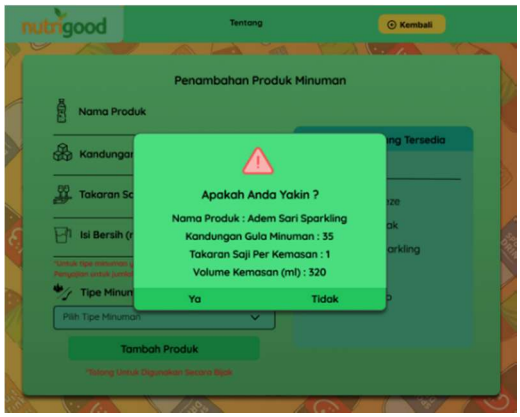

Fig.16 Confirm add beverage product

Displays a confirmation modal box before the product data is saved. with a warning icon that signals importance. Product information is displayed, making it easy for users to double-check. This can provide control and clarity, preventing input errors before data is submitted.

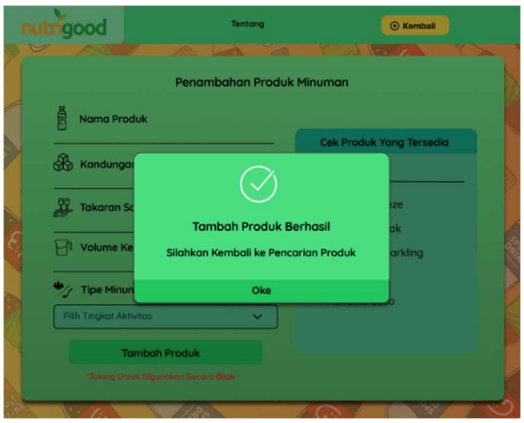

Fig.17 Add product successfully

Shows a success notification after the product has been successfully added. with an icon that confirms success message. instruction text directs user to the next step. this provides clear feedback and no confusion.

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Fig.18 About Page

This view contains personal information and project description with a balanced two-column layout. left side displays the author's profile with name, NIM, and institution, accompanied by author's photo. right side contains a brief explanation of purpose and benefits, making it easier for users to understand context of application. this serves as an introduction to purpose of using the system.

3. Build Prototype use Code

Prototype is developed using coding according to previously design. Core of this system use mifflin-st jeor formula to calculate daily calorie needs. this aims to determine amount of daily sugar limit. following are the calculation stages in the application.

1. System requests inputs from user, such as, Age, Gender, Weight (in kg), Height (in cm), and Physical activity level.
2. Based on data provided by user, system uses Mifflin-St Jeor formula to calculate BMR by adjusting formula for men or women, example, if a man is 30 years old with a body weight of 70 kg and a height of 175 cm. then BMR = (10 × 70) + (6.25 × 175) - (5 × 30) + 5 = 1648.75 kcal/day.

```
// jika radio button Laki-Laki terpilih
if (male.current?.checked) {
  // jika isi radio button berupa "male"
  if (male.current?.value === "male") {
    // maka rumusnya ini
    BMR = 10 * weight + 6.25 * height - 5 * age + 5;
  }
}
// jika radio button perempuan terpilih
if (female.current?.checked) {
  // jika isi radio button berupa "female"
  if (female.current?.value === "female") {
    // maka rumusnya ini
    BMR = 10 * weight + 6.25 * height - 5 * age - 161;
  }
}
```

Fig. 19 BMR calculation code based on gender

3. Adjustment to Activity Level (TDEE), calculated BMR value is then multiplied by activity factor based on user's activity level to obtain daily calorie requirement. For example, if user chooses an activity level of "ModeratelyActive", then TDEE = 1648.75 × 1.55 = 2555 kcal/day.

```
// variabel kosong untuk menampung nilai
let activityFactor;
// cek nilai dari tingkat aktifitas
// jika tingkat aktifitas "sedentary"
if(activityLevel.current?.value === "sedentary"){
  // maka "activityFactor = 1.2" akan mengisi nilai
  activityFactor = 1.2
} else if (activityLevel.current?.value === "lightlyActive"){
  activityFactor = 1.375;
}else if (activityLevel.current?.value === "moderatelyActive"){
  activityFactor = 1.55;
}else if (activityLevel.current?.value === "veryActive"){
  activityFactor = 1.725;
}else if (activityLevel.current?.value === "extraActive"){
  activityFactor = 1.9;
}
// lalu variabel TDEE menyimpan jumlah kalori perhari
const TDEE = BMR! * activityFactor;
```

Fig.20 Calculating TDEE based on activity level

4. Based on TDEE value, app calculates daily sugar consumption limit according to WHO guidelines, which is 10% of total daily calories. For example, if TDEE is 2555 kcal, then calorie limit is 2555 × 0.1 = 255.5 kcal. since 1 gram of sugar is equivalent to 4 kcal, daily sugar consumption limit is 255.5 ÷ 4 = 63 grams of sugar per day. These results are then saved into the browser's local storage using localStorage.

```
// untuk menghitung jumlah gula perhari
  const kalori = TDEE * 0.1 // berdasarkan pedoman WHO 10%
  // hasil kalori dibagi 4 karena 1 g gula = 4 kalori
  const maxGulaPerhari = kalori / 4;
  // untuk menyimpan ke penyimpanan lokal browser
  localStorage.setItem("maxGula", String(maxGulaPerhari));
```

Fig. 21 Calculate daily sugar limit from TDEE

5. After obtaining daily sugar consumption limit, user selects a beverage product. for example, user selects Product A, which contains 22 grams of sugar in 300 ml, then sugar content per 1 ml is calculated by dividing total sugar content and total contents of drink, which is 22 / 300.

```
// untuk mengambil data gula harian pengguna
useEffect(() => {
  const maxSugars = localStorage.getItem("maxGula");
  if (maxSugars) {
    setMaksimalGulaHarianPengguna(Number(maxSugars));
  }
}, []);
//ubah total gula menjadi per 1 ml
const gulaPerSatuML = kandunganGulaDidalamProduk / totalIsiMinuman;
```

Fig.22 Take sugar data & calculate per ml

6. Calculate number of bottles that can be consumed by dividing user's daily sugar consumption limit by sugar content per 1 ml, then dividing result by total contents of drink, and rounding the result.

```
// menghitung jumalah botol yang datap dikonsumsi
const maxKonsumsiPerMl = maksimalGulaHarianPengguna / gulaPerSatuML;
// hasilnya dibulatkan kebawah
const jumlahBotol = Math.floor(maxKonsumsiPerMl / totalIsiMinuman);
```

Fig. 23 Number bottles can consume

7. Calculate the remaining consumption in ml using modulus (%) to obtain amount of drink that is not enough to fill a full bottle. remainder is then converted into a percentage of total contents of one bottle or cup, which is then used for CSS masking styling purposes. If there is a remainder, then that percentage will be added as the last element in the array, representing an additional bottle with the remaining available consumption.

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```
// menghitung sisa konsumsi
const remaining = maxKonsumsiPerMl % totalIsiMinuman;
// sisa tersebut dikonversi ke dalam persen
const percentageFillForRemaining = Math.round(
  (remaining / totalIsiMinuman) * 100
);
// jumlah botol diubah menjadi array
// yang diisi 100 disetiap botol yang ada
const isiArray: number[] = Array(jumlahBotol).fill(100);
// jika terdapat sisa maka array "jumlahBotol"
// diisi oleh variabel ini "berapaPersenYangTersedia"
if (berapaPersenYangTersedia > 0) {
  isiArray.push(berapaPersenYangTersedia);
}
```

Fig. 24 Remaining consumption in percent

With this code, app can calculate the user's daily sugar consumption limit based on calorie needs, convert it into units of beverage bottles, and display remaining consumption visually, providing clear instructions.

D. User Evaluation prototype

Evaluation was conducted using the System Usability Scale (SUS). The data collection process was carried out online through distributing questionnaires using Google Form to respondents with a total of 38 respondents, the majority of whom were aged 17 years and under. This questionnaire produces a total SUS score from each respondent, which is then processed to get an average score, for more details the evaluation results are as follows.

Table 2. Result answer of SUS question

Q	Answer to the Question				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Q1	0	0	1	21	16
Q2	3	30	5	0	0
Q3	0	0	3	28	7
Q4	5	26	4	3	0
Q5	0	0	1	15	22
Q6	17	14	5	2	0
Q7	0	3	8	20	7
Q8	8	23	5	2	0
Q9	0	0	2	18	18
Q10	1	20	9	7	1

After all the data is collected, the value of each odd question is subtracted by 1, and the value of even questions is subtracted by 5. Next, the results of all questions are summed up, then multiplied by 2.5. Finally, the values are averaged to obtain a final score that represents the overall usability level of the system.

Table 3. Sus score result

Q	Answer to the Question					
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
Q1	0	0	2	63	64	129
Q2	12	90	10	0	0	112
Q3	0	0	6	84	28	118
Q4	20	78	8	3	0	109
Q5	0	0	2	45	88	135
Q6	68	42	10	2	0	122
Q7	0	3	16	60	28	107
Q8	32	69	10	2	0	113
Q9	0	0	4	54	72	130
Q10	4	60	18	7	0	89
Total Score						1164
Multiplied by 2.5						2910
Final Result Total Overall SUS Score (average)						76.6

The evaluation results show that system obtained an average score of 76.6 based on SUS interpretation classified as a “Good” category, with grade B and included in Acceptable range. this shows system is considered very easy to use and well received by users.

E. Refining Prototype

Based on the results of user evaluation by utilizing the System Usability Scale (SUS) method, prototype achieved an average score of 76.6. The score is included in “Good” category and is at grade B, which indicates that system has a good level of usability and is acceptable to users. Thus, no major revisions are needed to prototype design, because it has met the expected usability standards.

F. Implementation & Maintenance

Results of the fully finished prototype will be publicly hosted so that it can be used directly by users. hosting process is carried out by utilizing various free and paid hosting service provider platforms by being hosted online, the application can be accessed by anyone via internet network, without need for additional installations on the user's device.

This step aims to test the performance of application in real conditions to ensure that all application features work well on various devices and networks. hosting also makes it easier for the development team to further develop and improve the system.

With availability of prototypes available online, users can easily access and try application anytime and anywhere, so that the reach of users becomes wider and more flexible.

IV. CONCLUSION

After designing and evaluating a prototype web-based application to help people calculate the safe limit of consuming packaged sweetened drinks. by emphasizing usability aspect as the main parameter, with evaluation results using SUS obtained an average score of 76.6, which is categorized as “Good” and included in Grade B. These findings indicate that the interface design and interaction flow implemented have met the standards of user comfort and efficiency.

Scientifically, this work contributes to the field of software engineering and health with a primary focus on user evaluation. Practically, it also plays a role in increasing public awareness of the dangers of excessive sugar consumption and providing tools to manage daily sugar intake more wisely.

This research has limitations, especially regarding the number of respondents in the evaluation process. In addition, evaluation used is still limited to quantitative methods, so it does not fully describe the personal experience of users in depth.

In the future, it is recommended to expand scope of testing by involving more participants from diverse backgrounds so that the findings can be applied more widely. implementing qualitative evaluation methods such as interviews or direct observation, should be realized to

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gain a more thorough understanding of user needs and perceptions.

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