Tamang Kape: Rule-Based Caffeine Monitoring Mobile System with Intelligent Consumption Guidance and Alerts

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CHAPTER 1: INTRODUCTION

In today's rapidly changing and high-paced world, certain staples of daily life have withstood the test of time, evolving alongside humanity while retaining their core essence. One such staple is a widely consumed beverage first formally identified in the 18th century by Swedish botanist Carl Linnaeus. This beverage, coffee, is a complex blend of over a thousand chemical compounds, many of which offer subtle yet profound benefits to human health and well-being. Known for its stimulating properties, coffee works by blocking adenosine, an inhibitory neurotransmitter in the brain, thereby enhancing cognitive performance, boosting mood, and potentially combating depression.

While coffee is often celebrated, it is not the sole focus of this study. Instead, attention is drawn to its most prominent active ingredient: caffeine. Caffeine is a natural stimulant not only found in coffee but also in a wide variety of consumables, including tea, cocoa, cola, energy drinks, and even certain medicinal products. Its versatility and ubiquity make it one of the most consumed psychoactive substances globally. Beyond its ability to increase alertness, caffeine's antioxidant properties and role in improving concentration have cemented its place in many aspects of daily life.

Despite its benefits, caffeine consumption is not without drawbacks. It has become a go-to solution for many individuals seeking to stay awake, enhance focus, or energize themselves during demanding tasks. A morning cup of coffee, a mid-day energy drink, or a late-night tea to push through a deadline are common scenarios. However, the long-term implications of frequent and high caffeine intake remain underexplored. Research has shown that excessive consumption can lead to negative health outcomes such as heightened anxiety, elevated stress levels, and interference with sleep quality. For example, consuming caffeine within six hours of bedtime has been linked to reduced sleep duration and disrupted sleep patterns, which can have compounding effects on physical and mental health.

Recognizing the need for a practical solution, this study presents Tamang Kape, an innovative, rule-based mobile application designed to help users manage their caffeine intake intelligently. The system combines real-time tracking with personalized consumption recommendations and alert mechanisms to prevent overconsumption and mitigate potential adverse effects. By employing a rule-based approach, Tamang Kape equips users with the tools to make informed decisions about their caffeine habits, fostering improved health outcomes both in the short and long term.

Through the integration of advanced tracking technologies and intuitive guidance, this research aims to bridge the gap between caffeine's beneficial uses and its potential risks. Ultimately, Tamang Kape aspires to empower individuals to maintain a healthier relationship with caffeine, enhancing both productivity and overall well-being.

Objective of the Study

The objective of this study is to develop a Rule-based caffeine monitoring mobile system that can monitor the caffeine intake of the user so they can prevent the effects of caffeine overdose.

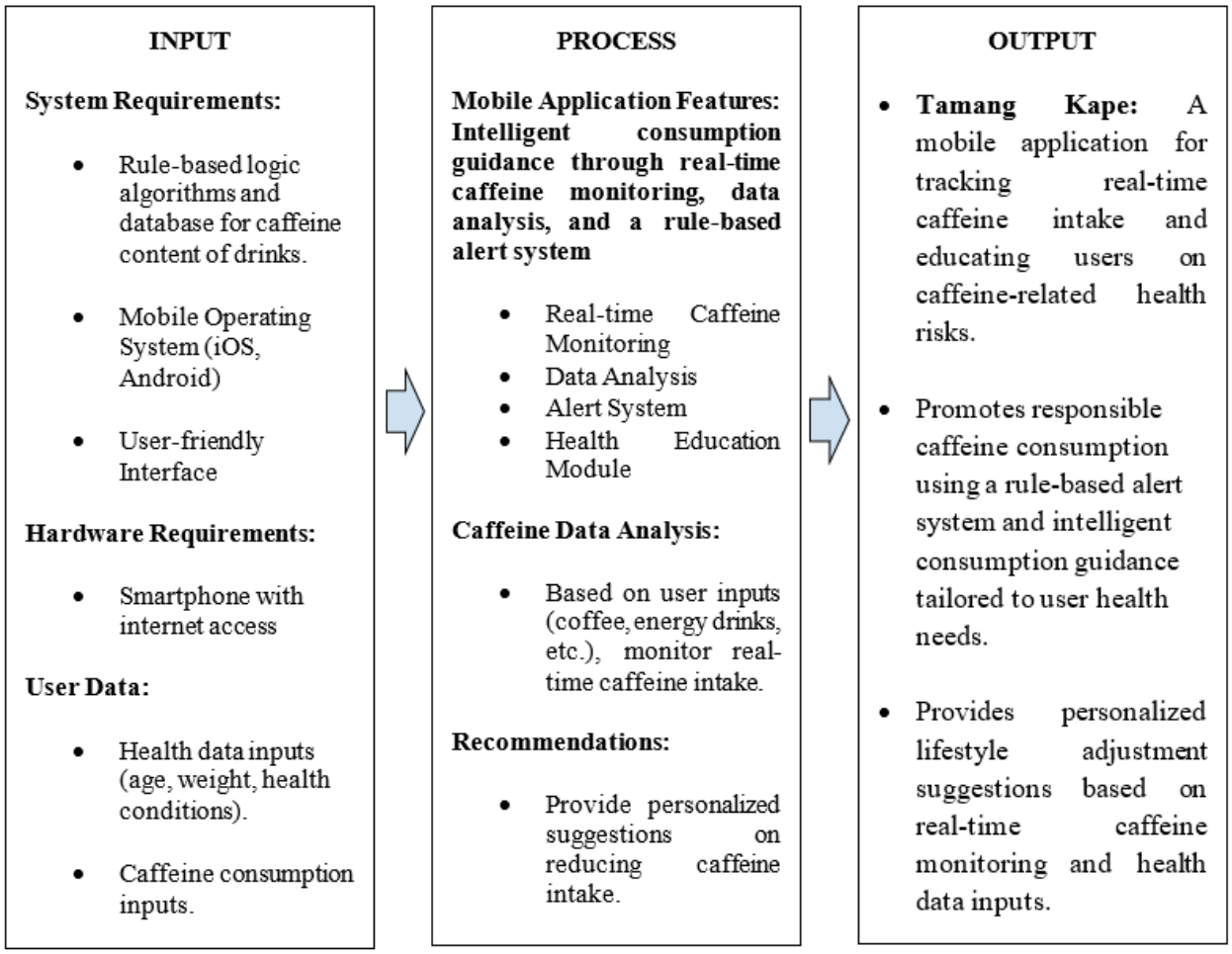
Specific Objectives:

Develop a user-friendly mobile application that integrates a real-time rule-based system for monitoring daily caffeine intake and providing personalized guidance through alerts and feedback to prevent health issues.

To integrate health education and preventive measures into the application, offering users information on the negative effects of caffeine overdose, tips for reducing intake, and recommendations for maintaining a balanced, healthy lifestyle while managing caffeine consumption.

Provide notification features through SMS and email, enabling the application to alert users about their caffeine intake status, send reminders, and deliver personalized recommendations for better management of caffeine consumption.

Conceptual Framework



Significance of the Study

This study is significant as it addresses the growing concern over the widespread consumption of caffeine through many caffeinated beverages. With caffeine being a part of many individuals' daily lives, unregulated consumption can lead to health risks such as high blood pressure, heart complications, and sleep disturbances. By developing a mobile application that monitors caffeine intake in real-time, this study offers a practical solution to prevent caffeine overconsumption and its associated health risks.

This study holds potential benefits for the broader public health domain by contributing to the reduction of caffeine-related health issues, thereby improving overall wellness in populations with high caffeine intake. The results of this study will benefit the following:

End Users

The application will provide real-time tracking and personalized alerts, empowering end users to manage their caffeine intake effectively. This can help reduce the risk of health problems such as high blood pressure, anxiety, unbalanced sleep, and cardiovascular issues.

Healthcare Professionals

Healthcare providers can use the application as a preventive tool to support patients at risk of caffeine-related health complications. It will facilitate better self-management among patients, potentially reducing the need for medical interventions related to caffeine overdose.

Future Researchers and Developers

The study will serve as a reference for future researchers and developers interested in creating real-time health tracking systems. It offers insights into the design, implementation, and application of such systems, potentially inspiring further innovation in this domain.

Scope and Limitations

This study focuses on developing a rule-based mobile application to track caffeine intake in real-time, aiming to prevent overconsumption and related health risks. The application will primarily monitor caffeine consumption from beverages such as coffee and energy drinks, providing users with alerts when their intake approaches unhealthy levels. The primary target audience includes college students and professors who often rely on caffeine to cope with intense academic demands, potentially leading to sleep disturbances, anxiety, or cardiovascular issues.

The application's effectiveness depends on users accurately recording their caffeine intake, which can result in errors if data is incorrectly entered. Additionally, the system is designed to monitor caffeine from beverages, which may overlook other sources such as food or medications. It requires a stable internet connection to deliver real-time alerts, limiting functionality in offline environments. As individual reactions to caffeine vary, the app's warnings may not be universally applicable, potentially reducing its effectiveness for some users.

Definition of Terms

Adenosine – A nucleoside and neurotransmitter that plays a crucial role in promoting sleep, regulating energy levels, and maintaining cellular function throughout the body.

Adverse Effects – Undesirable or harmful outcomes resulting from a particular action, substance, or condition, such as side effects from excessive caffeine consumption.

Alert Mechanism – A system or feature designed to notify or warn users about specific conditions or thresholds, such as excessive caffeine intake.

Anxiety – A mental health condition characterized by feelings of worry, nervousness.

Antioxidants – Substances that neutralize free radicals, which are unstable molecules that can damage cells and other structures in the body.

Caffeinated Beverages – Drinks that contain caffeine, a natural stimulant, commonly found in coffee, tea, energy drinks, and soft drinks. Caffeine is known for its effects on alertness and concentration.

Caffeine – A natural stimulant that primarily affects the central nervous system, promoting alertness and reducing fatigue. Found in coffee, tea, chocolate, soft drinks, energy drinks, and certain medications, caffeine is one of the most widely consumed psychoactive substances in the world.

Caffeine Intake – The amount of caffeine consumed by an individual from various sources such as coffee, tea, energy drinks, and certain foods or medications.

Caffeine Overdose – Occurs when an individual consumes an excessive amount of caffeine, leading to symptoms such as restlessness, rapid heartbeat, high blood pressure, nausea, or even more severe health issues.

Cronbach Alpha – A measure of internal consistency or reliability of a set of items.

End User – A person or other entity that consumes or makes use of the goods or services produced by businesses.

Health Information – Data and knowledge related to physical, mental, or social well-being.

Health Risk – The probability or likelihood of experiencing a negative health outcome due to certain behaviors, exposures, or conditions.

Healthcare Provider – A professional or organization that delivers medical care or health services, such as doctors, nurses, or clinics.

Heart Complication – Health issues affecting the heart, such as arrhythmias, palpitations, or increased heart rate.

High Blood Pressure – A medical condition where the force of the blood against the walls of arteries is consistently too high.

Intense Academic Demands – High levels of pressure and workload associated with educational pursuits, such as exams, deadlines, and extensive study requirements.

Internet Connection – The ability to connect to the internet, which is essential for online data sharing, real-time notifications, and cloud-based services.

Issues – Challenges, problems, or concerns that require attention or resolution.

Monitoring Mobile System – A mobile application or platform designed to track and manage specific behaviors or data.

Neurotransmitter – A chemical messenger that carries signals between nerve cells, muscles, or glands.

Preventive Measures – Steps or strategies implemented to reduce the risk of negative outcomes.

Psychoactive Substances – A drug or other substance that affects how the brain works and causes changes in mood, awareness, thoughts, feelings, or behavior.

Reduced Sleep Duration – A decrease in the amount of time a person spends sleeping, often leading to inadequate rest and potential health issues such as fatigue, impaired cognitive function, and mood changes.

Rule-based Algorithm – A computational approach that relies on explicitly defined rules or conditions to make decisions, perform tasks, or solve problems.

Slovin's Formula – Statistical method used to determine an appropriate sample size when the total population size and a desired level of precision are known.

Ubiquity – The fact of appearing everywhere or being very common.

User Data – Refers to the information stored, processed, and handled by individuals or organizations in a secure manner to maintain its integrity.

User-Friendly Mobile Application – A mobile app designed with a focus on ease of use, ensuring that users can navigate, input data, and access features intuitively and effectively.

Versatility – The ability to adapt or be adapted to many different functions or activities.

Review of Related Literature

Health Application

Mobile health (mHealth) applications have become increasingly popular for monitoring health metrics and enhancing patient engagement. However, assessing the quality and effectiveness of these apps presents unique challenges. Grundy, Wang, and Bero (2015) conducted a systematic review that examined common and innovative methods for evaluating mHealth app quality. Their findings indicate that many mHealth apps lack rigorous quality standards, leading to potential reliability issues in health monitoring tools. This review highlights the importance of developing standardized assessment criteria for health applications to ensure user safety and accuracy in health data, supporting the need for robust quality checks in mobile health app development (Grundy et al., 2015).

Mobile health (mHealth) applications have become widely used tools for tracking health behaviors and encouraging user engagement in health management. A study by Krebs and Duncan (2015) analyzed the trends and characteristics of mHealth app usage among U.S. mobile phone users, revealing significant interest in fitness and nutrition tracking. However, the study found that many apps lack advanced, evidence-based functionality and have high discontinuation rates due to data entry demands and concerns about data privacy. Younger, higher-income, and higher BMI individuals were more likely to use these apps, while users expressed a strong preference for apps that integrate with healthcare providers through features like appointment scheduling and secure data sharing. This study emphasizes the need for more user-centered and secure app designs to enhance adoption and sustained use in health management (Krebs & Duncan, 2015).

Mobile health (mHealth) applications are increasingly recognized for their role in improving disease management, particularly in underserved rural areas with limited healthcare resources. In a systematic review, Emeihe, Nwankwo, Ajegbile, Olaboye, and Maha (2024) examined the impact of mHealth apps on disease management in rural settings, noting substantial benefits such as improved healthcare access, remote monitoring, and timely medical interventions. The study highlights app features like symptom tracking, medication reminders, health education, and telemedicine, which collectively enhance patient outcomes for chronic conditions like diabetes and hypertension. However, the authors identify barriers such as limited internet, low digital literacy, and privacy concerns, which constrain app effectiveness in these regions. The study underscores the importance of context-specific applications that address rural challenges and the need

for integration into existing healthcare systems, affirming mHealth's potential to advance public health in underserved areas (Emeihe et al., 2024).

The usability of mobile health (mHealth) applications plays a crucial role in their effectiveness, particularly given the unique characteristics of health apps compared to general applications. Septiani, Rahmawati, Safitri, and Luis (2023) conducted a systematic literature review on mHealth usability, analyzing 65 papers from 799 potential studies between 2013 and 2023. Using the PRISMA approach, the review identified that usability evaluations serve purposes such as validating system design, comparing usability methods, enhancing performance, and assessing usability outcomes.

Jozpoor et al. (2024) highlighted the potential of mobile health (mHealth) applications in enhancing self-care practices among patients with colostomies. This study developed and evaluated an mHealth application aimed at addressing the physical, social, and psychological challenges faced by colostomy patients. The application focused on improving self-care, providing continuous education, and enabling better management of complications, ultimately enhancing patients' quality of life.

Caffeine Health Impacts

Overview of Caffeine Effects on Human Health and Emerging Delivery Strategies, comprehensively examines caffeine's diverse effects and the mechanisms by which it interacts with physiological processes, while exploring new delivery approaches that improve caffeine's health-related benefits. The review highlights caffeine's impact on inflammation, neuroprotection, and disease-specific conditions, such as neurodegenerative disorders, liver health, and cognitive function. Additionally, emerging delivery methods, such as targeted and sustained-release forms, are discussed for their potential to maximize caffeine's health benefits while minimizing side effects. This review emphasizes caffeine's therapeutic potential and the importance of innovative delivery systems to enhance its efficacy and safety in health management (MDPI, 2023).

Caffeine, Human Health and Sustainability. provides an in-depth look at the caffeine sources It highlights caffeine's widespread presence in foods and beverages, as well as its dual nature of health effects. Benefits include enhanced alertness and cognitive performance, while risks range from sleep disturbances to cardiovascular and gastrointestinal concerns. The review emphasizes individual differences in caffeine tolerance due to genetics and health factors. Additionally, it underscores coffee's sustainability challenges, particularly in major coffee-producing countries,

and advocates for environmentally responsible farming practices to combat deforestation and soil erosion. This review offers a holistic perspective on caffeine's health effects and sustainable coffee production practices, aiding stakeholders in making informed decisions on consumption and policy (Niazi, 2023).

Coffee and caffeine consumption are increasingly recognized for their associations with various health outcomes, driven by interest in their potential protective and adverse effects. Grosso, Godos, Galvano, and Giovannucci (2017) conducted an umbrella review synthesizing findings from 112 meta-analyses of observational studies and 9 meta-analyses of randomized controlled trials (RCTs). Their analysis examined the impact of coffee and caffeine on 59 distinct health outcomes. They observed a probable reduction in the risk of several chronic conditions, including breast, colorectal, colon, endometrial, and prostate cancers, as well as cardiovascular disease, mortality, Parkinson's disease, and type-2 diabetes in association with coffee consumption. While caffeine appears to increase blood pressure acutely. These findings underscore the broad health implications of coffee and caffeine, presenting coffee as a potentially beneficial component of a balanced diet when consumed with consideration of individual health profiles (Grosso et al., 2017).

Jahrami et al. (2020) explored the relationship between caffeine intake and physical and mental health among university students in Bahrain. Using a semi-quantitative food frequency questionnaire, the study assessed caffeine consumption from various sources and its associations with health symptoms. Findings revealed high caffeine prevalence, with a mean daily intake of 268 mg, primarily from coffee, tea, and energy drinks. High caffeine intake (≥400 mg/day) was linked to an increased risk of anxiety-related symptoms such as headaches, panic attacks, and feelings of worthlessness.

Rule-based Algorithm

Soleimani-Neysiani et al. (2019) focused on enhancing the performance of association rule-based collaborative filtering recommendation systems by incorporating genetic algorithms. Collaborative filtering, a widely used method in recommendation systems, often suffers from issues like data sparsity and low accuracy. The authors proposed a solution by applying genetic algorithms to optimize association rule mining, improving the system's ability to generate high-quality recommendations. Their method outperformed traditional approaches, such as particle swarm optimization, by offering more accurate predictions with faster runtime. Previous studies, like those by Huang et al. (2004) and Tyagi and Bharadwaj (2013), explored various evolutionary algorithms and their integration into recommendation systems, emphasizing the importance of improving the scalability and accuracy of recommendations. Soleimani-Neysiani et al.'s

work builds on these concepts, demonstrating the efficacy of genetic algorithms in solving the challenges faced by collaborative filtering methods.

The development of recommendation systems has increasingly focused on enhancing accuracy and efficiency through innovative algorithms. Soleimani-Neysiani et al. (2019) addressed the limitations of traditional collaborative filtering methods, such as data sparsity and low precision, by employing a genetic algorithm to optimize association rule mining. This approach builds on prior studies that highlight the efficacy of rule-based systems in identifying patterns and improving scalability, such as Huang et al. (2004), who utilized associative retrieval techniques, and Tyagi and Bharadwaj (2013), who integrated multi-objective particle swarm optimization into rule mining. By leveraging genetic algorithms, the study demonstrates significant improvements in runtime and recommendation quality, showcasing the potential of evolutionary algorithms in solving complex optimization problems in recommendation systems.

Jia et al. (2020) proposed a novel rule-based method, AutoSM, for the automated selection of surrogate models in engineering design. Surrogate models are critical in approximating complex engineering systems, but selecting the most appropriate model can be time-consuming and challenging due to the variety of models and their hyperparameters. To address these challenges, the authors developed a method that combines interpretable decision trees with genetic algorithms (GA) to automate the model selection process. Their approach drastically reduces the time required for surrogate model selection—by up to nine times compared to other methods—while maintaining accuracy and robustness. The AutoSM method maps key problem features, such as scale, noise, and nonlinearity, to model types, offering both efficiency and interpretability, which were lacking in previous evolutionary algorithm-based methods.

Abu-Nasser and Abu-Naser (2018) developed a rule-based expert system designed to assist farmers in diagnosing and treating watermelon diseases. The system employs a set of if-then rules to identify common diseases such as Downy mildew, Powdery mildew, and Fusarium wilt. Using CLIPS language, the system enables farmers to input symptoms, and it then provides diagnoses and potential treatments. This approach leverages the efficiency of expert systems to replicate the decision-making process of agricultural experts, offering a practical tool for disease management in watermelon cultivation. The expert system was well-received by farmers for its ability to simplify the complex process of disease diagnosis, showcasing the effectiveness of rule-based systems in agricultural applications.

Soleimani-Neysiani et al. (2019) proposed an improved method for association rule-based collaborative filtering recommendation systems by integrating genetic algorithms to enhance the system's performance. Collaborative filtering, widely used in recommender systems, often faces challenges like low accuracy and slow performance due to data sparsity. The authors addressed these issues by applying genetic algorithms, which optimize the discovery of association rules, improving recommendation quality and reducing runtime. Their approach outperforms traditional methods, such as particle swarm optimization, in both accuracy and efficiency, demonstrating the effectiveness of evolutionary algorithms in enhancing the performance of recommendation systems.

CHAPTER 2: METHODOLOGY

This chapter presents the research design, research locale, research participants, sampling techniques, data gathering procedure, research instrument, and data analysis. The detailed discussion on the research process will be conducted to obtain the objectives of this research study.

2.1 Research Design

This study employs a descriptive developmental research design utilizing quantitative methods. The descriptive aspect focuses on systematically documenting and analyzing user interactions, feedback, and behavior patterns related to the mobile health application. The developmental component emphasizes the design, creation, and evaluation of the application itself, ensuring its functionality aligns with user needs and intended objectives.

2.2 Research Locale

This research will be conducted at Emilio Aguinaldo College (EAC) Cavite, located in Dasmariñas, Cavite. This educational institution is chosen since many college students and professors in this institution use caffeinated beverages daily. Emilio Aguinaldo College Cavite is a private higher education institution known for its diverse academic programs and its commitment to fostering holistic development among its students.

Emilio Aguinaldo College Cavite offers diverse academic programs, particularly excelling in health-related fields such as Nursing, Pharmacy, and Medical Technology, alongside programs in Business, Engineering, IT, Tourism, and Education. The campus provides state-of-the-art facilities, including laboratories, libraries, and student activity centers, supporting both academic and extracurricular activities.

2.3 Research Participants

The target research participants for this study will be professors and college students enrolled at Emilio Aguinaldo College Cavite. To ensure relevance to the research objectives, the researchers will ensure that the participants must meet the following criteria:

a) Current professor or college student at Emilio Aguinaldo College Cavite.

b) Regularly consume caffeinated beverages, such as coffee, tea, energy drinks, or soda.

c) Have access to a smartphone and be willing to use an app to log their caffeine intake throughout the study period.

2.4 Sampling Techniques

This study will employ snowball sampling to recruit participants. The process will begin by identifying a small group of individuals who regularly consume caffeine, such as coffee or energy drink users, and those with health conditions requiring caffeine monitoring. These first participants will be asked to refer to others who meet the same criteria, thereby building a network of participants who can provide valuable insights for the study.

The participants will include college students and professors from Emilio Aguinaldo College Cavite who are regular caffeine consumers. By using snowball sampling, the study ensures that participants are selected based on their caffeine consumption habits and their willingness to use the mobile app.

Since snowball sampling depends on referrals, the total number of participants will be determined as the recruitment process progresses, with the final sample size influenced by the number of referrals from the first participants.

2.5 Data Gathering Procedure

This study will involve recruiting students from Emilio Aguinaldo College Cavite, teaching them to use the app to track their caffeine intake, collecting data through app logs and questionnaires, and analyzing the results to assess the app's effectiveness and user experience.

Step 1: We'll invite students from Emilio Aguinaldo College Cavite to join the study.

They'll need to be regular caffeine drinkers, own a smartphone, and be willing to try out the app.

Step 2: Once they're in, we'll explain the study to them, show them how to use the app to track their caffeine intake.

Step 3: Have them answer a starting questionnaire about their current caffeine habits and awareness.

Step 4: We will wait for a few weeks. They'll use the app daily to log what caffeinated drinks they consume and when.

The app might remind them to log consistently and warn them if they're drinking too much caffeine.

Step 5: After the study period, they'll fill out another questionnaire about their experience using the app and whether it helped them manage their caffeine intake better.

If needed, we might also have small group discussions to hear their thoughts directly, like what they liked about the app and what could be improved.

Step 6: Finally, we'll gather all the data from the questionnaires and the app, check it for any gaps, and then analyze it to see what we've learned about the app's effectiveness and user experience.

2.6 Research Instrument

According to Sroopa and MS Rani (2012), A questionnaire is the main means of collecting data. A questionnaire enables quantitative data to be collected in a standardized way so that the data are internally consistent and coherent for analysis.

This research will use a questionnaire that we will be using to survey the participants about the effects of caffeine consumption in their life. The questionnaire will be based on research objectives. The questionnaire will contain questions about caffeine consumption habits and the respondents can answer this question using the following 4-point likert scale: (1) Strongly Disagree; (2) Disagree; (4) Agree; (5) Strongly Agree.

2.7 Data Analysis

The data analysis in this study will primarily utilize quantitative methods to evaluate the effectiveness of the mobile application for caffeine monitoring. Statistical techniques will be employed to identify patterns, test hypotheses, and generalize findings.

To determine the appropriate sample size, we will use the Slovin's formula, ensuring that the sample is representative of the population and accounts for a manageable margin of error. Additionally, the reliability of the questionnaire items will be assessed using Cronbach's alpha, providing a measure of internal consistency. A high Cronbach's alpha score will confirm the reliability of the data collection instruments, ensuring the validity of the insights gained.

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