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Empowering local communities through digital marketing automation: A case study of eco-friendly dragon fruit kombucha

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ABSTRACT

Background: This study examines the application of automation technology in the production of environmentally friendly dragon fruit-based kombucha in Kediri using the n8n platform. Kombucha is a fermented beverage that has attracted growing consumer interest due to its potential health benefits, while dragon fruit serves as a natural ingredient with added nutritional value. **Methods:** The study employs a research and development (R&D) approach aimed at improving production efficiency and maintaining product quality. Automation is applied to several stages of the production process, including raw material management, fermentation time regulation, as well as distribution and marketing activities. The development process is based on the Borg and Gall model, which emphasizes systematic testing and evaluation at each stage of product development. This approach allows for continuous refinement to ensure the feasibility and effectiveness of the production system. **Findings:** The results of the study show that the integration of the n8n platform has successfully automated key workflows, from monitoring raw materials to managing fermentation times and marketing distribution. This implementation has significantly improved operational efficiency by reducing dependence on manual processes and minimizing the risk of human error. From a product perspective, consumer trials showed a high level of acceptance; dragon fruit kombucha produced by this system was rated superior in terms of flavor balance, fresh aroma, and attractive natural color. **Conclusion:** This study concludes that the use of low-code automation technology such as n8n is an effective solution for optimizing the production and marketing of environmentally friendly kombucha at the local level. **Novelty/Originality of this article:** The novelty of this research lies in the use of the n8n platform—which is commonly used for pure IT workflows—in the context of MSME-scale fermented beverage production.

KEYWORDS: automation; dragon fruit; kombucha.

1. Introduction

Kombucha is a fermented beverage that has gained increasing public attention, particularly because of its potential health benefits, including immune system support, detoxification, and digestive health improvement (Abaci et al., 2022). This beverage is commonly produced through the fermentation of tea using a symbiotic culture of bacteria and yeast (SCOBY), which converts sugar into organic acids, probiotics, and various enzymes. In recent developments, kombucha production has been innovated through the incorporation of natural ingredients such as dragon fruit, which not only enhances the

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nutritional value of the beverage but also improves its taste and visual appeal (Salsabilah & Handayani, 2024).

Along with the growing awareness of healthy lifestyles, the market for health-oriented products continues to expand, including in the Kediri region, indicating strong potential demand for functional beverages. Despite this opportunity, the effective and efficient marketing of dragon fruit–based kombucha requires a more systematic production and distribution approach (Bishop et al., 2022b). One strategy that can be adopted is the utilization of automation technology in both production and marketing processes to improve operational efficiency and maintain consistent product quality. The application of automation can be facilitated through the n8n platform, which enables workflow management to be carried out automatically with minimal manual involvement.

Therefore, this study aims to optimize the production and marketing processes of environmentally friendly dragon fruit kombucha in Kediri through the implementation of process automation using n8n technology. This research focuses on analyzing the kombucha production process, the nutritional content of the product, and the time required for fermentation and production. The findings are expected to provide a comprehensive understanding of the potential integration of automation technology in managing the production and marketing of environmentally friendly products, thereby enhancing their competitiveness in the local market.

2. Methods

2.1 Research approach and development framework

This study employs a research and development (R&D) approach aimed at developing an environmentally friendly dragon fruit–based kombucha product while integrating automation technology into the production process using the n8n platform. The primary objective of this research is to design, implement, and evaluate a kombucha production model that is more efficient and capable of maintaining consistent product quality through the use of sustainable raw materials and an automated workflow system. The research framework is adapted from the Borg and Gall product development model, which emphasizes systematic testing and evaluation at each stage to ensure the feasibility and effectiveness of the developed product.

2.2 Kombucha formulation and n8n automation workflow system

The research procedure is carried out through several sequential and interrelated stages. The first stage focuses on an initial analysis of kombucha as a functional beverage product. Kombucha is produced through the fermentation of tea using a symbiotic culture of bacteria and yeast (SCOBY) (Kapp & Sumner, 2019). In this study, dragon fruit is selected as the primary raw material due to its nutritional value and its contribution to enhancing the sensory characteristics of the beverage. At this stage, an analysis is conducted on the preparation and processing of dragon fruit, appropriate fermentation techniques, and the selection of supporting equipment, including fermentation containers, temperature control devices, and quality monitoring tools (Khasanah & Dewi, 2024). This stage also examines the influence of raw materials, processing methods, and equipment on the final quality of the kombucha product.

The second stage involves the design and implementation of an automation system utilizing the n8n platform. Automation is applied to various components of the production process, including fermentation monitoring, production data management, distribution, and marketing activities (Calado, 2025; Prusova et al., 2023). The system is developed by integrating multiple applications to enable real-time monitoring of production stages, streamline data processing, and support digital-based marketing communication. The implementation of automation aims to minimize manual intervention, reduce production

time, and improve consistency and efficiency in both production management and marketing processes.

The third stage consists of evaluating the outcomes of the automated production process by comparing kombucha products produced using the n8n-based automation system with those produced through conventional manual methods. Product evaluation is conducted based on several parameters, including taste, nutritional content, and production duration. The comparative analysis is intended to assess the effectiveness of automation technology in optimizing the production process and its contribution to improving product quality and operational efficiency. The collected data are analyzed to determine the role of automation in supporting the marketing performance of environmentally friendly dragon fruit kombucha in the local Kediri market. Overall, this research methodology is designed to offer a practical approach to developing environmentally friendly dragon fruit kombucha while exploring the potential of automation technology in enhancing production and marketing efficiency. The findings are expected to contribute to the formulation of a more sustainable production model and to strengthen the competitiveness of environmentally friendly products within the growing local market.

3. Results and Discussion

3.1 Definition of kombucha

Kombucha is a functional fermented beverage containing various bioactive compounds such as vitamins, minerals, enzymes, and organic acids, with a distinctive taste that is slightly sweet and sour (Anantachoke et al., 2023). This beverage is produced through the fermentation of black or green tea (Camellia sinensis) using SCOBY (Symbiotic Culture of Bacteria and Yeast), a symbiotic culture of bacteria and yeast that forms a cellulose biofilm layer. This fermentation process requires the addition of sucrose or sugar as a carbon source for microorganisms to produce metabolites such as acetic acid, gluconic acid, and lactic acid(Rachmawati et al., 2023). Historically, kombucha originated in ancient China and has long been known as a traditional beverage with health benefits. The main components of kombucha are organic acids produced during fermentation, such as acetic acid, glucuronic acid, and various phenolic compounds that have antioxidant properties (Naufal et al., 2023; Rebecca et al., 2010). Several studies indicate that kombucha fermentation leads to an increase in bioactive compounds that can potentially enhance the immune system, protect the body from oxidative stress, and maintain gut microflora balance.

The fermentation process of kombucha is influenced by various factors, including the type of microbial culture used, the type of tea, water source, type and amount of sugar (Sun et al., 2022), fermentation temperature, fermentation duration, and oxygen availability. Variations in these factors will affect the chemical and sensory characteristics of kombucha, such as acidity, aroma, flavor, and color(Chen et al., 2024; Bishop et al., 2022a). In the context of developing green halal food products, the use of local natural ingredients such as red dragon fruit (Hylocereus polyrhizus) as an additive in kombucha tea offers a promising alternative. Red dragon fruit contains high levels of anthocyanins and polyphenols that can enhance the antioxidant activity of the beverage (Júnior et al., 2025). The utilization of this seasonal fruit not only supports the diversification of local food products but also aligns with the principles of zero waste and environmental sustainability (Suharman et al., 2024).

The addition of various natural sugars such as coconut sugar, honey, or palm sugar can also provide flavor variations and affect the microbial fermentation metabolism (Yuliana et al., 2023; Bader et al., 2010). Each type of sugar has a different composition and purity level, which impacts the activity of yeast and acetic bacteria, thus influencing the final fermentation results, such as ethanol content and pH (Putri et al., 2023; Kucharska et al., 2018). The kombucha fermentation process produces various bioactive components that provide important health benefits for the human body. The primary components produced include organic acids, enzymes, vitamins, amino acids, and polyphenols, which play a role

in maintaining metabolic function, immune system health, and preventing various degenerative diseases (Khasanah & Dewi, 2024).

3.1.1 Process of making dragon fruit Kombucha

For brewing kombucha, use a stainless steel pot to boil water, dissolve sugar, and steep tea, stirring the mixture with a wooden or food-safe plastic spoon. Once brewed, use a tea strainer to filter out the tea leaves before transferring the liquid to a large glass jar—preferably clear—for primary fermentation. The jar is then covered with a thin cotton cloth or clean, thin towel, secured tightly with a rubber band or string to allow air circulation while preventing contaminants from entering.

While cooling the solution, a kitchen thermometer can be used optionally to monitor the temperature. Once the fermentation process is complete, a funnel and fine strainer are used to transfer the liquid into a glass bottle with a tight-fitting lid, which is used for storage or the second fermentation stage. During this process, a digital scale ensures that sugar and other additives are measured accurately.

Tabel 1. Ingredients

No	Material	Number	Explanation
1.	Boiled Water	500 liters	The water must be sterile and chlorine-free.
2.	White Granulated Sugar	80-100 grams	Energy source for fermentation.
3.	Black tea or green tea	2-3 bags or 5 grams	Main ingredient for tea infusion.
4.	Scoby	1 sheet (± 50 grams)	Symbiotic culture of bacteria and yeast.
5.	Kombucha Starter (Kombucha tea from previous fermentation)	±100 ml	To lower the initial pH.
6.	Red dragon fruit/Flavor additives (optional)	± 50-100 grams	For flavor variations (second stage of fermentation).

The kombucha-making process begins with the first fermentation step, which involves boiling 500 liters of water in a stainless steel pot (Villarreal-Soto et al., 2024). Once the water comes to a boil, tea is added and steeped for 5 minutes to allow the flavors to infuse properly; the heat is then turned off, and white granulated sugar is stirred in until completely dissolved. The tea leaves are then strained, and the solution is cooled to room temperature (±25–30°C) before being poured into clean, sterilized glass jars. To initiate fermentation, the kombucha starter and SCOBY are added to the surface, then the jars are covered with a thick cloth secured with a rubber band and left to ferment in a clean, shaded area for 7–10 days. For the second fermentation (Dragon Fruit variant), the SCOBY is removed after the 7th day and stored for future use. The kombucha liquid is strained into a clean glass bottle, to which red dragon fruit puree is added at approximately 10% of the total volume. The bottle is tightly sealed and fermented for an additional 2–3 days at room temperature to develop flavor and natural carbonation. Finally, the kombucha is stored in the refrigerator to halt the fermentation process and preserve its flavor.

3.1.2 Kombucha drinking guidelines

3.1.2.1 Safe consumption portion

Beginners should start with 50 ml per day, gradually increasing the amount. Children and pregnant/breastfeeding women should avoid kombucha unless under medical supervision, as its fermentation contains organic acids and trace amounts of natural alcohol (<0.5%). Best Time to Drink In the morning before breakfast, as it helps balance digestion and boost energy. After a heavy meal, as it aids in detoxification and

supports metabolism. Avoid consumption before bedtime, as the acid content and slight caffeine (from the tea) may disrupt sleep for some individuals.

Kombucha is an acidic fermented beverage, and excessive consumption can lead to stomach upset or bloating (Wang et al., 2022a; Kim & Adhikari, 2020). Therefore, kombucha is best consumed 1-2 times a week with a gap between servings. Store kombucha at 4-8°C (in the refrigerator) to maintain probiotic quality. Serve cold and do not shake, as the fermentation process generates natural CO_2 gas. Use glass or stainless steel containers, not plastic, to prevent reactions with the acids.

3.1.3 Pictures of tools, materials, and their function

The kombucha-making process begins with the first fermentation step, which involves boiling 500 liters of water in a stainless steel pot. Once the water comes to a boil, tea is added and steeped for 5 minutes to allow the flavors to infuse properly; the heat is then turned off, and white granulated sugar is stirred in until completely dissolved. The tea leaves are then strained, and the solution is cooled to room temperature (±25–30°C) before being poured into clean, sterilized glass jars.

Tabel 2. Funciont tools and material

No	Tools and Materials	Function
1.	Lab coat	Serves as protection for researchers from chemicals, biological agents, or contamination during experiments. This jacket also maintains laboratory cleanliness and prevents cross-contamination.
2.	Disposable gloves	Protecting hands from exposure to chemicals, biological agents, and contaminants. Gloves also maintain cleanliness and prevent the spread of contaminants in the laboratory, as well as protecting researchers from skin irritation.
3.	Face Mask	Provides protection against harmful airborne particles and vapors, and prevents researchers from inhaling hazardous substances. Masks also reduce the spread of bacteria or viruses in the laboratory environment.
4.	Glass jar	Used to store chemicals, samples, or other materials with an airtight lid that keeps the contents safe from contamination or environmental changes.
5.	Measuring cup	Used to measure liquid volume with high accuracy, it is important in mixing chemicals to ensure consistency in experiments.
6.	Thermometer	Used to measure temperature in laboratory experiments, which is essential for monitoring chemical reactions, material temperatures, or environmental conditions in research.
7.	Stirring Stick	Used to mix or stir solutions, ensuring that chemicals are evenly mixed in the container and supporting the smooth running of experimental reactions.
8.	Rolled tissue	Used to clean up or wipe up spilled liquids in the laboratory, it is important to maintain cleanliness and prevent cross-contamination.
9.	Rubber Band	Used to tie or hold objects in the laboratory, such as test tubes or other containers, so that they do not spill or separate easily.
10.	Sticker label	Used to identify objects or containers, such as test tubes or sample bottles, to ensure proper management of chemicals or samples.
11.	Tea bag	Used to brew tea, measure or extract flavor from tea leaves in hot water. In laboratories, tea bags can be used for experiments involving the extraction of certain substances
12.	Measuring cup	Used to measure the volume of liquid or solid materials with precise accuracy, such as in material measurement experiments.
13.	Chemical Glass (Beaker)	Used to measure liquid volume, although less accurate than measuring cups or measuring flasks. This glass is also used to brew ingredients or solvents in experiments.

14.	Glass Jar	Used as a kombucha fermentation vessel, it is non-reactive and allows observation of the fermentation process. Stopes also maintains the safety and quality of kombucha during fermentation.
15.	Scoby	A kombucha starter culture consisting of bacteria and yeast, which ferments sweet tea and turns it into kombucha, producing organic acids, carbon dioxide, and a small amount of alcohol.

To initiate fermentation, the kombucha starter and SCOBY are added to the surface, then the jars are covered with a thick cloth secured with a rubber band and left to ferment in a clean, shaded area for 7–10 days. For the second fermentation (Dragon Fruit variant), the SCOBY is removed after the 7th day and stored for future use. The kombucha liquid is strained into a clean glass bottle, to which red dragon fruit puree is added at approximately 10% of the total volume. The bottle is tightly sealed and fermented for an additional 2–3 days at room temperature to develop flavor and natural carbonation. Finally, the kombucha is stored in the refrigerator to halt the fermentation process and preserve its flavor.

In the early stages of development, it is important to understand the characteristics of Kombucha as a beverage that undergoes fermentation with bacterial and yeast cultures (SCOBY). The proper fermentation process is highly dependent on temperature control, sugar content, and time. In this study, dragon fruit was chosen as the raw material because of its high nutritional content, including vitamin C, fiber, and antioxidants that can improve the quality and health benefits of Kombucha (Wang et al., 2022b; Naufal et al., 2023). Analysis of how dragon fruit is processed, including the selection of quality raw materials and the use of appropriate fermentation tools and techniques, is an important aspect in producing an optimal product (Jalgaonkar et al., 2022). We equate this research with the fermentation of tape, which according to scholars is permissible.

تفسير البغوي ما نصه: وجملة القول على تحريم الخمر أن الله أنزل في الخمر أربع آيات نزلت بمكة وهي: (من ثمرات النخيل والاعناب تتخذون منه سكرا ورزقا حسنا) فكان المسلمون يشربونها، وهي لهم حلال يومئذ .ثم أن عمر بن الخطاب ومعاذ بن جبل وجماعة من الانصار أتوا رسول الله صلى الله عليه وسلم فقالوا: يا رسول الله أفتنا في الخمر والميسر فإنهما مذهبة للعقل مسلبة للمال، فأنزل الله تعالى: * (يسألونك عن الخمر والميسر قل فيهما إثم كبير ومنافع للناس) * إلى أن صنع عبد الرحمن بن عوف طعاما فدعا أناسا من أصحاب النبي صلى الله عليه وسلم وأتاهم بخمر فشربوا وسكروا وحضرت صلاة المغرب وتقدم بعضهم ليصلي فقرأ: (قل يا أيها الكافرون، لا أعبد ما تعبدون) بحذف لا النافية، فأنزل الله تعالى: (يا أيها الذين آمنوا لا تقربوا الصلاة وأنتم سكارى حتى تعلموا ما تقولون) * فحرم السكر في أوقات الصلاة.

Al-Baghawi's Tafsir states:
In summary, regarding the prohibition of wine, Allah revealed four verses concerning it. The first was revealed in Makkah: "And from the fruits of palm trees and grapevines, you take intoxicant and good provision."

At that time, the Muslims used to drink it, and it was lawful for them.

Then Umar ibn al-Khattab, Mu'adh ibn Jabal, and a group of the Ansar came to the Messenger of Allah ﷺ and said, "O Messenger of Allah, give us a ruling regarding wine and gambling, for they take away reason and consume wealth." So Allah revealed:
"They ask you about wine and gambling. Say: In them is great sin and some benefit for people."

Later, Abd al-Rahman ibn Awf prepared food and invited some of the Companions of the Prophet ﷺ. He brought them wine, and they drank until they became intoxicated. When the time for Maghrib prayer arrived, one of them stepped forward to lead the prayer and recited: "Say: O disbelievers, I worship what you worship,"

omitting the negative particle "not." Therefore, Allah revealed: "O you who believe, do not approach prayer while you are intoxicated until you know what you are saying." Thus, intoxication was prohibited during the times of prayer.

Al-Baghawi's interpretation states that the verse regarding the prohibition of khamar (alcoholic beverages) was revealed in four stages. The discussion on intoxicating beverages in Islam can be traced through the gradual revelation of Qur'anic verses. Allah SWT states as follows.

"And from the fruits of the date palm and the grapevine, you derive intoxicating drinks and good provision" (QS. An-Nahl: 67).

At the time this verse was revealed, the consumption of khamr had not yet been prohibited, and Muslims were still permitted to consume it. Subsequently, several companions, including Umar bin Khattab, Mu'adz bin Jabal, and members of the Ansar, approached the Prophet Muhammad SAW to seek clarification regarding the ruling on alcohol and gambling, as both were perceived to harm intellect and wealth. In response, Allah SWT revealed,

"They ask you about alcohol and gambling. Say: in both of them there is great sin and some benefit for people" (QS. Al-Baqarah: 219).

The prohibition was further reinforced following an incident in which Abdullah bin Auf hosted a gathering and served wine to several companions. As a result of intoxication, one of them incorrectly recited Surah Al-Kafirun while leading the Maghrib prayer, omitting the negation word *"laa."* This event led to the revelation of the verse.

"O you who believe, do not approach prayer while you are intoxicated until you know what you are saying" (QS. An-Nisa: 43), *which explicitly forbids approaching prayer in a state of intoxication.*

Imam Al-Jashshash, a Hanafi scholar, explains in *Ahkam al-Qur'an* that the term *sakar* includes both *khamr* and *nabidh*, as each has the potential to cause intoxication. Nevertheless, the Qur'an explicitly prohibits *khamr* in Surah Al-Maidah (5:90), while no equally explicit prohibition is found regarding *nabidh*. This absence has led some scholars to consider *nabidh* permissible, particularly since its intoxicating effect is not immediate, unlike *khamr*, which becomes intoxicating upon consumption.

Imam Ibn Abidin, in his *Hashiyah*, cites Imam Abu Hanifah's opinion that various forms of *nabidh* are permissible as long as they are not consumed for sinful purposes and are intended solely for *istimrarut tha'am* (facilitating digestion). However, when consumption reaches the point of intoxication, the act becomes unlawful, and the final sip that causes intoxication is deemed haram. Ibn Abidin illustrates this with the example that if a person knows intoxication will occur after three glasses, the first two are permissible, while the third becomes forbidden.

Reports from Iraqi scholars also indicate that some companions consumed *nabidh* made from dates with a strong odor without becoming intoxicated. Abdullah bin Abbas is reported to have allowed the consumption of one to three glasses of *nabidh* as long as intoxication was avoided. These narrations contributed to Imam Abu Hanifah's conclusion that *nabidh* is not inherently unlawful, but becomes haram when it results in intoxication.

Based on these views, Hanafi scholars distinguish between drinks that are *potentially intoxicating* (*al-iskar bil quwwah*) and intoxication that occurs through actual excessive consumption (*al-iskar bil fi'li*). According to Iraqi scholars, including those of the Hanafi school, *nabidh* becomes haram only when consumed in quantities that lead to intoxication. This position differs from that of the Shafi'i, Maliki, and Hanbali schools, which maintain that any substance with intoxicating potential is prohibited, even in small amounts, as *nabidh* is categorized as a form of *khamr*.

Scholars who prohibit *nabidh* entirely often refer to Ibn Abbas's interpretation of QS. An-Nahl: 67, arguing that the verse was revealed prior to the explicit prohibition of *khamr* and that all intoxicating beverages, whether immediately intoxicating or not, fall under the category of *khamr*. This view is also supported by Imam Al-Qurthubi in *Al-Jami' li Ahkam al-Qur'an*. Regarding narrations that allow the consumption of small amounts of intoxicating beverages, Abdullah bin Mubarak notes that these reports largely originate from Ibrahim al-Nakha'i, a Tabi'i from Iraq. Ibn Hajar al-Asqalani, in *Fath al-Bari*, explains that such solitary reports (*ahad*) contradict more widely accepted hadiths stating that any intoxicant, even in small quantities, is prohibited.

Differences in scholarly opinion between Iraqi and Hijazi scholars appear to stem from variations in scriptural interpretation, hadith transmission, and social context. Ibn Khaldun observed that scholars in Iraq narrated fewer hadiths than those in Hijaz, who were geographically closer to the Prophet and his companions. However, historical developments show that hadith scholarship in Iraq later flourished, particularly during the period when hadith sciences became more systematized, such as in the era of Imam al-Shafi'i. Consequently, some narrations used to justify the permissibility of *nabidh* were later deemed weak based on established hadith criteria.

Despite these differences, scholars agree that intoxication itself is unequivocally prohibited. Disagreement primarily concerns the threshold and conditions under which a beverage is considered intoxicating. These determinations are closely linked to cultural practices, scholarly interpretation, and the characteristics of the beverage.

In the Indonesian context, various fermented beverages such as *tuak*, *ciu*, and fermented salak are known, alongside grape-based drinks. However, these beverages are not commonly integrated into daily consumption patterns and are typically consumed during leisure activities rather than for functional purposes such as digestion. Under such circumstances, the likelihood of excessive consumption leading to intoxication becomes significant, which reinforces concerns regarding their permissibility.

In some parts of the world, like France, people often drink a small glass or sip of wine as a way to finish a meal. European societies that legalize alcohol have a concept of "standard drinks," which refers to the minimum amount of alcoholic beverage that is considered acceptable and tolerable for the body. These standard drinks are measured and researched by experts, so "rational drinkers" understand the limits and avoid types of alcohol that they cannot tolerate (Puspitasari et al., 2016).

Choosing not to consume intoxicating beverages seems to be the best option when considering both the Indonesian societal context and health perspectives. Many health risks can occur as a result of alcohol-related behavior. For traditional beverages like tuak, fermented salak, or bir salak pondoh, there is no standard alcohol content yet to determine how much it can intoxicate. Therefore, avoiding such beverages is the best option (Salsabilah & Handayani, 2024). Understanding the scope of the scholars' fatwas on this issue helps us make wiser decisions when consuming products, discussing societal issues, and viewing traditions.

The law here states that it is permissible to consume kombucha made from fermented tape (fermented cassava) with a specified amount set by the seller (Bassey et al., 2025). The informant explained that their motivation for making kombucha originated from a personal experience after giving birth, which led to an infection. After being advised by a doctor to consume probiotics, they chose kombucha as a natural alternative. The kombucha they consumed helped accelerate their recovery, and the infection healed without additional medication. The informant also shared knowledge about how to make kombucha, safe

consumption guidelines, and how to care for the SCOBY culture to keep it healthy and active (Augustin et al., 2024) From this, we found through laboratory research, surveys, and our studies that there are no harmful substances in kombucha for widespread implementation in the community.

3.2 Development of n8n for sales optimization and application of borg and gall

This research is conducted to develop and improve the marketing of environmentally friendly dragon fruit–based kombucha in Kediri through the application of automation technology in the production process using the n8n platform. As a fermented beverage recognized for its potential health benefits, kombucha has promising prospects in the Indonesian market, particularly when combined with natural ingredients such as dragon fruit, which contains high levels of antioxidants and essential nutrients (Kitwetcharoen et al., 2023). Accordingly, this study emphasizes two main aspects, namely the use of dragon fruit as a primary raw material and the integration of automation technology to enhance production efficiency and product quality.

The research development involves the application of automation technology in the production workflow through the n8n platform. This system enables automated workflow management by integrating various applications that support real-time monitoring and control of the fermentation process, ranging from raw material data management to distribution and marketing activities. The implementation of n8n is expected to minimize reliance on manual processes, shorten production time, and maintain consistency in product quality. Each stage of the workflow, including data processing, is automated to facilitate effective quality control and more efficient distribution management.

One of the key focuses of this study is the analysis of kombucha production time. The duration of fermentation required to achieve optimal product quality is influenced by several factors, including the type of raw materials used and environmental conditions such as temperature and humidity. The use of automation technology allows these factors to be monitored and regulated more precisely, thereby reducing process variability and improving product consistency. Through automated workflow management, the production of dragon fruit kombucha is expected to become more time-efficient, reduce material waste, and optimize the use of available resources. The approach used in this research refers to the product development model proposed by Borg and Gall, which emphasizes the importance of continuous testing and evaluation at every stage of product development. This model involves several critical phases, such as planning, development, and product testing, all designed to ensure that the developed product not only meets high-quality criteria but also effectively addresses market needs and preferences.

3.2.1 Use of automation technology with n8n platform

One of the key innovations highlighted in this study is the application of automation technology in the kombucha production process through the use of the n8n platform. This platform enables automated workflow management by integrating multiple applications that support real-time monitoring and regulation of the fermentation process. Automation is applied across the entire production cycle, starting from raw material data management to the control of distribution and marketing activities.

The use of n8n is intended to minimize dependence on manual procedures, which are often inefficient and susceptible to human error. Through this system, each stage of production can be automated, including the monitoring of raw material quality, the regulation of temperature and humidity during fermentation, and the coordination of product distribution to the market. The integration of data within the automation system enhances process transparency and accuracy, ultimately enabling the production of kombucha with more consistent quality and shorter production time.

3.2.2 Fermentation time management and its impact on product quality

In the development of this dragon fruit-based Kombucha product, fermentation time is a key factor that significantly impacts the final product quality. Optimal fermentation will result in Kombucha with a balanced taste and maximum health benefits. However, the precise fermentation time may vary depending on the type of raw materials, ambient temperature, and humidity around the fermentation area.

This is where automation technology plays a vital role. By leveraging the n8n platform, fermentation time can be monitored more accurately and adjusted to meet the needs of each production batch. This automation system allows for the regulation of temperature, humidity, and other important parameters in the fermentation process, ensuring that each batch of Kombucha reaches optimal quality in a more efficient time frame. This technology helps minimize variability in production outcomes, which is often a challenge in manual processes, and allows for more consistent production.

3.2.2.1 Chatbot interface display and MIT license text

The bot appears to be in a "loading" or "ready" state, awaiting input from the user. This design is commonly used for interactive chatbots integrated into websites or applications to provide automated customer support, answer questions, or guide users. The design of chatbots often prioritizes ease of use and friendly interaction, enhancing the user experience in accessing automated services via the web or app.

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3.2.2.2 JavaScript code for chatbot integration and CSS code for chatbot styling

The code handles elements of the interface, such as message input, send buttons, and file handlers, and also interacts with an API to process user messages. This type of code is commonly used in the development of web-based chatbots. JavaScript serves as a bridge between the user interface and the backend system, allowing the chatbot to function dynamically and interactively. CSS code used to style the appearance of a chatbot. With a gradient background and interactive button designs, this CSS code provides a modern and attractive visual design for the chatbot used on a webpage. The visual design of the chatbot with CSS helps create a better user experience, influencing the comfort of users when interacting with the automated system.

3.2.2.3 HTML structure for chatbot pop-up, kombucha equipment, and material costs

This is a snippet of the HTML structure that defines the header and body of the chatbot, including the bot's avatar image and message input area. There is also a button to close the chatbot. This structure helps display the chatbot on a webpage in an organized and user-friendly way. The basic HTML structure ensures that the chatbot appears responsively, adapting to different device screen sizes.

Furthermore, the image provides an estimate of the costs for equipment and materials needed to make Kombucha. The equipment listed includes large glass jars and bottles, while materials include tea and sugar. Knowing the cost of materials and equipment is essential for businesses involved in production, like Kombucha, for more efficient budgeting.

3.2.2.4 Chatbot user interface in action and financial calculation for Kombucha

The active chatbot interface of displaying messages such as "How can I help you today?". This is the frontend design of the chatbot interacting directly with users. The user-friendly and interactive design allows the chatbot to provide efficient services and helps users communicate easily.

This snippet shows a chatbot response providing details on how to calculate revenue from Kombucha sales based on data provided by the user. Factors such as brand quality, bottle size, and sales regions are explained in detail. Using a chatbot for financial calculations helps business owners easily calculate potential revenue and plan pricing strategies.

3.2.2.5 Workflow of Chatbot AI integration with google sheets and in action

The backend workflow for an AI chatbot integrated with Google Sheets using automation tools. This chatbot listens for incoming messages and automatically stores or retrieves data from Google Sheets. Using such integrations allows for efficient data collection and more organized interaction between the user and the backend system. Furthermore, the image continues of workflow the chatbot automation, showing that the chatbot continuously interacts with the AI model and uses external services such as Google Sheets to fetch relevant data based on user input. Using automated workflows in chatbots allows for faster and more responsive interactions, while also reducing the manual workload for users.

3.2.3 Resource efficiency and waste reduction

One of the main goals of this research is to reduce waste in the production process of dragon fruit-based Kombucha. By optimizing resource usage through automation technology, it is expected that the production process can be carried out more efficiently in terms of both time and cost. Automation allows for real-time monitoring of raw material usage, energy consumption, and waste produced during production. By leveraging automation technology such as n8n, each resource can be more carefully monitored and directed for more efficient use, reducing waste and optimizing production outcomes. This not only offers cost benefits but also supports sustainability goals by reducing the environmental impact of the Kombucha production process.

3.2.4 Testing and evaluation at every stage of product development

In accordance with the Borg and Gall development model, this study incorporates systematic testing and evaluation at each stage of product development. Any modifications made to the automation system or production process are examined to determine their effects on production efficiency and product quality. Evaluations are also carried out to ensure that the final product complies with established quality standards and aligns with consumer expectations.

This research further includes trials conducted at different production scales to assess the performance of the automation system under broader operational conditions. Through these trials, the effectiveness of automation technology in improving both production efficiency and the quality of dragon fruit–based kombucha can be identified. The evaluation outcomes are used as a foundation for continuous refinement of the production process, ensuring that the final product possesses competitive value when introduced to the market.

Overall, the development and application of automation technology in the production of environmentally friendly dragon fruit kombucha are expected to offer a practical solution for enhancing product quality, operational efficiency, and market competitiveness at the local level (Yang et al., 2022). The utilization of n8n technology enables a more streamlined production process, while the use of natural and environmentally friendly raw materials,

such as dragon fruit, increases product value in response to growing consumer awareness of sustainability and health. The findings of this study may serve as a reference for the development of the fermented beverage industry in Indonesia, particularly in Kediri, which holds considerable potential for technology-based and natural health beverage products.

From the perspective of Ecological Fiqh, which emphasizes sustainability and responsible resource management, the application of automation technology is consistent with Islamic principles that promote environmental preservation. One of the key objectives of *maqasid shariah* is *hifz al-mal* (the protection of wealth), which can be achieved through the efficient and prudent use of natural resources. The implementation of automation technology, such as the n8n platform, contributes to reducing waste and optimizing resource utilization. By automating the kombucha production process, efficiency is improved while losses of raw materials and energy are minimized (Ojo & de Smidt, 2023).

In addition, the principle of *hifz al-nafs* (the protection of life) highlights the importance of safeguarding human health and well-being. As a beverage that offers potential health benefits, kombucha supports efforts to promote a healthy and balanced lifestyle (Leal et al., 2018). The use of automation technology helps ensure that the product is produced in a controlled, safe, and consistent manner, thereby increasing its accessibility and contributing positively to public health.

Furthermore, the concept of *mashlahah* (public benefit) within *maqasid shariah* underscores that human activities should generate benefits for both society and the environment. In this context, the adoption of environmentally friendly automation technology through the n8n platform can be viewed as an effort to achieve long-term benefits that support social welfare, environmental sustainability, and business continuity. The use of natural ingredients such as dragon fruit also reflects the principles of Ecological Fiqh, which encourage the utilization of sustainable resources and the avoidance of environmental harm. Islamic teachings emphasize that humans, as stewards of the earth, bear the responsibility to protect and preserve natural resources for both present and future generations.

3.2.5 Analysis of respondent questionnaire data

The questionnaire was distributed to a number of respondents to assess the quality of the dragon fruit Kombucha product, as well as the public's perceptions regarding the product's halal status and sustainability. The trial results showed that all respondents gave positive feedback regarding the dragon fruit Kombucha produced. Based on the taster results, the majority of respondents evaluated the product as having a fresh taste with the right balance between sweetness and sourness. 87% of respondents stated that the dragon fruit Kombucha tasted lighter and more natural compared to regular Kombucha, with a soft fermentation aroma that was not overpowering. The natural pink color from the dragon fruit was also considered a unique feature that provided a clean, natural, and visually appealing impression. Overall, the acceptance rate among respondents reached approximately 85%, indicating that the dragon fruit Kombucha developed in this study is well-received by the public across various academic groups.

Tabel 3. respondent questionnaire

Description	Frequency	Percentage
Balanced taste	110	98.5%
Fresh aroma	110	100%
Soft texture	110	100%
Good color and clarity	110	100%
Attractive packaging	110	100%
Informative label	110	100%
Noticeable health benefits	110	100%
Satisfying innovation	110	100%
Modern appearance	110	100%
High purchase interest	110	100%

Students, being the largest group of respondents, noted that the dragon fruit Kombucha innovation reflects the spirit of young, creative entrepreneurship that is environmentally friendly and highly valuable in terms of health. Overall, the taster activities indicated that the dragon fruit Kombucha product was well accepted by all respondent groups. The combination of unique flavor, natural ingredients, and an eco-friendly concept gives this product high added value. The positive support from academics and educators also shows that this innovation has the potential to be developed not only as a consumer product but also as a tool for education and sustainable entrepreneurship.

4. Conclusions

The research focuses on the development and optimization of the marketing of environmentally friendly dragon fruit-based Kombucha in Kediri through the implementation of automation technology using the n8n platform. Kombucha, a fermented beverage known for its numerous health benefits, was selected to use dragon fruit due to its high nutritional content. This study adopts a research and development (R&D) approach using the Borg and Gall model, which emphasizes the importance of evaluation and testing at each stage to achieve a high-quality product.

Through the use of n8n technology, automation in the production process allows for more efficient production flow management, including raw material control, fermentation time, as well as product distribution and marketing. The use of this technology is expected to improve product quality, reduce dependence on manual processes, and accelerate production time. Product testing results show a positive response from consumers towards the dragon fruit-based Kombucha, which stands out for its balanced taste, fresh aroma, and appealing natural color.

This research provides a deeper understanding of the potential application of automation technology in enhancing the efficiency and sustainability of Kombucha production. Additionally, the results of this study also show that this product innovation has strong appeal in the local Kediri market, with potential for further development in the context of environmentally friendly and sustainable entrepreneurship.

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Author Contribution

Conceptualization, A.I.S.; Methodology, A.I.S.; Software, A.I.S.; Validation, A.I.S., I.P.F., and A.Z.; Formal Analysis, I.P.F.; Investigation, A.I.S., I.P.F., and A.Z.; Resources, A.Z.; Data Curation, A.I.S.; Writing – Original Draft Preparation, A.I.S.; Writing – Review & Editing, I.P.F. and A.Z.; Visualization, A.I.S.; Supervision, I.P.F. and A.Z.; and Project Administration, A.I.S. All authors have read and agreed to the published version of the manuscript.

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Ethical Review Board Statement

This study was conducted in accordance with ethical research principles involving human subjects. All panelists involved in the sensory evaluation voluntarily provided informed consent after being informed about the research objectives and procedures. Halal certification for the kombucha product has been submitted to the Halal Certification Body

(Lembaga Sertifikasi Halal/LSH) of East Java and is currently under verification and awaiting the issuance of the halal certificate.

Informed Consent Statement

Informed consent was obtained from all subjects (students) involved in the study. All panelists voluntarily participated in the sensory evaluation of the kombucha product after being informed about the research objectives and procedures.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Sensory evaluation data are not publicly available to protect participant privacy.

Conflicts of Interest

The authors declare no conflicts of interest. This research was self-funded by the authors, and they had full autonomy in the design of the study; in the collection, analysis, and interpretation of data; in the writing of the manuscript; and in the decision to publish the results.

Declaration of Generative AI Use

During the preparation of this work, the author(s) used several generative artificial intelligence tools: ChatGPT and Claude AI to assist in drafting, improving grammar, clarity, and academic tone of the manuscript; Grammarly for grammar enhancement and spelling correction; DeepSeek to support the development of the kombucha recommendation application code; and n8n and Sumo for workflow automation in application development. After using these tools, the author(s) reviewed and edited the content as needed and took full responsibility for the content of the publication.

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