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Technology Innovation and Creativity Process in Coffee Drinking Business

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Abstract: The coffee drinking culture has become a part of daily life. Many studies have been conducted on the coffee business, coffee drinking culture, and technological advancements. However, there is still a lack of focus on the creativity process and the impact of the coffee drinking culture. This research focuses on the technological changes in coffee machines, especially the transition from manual to semi-automatic roasting machines, and how this affects the coffee beverage business and the coffee drinking culture. Using observation and several interviews with three entrepreneurs in the coffee drinking businesses in West Java, Indonesia, the research findings indicate that coffee machine technology has been utilized to develop the coffee beverage business and has contributed to changing the landscape of coffee drinking culture in Indonesia. Coffee drinking now serves as a beverage and a symbol of social status and individual identity. The four steps of the creativity process by Richard Florida confirmed that business continuity needs to adopt four stages: preparation, incubation, illumination, and verification. If one or several creative ethos are skipped, business sustainability will be impacted.

Keywords: technology innovation, creativity process, entrepreneurship, coffee drinking culture, sustainability

Introduction

The coffee drinking culture has become a part of life and society in various parts of the world, including Indonesia. Since its introduction, coffee has served not only as a beverage but also as a cultural element that fosters connection and serves as a social symbol in various interactions. In Indonesia, the tradition of drinking coffee has existed since the 15th century and continues to evolve with the changing times. According to Fitriani (2023), the term "coffee waves" (three waves) describes the evolution of coffee culture, from the introduction of coffee as a commodity to the emergence of modern coffee shops that offer unique experiences for their patrons. The trend of drinking coffee in cafés has increased by 13.9% per year in Indonesia over the past six years (Safitri & Arina, 2022). This increase in coffee consumption even surpasses the global trend, which has only seen an 8% annual growth from 2016 to 2021. Digital marketing across various e-commerce platforms marks the development of coffee drinking trends and culture on a global scale. Indonesian coffee commodities have proven to have a variety of flavors distinct from those of other countries, leading to a continuous increase in coffee product exports (Intan, 2022).

Several previous studies on coffee have shown findings regarding various health benefits of caffeine, in addition to its negative effects. Research conducted at the University of Bologna (2023) found that drinking coffee 2 to 3 times a day can reduce blood pressure, especially systolic pressure, and lower pulse rates. Another study conducted by the Colorado Multiple Institution Review Board involving over 5,000 participants (2021) revealed that individuals who consume 1 cup or more of coffee per day have a lower risk of heart failure (Cicero et al., 2023; Stevens et al., 2021). Other studies have found various negative effects associated with daily consumption of coffee. Among these concerns is that regular caffeine consumption is worrisome due to its long-term effects on users' health. A direct consequence is that tolerance to caffeine can lead to an increased risk of withdrawal symptoms. Results from surgical and invasive procedures indicate that caffeine may speed up a surgeon's tasks but can reduce their dexterity and motor function.

While high-frequency caffeine consumption can be beneficial for endurance and muscle strength, it may impair the motor skills that are crucial for surgeons during operations (Parry et al., 2023).

These days, coffee has become a part of the lifestyle of the younger generation, whether they are working in offices or studying in higher education. The coffee drinking culture is not only a symbol of familiarity and social interaction but has also shaped and reflected an individual's social status and identity, depending on which type of coffee they choose to drink. Knowledge about the coffee-making process has significantly developed and been well disseminated among consumers. Coffee enthusiasts can select the type of coffee beverage that suits them, and this knowledge adds to their identity, alongside factors such as price and flavour, which previously influenced their decisions.

The trend of coffee drinking and caffeine consumption has been the focus of many previous studies, however, the increase in this coffee drinking trend is also very interesting to examine from the perspective of technological innovations in the machines and equipment used, in addition to lifestyle and cultural aspects. Unlike previous research, this study focuses more on how new breakthroughs and technological innovations in the form of coffee machines and their equipment, as well as the coffee-making process, contribute to shaping the culture of contemporary coffee enthusiasts.

Literature Review

Creative Ethos

Florida (2003), in his writing *"The Rise of the Creative Class,"* states that the term "creative class" refers to creativity that is not solely possessed by artists. The creative class includes workers who create or initiate new products and services that have value and meaning. Additionally, Richard Florida mentions that creativity is a process within a 'closed system' to initiate breakthroughs, experiment with those ideas, communicate the results of the experiments, and test them with potential users, as well as obtain feedback from them to align and make evaluations/adjustments if necessary. These stages are illustrated in Figure 1.

Figure 1. The Creative Process in Entrepreneurship

Source: Florida (2003)

Richard Florida's explanation of creative ethos reinterprets the creative process in entrepreneurship aimed at generating innovation in the modern world. This process involves a dynamic, collaborative, and adaptive approach to the changing times, allowing individuals and industries to continuously evolve and compete in the ever-changing digital era. The stages illustrated in Figure 1 include:

a) Preparation

The initial process of idea emergence usually stems from a problem that is currently being faced and requires an immediate search for a solution. It begins with gathering all relevant information and the process of refining the idea.

b) Incubation

The process of executing ideas and experimenting to find the best solution. This process can be time-consuming and costly, requiring strong teamwork and collaboration, as well as various technical resources to bring the initial idea to fruition and make it ready for use.

c) Illumination
The process of presenting the solution—based on the results of idea experimentation—to users, in order to solicit feedback from the user community.
d) Verification and Revision
The process of adjusting the idea, product or service resulting from the experiments based on the feedback received from users.

The creative process in entrepreneurship emerged with the term "creative economy" introduced by Howkins (2001) in his book *The Creative Economy: How People Make Money from Ideas*. Howkins defines the creative economy as economic activities that rely on ideas, creativity, and innovation to create value. The creative economy encompasses various sectors within industries that utilize creativity and innovation as the foundation for entrepreneurship in producing high-value economic products or services (Nisa & Syafitri, 2024).

Technology Innovation

The development of coffee machine technology has seen significant advancements. Coffee machines, particularly roasting machines, have evolved from manual systems that rely on human labor to semi-automatic machines equipped with various advanced features. This technology allows producers to better control the coffee processing, resulting in high-quality and consistent coffee beans. Automatic roasting machines, for example, are equipped with control panels that enable adjustments to temperature and roasting time according to production needs, thereby enhancing efficiency and the quality of the final product (Sulistyo & Suhono, 2023).

As one of the world's most popular beverages, coffee has undergone significant changes in production and consumption due to technological advancements. From cultivation to brewing, innovation has reshaped how coffee is grown, processed, and enjoyed (Mackenzie, 2024). Several advancements in coffee production, from the plantation to grinding and the final result in the form of coffee preparation methods, are summarized as follows:

1. *Precision Agriculture*
   Modern technology has enhanced coffee farming by improving efficiency and sustainability. GPS, drones, and sensors provide data on soil health, weather, and cops, optimizing irrigation, fertilization, and harvesting for better yields and lower resource use.
2. *Coffee Plant Breeding and Genetic Engineering*
   Advancements in plant science have produced coffee varieties that withstand climate change, pests, and diseases. Through breeding and genetic engineering, scientists have developed resilient plants that thrive in heat, need less water, and resist coffee leaf rust.
3. *Innovations in Coffee Processing*
   - Improve drying techniques
   - Fermentation control for flavour enhancement
   - Advanced milling and sorting processes
4. *Technological Developments in Coffee Brewing*
   - High-tech home brewing equipment
   - Growing popularity of single-serve machines
   - Cold brew and nitro coffee technology
5. *E-commerce and Digital Marketing in Coffee*
   - Expansion of online coffee sales
   - Influence of digital marketing and social media
   - Blockchain for transparency: Enhances traceability by recording each step of the supply chain, allowing consumers to verify coffee origins and ethical sourcing.

Producers benefit by showcasing a quality and securing better market prices.

6. *Sustainability and Environmental Impact*
    - Reducing coffee's carbon footprint
    - Eco-friendly packaging solutions
    - Waste reduction and recycling initiatives

Several innovative technologies in the coffee production process, from the plantation to the final coffee beverage product, have shaped a new coffee drinking culture to this day.

Cultural and Technological Relations

According to Baudrillard (1998), as cited in Imbir, Lesawengen, and Mumu (2023), the situation of contemporary society is shaped by the reality that humans are now surrounded by consumption factors. Baudrillard concludes that the conditions occurring among consumer societies are related to the circumstances regulated by capital owners. Thus, the control system used is a massive campaign concerning lifestyle and prestige. The consumptive behaviour referred to here is that of coffee drinkers. Coffee consumption is often found in coffee shops. Coffee is regarded as a symbol of togetherness, hospitality, and unity, with its presentation reflecting the social status of the host. The coffee drinking culture has continued to evolve, leading to the emergence of the term "coffee waves" (three waves) from the 15th century to the present day (Fitriani, 2023). Coffee beverages contain psychotropic substances, one of which is caffeine, which can stimulate two hormones: cortisol and adrenaline. Therefore, coffee produces effects that can eliminate drowsiness and enhance mental awareness, thought, focus, and response (Demartoto et al., 2015).

The discussion regarding the relationship between science, technology, and culture can involve two value systems: the value system in the process of creating technology and the value system in the use and acceptance of technology. Technological culture demands creative abilities and innovative capacities from each individual involved. In this context, the need for innovation can drive Western science and technology to explore new areas, leading to novelty and progress.

Another characteristic of technological culture can be seen in the mindset of the individuals oriented within it. These individuals can be described as a group that is perpetually dissatisfied with what has been achieved, necessitating novelty, imagination about future life, and a utopia they wish to attain through science and technology. Technological culture encourages each individual to develop a productive attitude, which involves maximizing the use of science and technology to enhance productivity. This productive attitude is closely related to an innovative mindset, as innovation can increase production, and conversely, production requires innovations. However, Indonesian culture currently still experiences a gap between production culture and consumer culture. Consumerism and a consumptive lifestyle dominate society more than the drive to produce (Demartoto, Kartono, & Solikatun, 2015).

Methodology

In conducting this research, the authors employ a qualitative method in the form of literature studies and interviews with three café owners regarding the use of machines and equipment. A literature review has been conducted on the development of coffee machine technology, especially focusing on the use of semi-automatic roasting machines that facilitate the coffee production process. Based on this, knowledge has been gained about how semi-automatic roasting machines make work easier and maximize the output produced, ensuring that the quality of the coffee grounds meets the varying levels of maturity according to consumer demand. The stages of the research are illustrated in Figure 2.

Figure 2. Three Stages of Research

Data Analysis

In the coffee-making process, there is a crucial step that must be considered: the roasting process. The roasting process in coffee production is the initial stage before grinding. It begins with the evaporation of water, followed by the process of pyrolysis. The variation in roasting time typically ranges from 20 to 30 minutes. Therefore, in this era of globalization, there has been a development from manual roasting machines to semi-automatic roasting machines using microcontrollers. This advancement in roasting machines is aimed at improving the efficiency of the equipment. Energy efficiency is necessary to operate the machines and reduce the waiting time for the coffee beans to roast more quickly compared to manual roasting machines (Sulistyo & Suhono, 2023). The three levels of maturity in the roasting process can be seen in Table 1.

Table 1. Levels of Coffee Bean Maturity in the Roasting Process

No.	Maturity Type	Example Image	Explanation
1.	Light Roast		At this level, the coffee beans are roasted at a temperature of 196-205°C until the first crack occurs. This level of maturity is characterized by a yellowish-brown color.
2.	Medium Roast		At this level, the coffee beans are roasted at a temperature of 210-219°C until they pass the first crack but do not reach the second crack. At this maturity stage, the color of the coffee beans becomes darker than before.
3.	Dark Roast		At this level, the coffee beans are roasted at a temperature of over 225°C, and roasted until the second crack occurs. As a result, the beans take on a much darker color, and oil appears on the surface.

Source: Sulistyo & Suhono (2023)

The physical changes in coffee beans during the roasting process can be categorized into three types:

1. ***Change in moisture content***: This process occurs due to the transfer of heat from the roasting medium to the material, resulting in the transfer of water mass during the roasting process. The water contained in the material evaporates until the moisture content reaches a saturated condition.
2. ***Change in texture*****:** This process occurs due to the temperature variation used during the roasting time. The roasting process affects the rate of moisture evaporation in the coffee beans.
3. ***Colour change*****:** The change in colour during the roasting process is due to the caramelization of sugars, resulting in a dark brown colour when the coffee is fully roasted. The chemical reaction that occurs between sugars and amino acids from proteins is known as non-enzymatic browning or the Maillard reaction.

The development of coffee machines, particularly roasting machines, can determine the quality of the coffee grounds that will be sold. The coffee roasting machine owned by Anilatul Bahroin and Agung Prijo Budijono, as mentioned in Sulistyo & Suhono (2023), features a roasting system that uses temperature as a reference in the roasting process. This roasting machine system employs thermocouples to respond to temperature changes and thermocontrol for temperature regulation set by the production unit. When the temperature on the thermocouple is reached, the thermocontrol cuts off the AC power supply to the solenoid valve. The solenoid valve acts as a closure for the gas inlet to the burner, causing the burner to turn off. The control for the roasting speed of this machine uses pulse width modulation (PWM) as a speed control mechanism, which is adjusted through a potentiometer. This allows users to change the speed according to their preferences based on the previous tests. The performance of this roasting machine control system operates at speeds of 30 rpm and 60 rpm. The set temperatures are 140°C, 150°C, and 160°C. Consequently, the performance of this control system yields variations in the roasting results of coffee beans that approach coffee standards. At a speed of 60 rpm with a temperature of 150°C and a roasting time of 25 minutes, a moisture reduction of 22% in the coffee beans was achieved, resulting in a light roast colour (Sulistyo & Suhono, 2023).

Another finding emerged at Astrophilia Coffee, which is a small and medium-sized enterprise (SME) coffee shop located on Jl. Tanah Serela Raya, Tambora, West Jakarta. Astrophilia Coffee has a coffee machine, but its use is still semi-automatic. Therefore, operating the machine still requires the buttons on the machine and human estimation. However, there are often malfunctions with these buttons, making the equipment difficult to use properly and resulting in inconsistent coffee flavour quality. To address this issue, an Arduino-based automatic espresso machine with Android control has been designed. This way, the workload of the barista in preparing beverages can be reduced. In this context, manual control systems are described as control systems that use subjects or living beings, such as humans. Meanwhile, automatic control systems are those that use control devices like controllers. Therefore, the designed control system is also influential because the equipment is created with the assistance of Android control. The application implements this control system (Wasid & Fadilah, 2024). All findings are shown in Table 2.

Table 2. Results of Interviews with Three Entrepreneurs in West Java

No	Cafe Name, Years of Operation	Number of Employees or Visitors	Type of Coffee Machines and Equipment Owned	Development Strategy
1	"AL" (10 years)	14, 50-60 visitors on weekdays, 15-200	a. The Petroncini roasting machine with a capacity of 15 kg produces consistent roasting and meets supply demands effectively.	a. Product development is crucial because customers are

		visitors on weekends.	b. The La Cimbali 2-group espresso machine can quickly make espresso and steam milk, but it is less consistent due to its age of about 9 years. c. The Mazzer grinder produces good and consistent grinds, but the grinding process takes quite a long time. d. Manual brew equipment, such as the Hario V60, Kalita Wave, Flat Bottom, and Cold Drip, along with the 600N grinder, is very helpful in production as it is designed for commercial needs. However, the espresso machine should be replaced because it is old, and its technology is outdated.	always looking for something new. b. Keeping up with current trends and improving quality and flavour is essential. c. Location is also important, including maintaining cleanliness and ambiance for the comfort of customers.
2	"SG" (2 years)	7, with 40-50 visitors on weekdays and 100-150 visitors on weekends.	a. The La Marzocco Linea 2GR espresso machine is a high-end coffee machine that offers consistent extraction and advanced volumetric technology for fast production. b. The Anfim Milano grinder, with its large burrs, allows for faster and more consistent coffee grinding. c. Manual brew equipment such as the Hario V60, AeroPress, and Hario electric grinder. d. The La Marzocco brand is often regarded as the "Rolls-Royce" of the coffee world, so it is no surprise that the quality of its products in "SG" is exceptional.	a. Promotion is a key factor. b. The weakness of SG lies in the lack of promotion.
3	"LK" (4 years)	11employees 60 visitors on weekdays and 150-200 visitors on weekends.	a. The Nouva Simonelli Appia 2 espresso machine is a mid-to-high-end coffee machine with high quality, the latest technology, ease of production, good after-sales support, and easy maintenance. b. The Anfim Milano Dose grinder features large burrs, allowing it to grind coffee quickly and with high consistency. c. Manual brew equipment, such as the Hario V60, Flat Bottom, and Cold Brew, is supported by the Latina 600N grinder for optimal brewing results. With this equipment, the quality of the products produced is already very good, although still below that of "SG".	a. Location selection plays an important role in business. b. LK lost the competition because its location is far from the city centre and has narrow access. As a result, this café closed in March 2024.

From the interviews conducted between September 2024 and January 2025 in Table 2, it can be concluded that technological innovation in coffee machines plays a crucial role in the success and sustainability of coffee beverage businesses, alongside other factors such as location and marketing strategies.

Discussion

Product development is crucial in business competition and sustainability, especially in the coffee beverage sector. If a café that sells coffee drinks does not try to continue to create new product variations based on consumer preferences, then it can be predicted that the business will fail. Apart from location and cleanliness factors, consumer tastes that are manifested in the form of product development are the main needs of this business. From the three cases observed, coffee machine innovation needs to be observed and studied. Entrepreneurs must increase their knowledge and skills about this, which is then reflected in the product menu sold in their business.

Adopting Florida's theory (2003) on the creative ethos, only two out of the three coffee beverage businesses studied survived because they carried out all four processes: (i) preparation, (ii) incubation, (iii) illumination, and (iv) verification. Meanwhile, one business—"LK"—did not complete all four stages, remaining in the "incubation" stage and failing to progress further. While the company adopted the innovation of coffee machine technology, the illumination and verification processes were not carried out, because the business had gone bankrupt. Location and promotion factors are the next crucial factors that need to be observed and considered better by the company. Thus, the last two stages of the creativity process by Florida provide feedback on the incubation stage carried out in the form of technology innovation (by the company) as shown in Figure 3.

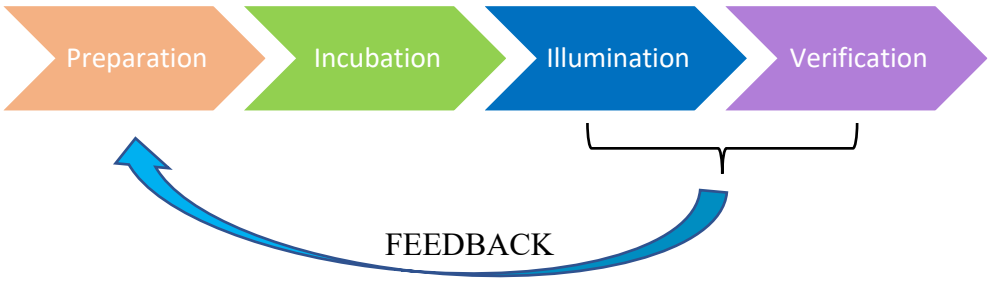

Figure 3. Closed Loop of Creativity Process

Conclusion

Technology has significantly transformed coffee production and consumption, enhancing efficiency, quality, and sustainability. From cultivation to brewing, innovators have improved processes and introduced new ways for consumers to enjoy coffee. As the industry evolves, producers, retailers, and consumers need to adopt these advancements while addressing potential challenges. Embracing technology will enable the coffee industry to grow, meeting the increasing demand for high-quality, ethically sourced, and sustainably produced coffee. In the process of creativity, an entrepreneur needs to carry out the creative ethos initiated by Richard Florida. Technological innovation needs to be followed and carried out, but it still has to be equipped with the illumination and verification stages. Thus, the business can survive and win in the competition.

Coffee consumption today not only fulfils social and functional needs but also brings new values in the form of social status and identity. The coffee drinking culture in Indonesia, which has emerged since the 15th century, has rapidly evolved alongside the current behaviours of coffee consumers. The development of coffee machine technology, particularly

the machines used in plantations and roasting machines during the coffee beverage preparation process, has shifted from manual to semi-automatic, facilitating the production process and enhancing the quality of coffee up to the final product. Technological innovations in the field of coffee machines have also contributed to the growth of the coffee industry and business in various countries, especially in Indonesia. Technological innovations in the form of more automated machines and equipment, equipped with control panels that allow for adjustments in production results according to needs, have produced new quality in the form of a wider and more varied range of products. Ultimately, consumers benefit and gain various advantages from these technological innovations. The way coffee beverages are enjoyed has also contributed to the development of societal culture and has enriched and complemented the perspectives of their users.

Practical Implications

The results of this study indicate that technological innovations, particularly in coffee machines and their equipment, have significantly driven the advancement and development of the coffee beverage business. Therefore, industry players are encouraged to adopt and utilize the latest technology in coffee machines and equipment for the sustainability and success of their businesses. Additionally, it is recommended to educate consumers about the importance of local coffee and the tradition of coffee drinking, in order to reduce excessive consumerist lifestyles. Thus, it is hoped that a balance will be created between modernization and cultural preservation, as well as an increased awareness among the public regarding the importance of coffee product quality and maintaining the traditional values of enjoying coffee as a symbol of closeness and social interaction.

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