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ANALYSIS: ALIGNING INFORMATION SYSTEMS AND BUSINESS PROCESSES IN THE COFFEE INDUSTRY

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Abstract

The coffee industry, which encompasses more than 25 million smallholder farmers worldwide, requires efficient and sustainable supply chain management. Integrating Information Systems (IS) with business processes in the coffee sector can enhance operational performance. This study utilizes a combination of literature reviews and field surveys to examine the alignment of IS in the industry. The primary findings underscore the significance of web-based and desktop solutions in facilitating stakeholder access to accurate information. Entity Relationship Diagrams (ERD) and Data Flow Diagrams (DFD) ensure a comprehensive understanding of the system's structure. The integration of IS supports sustainable practices by monitoring environmental impact and promoting fair trade. The discussion highlights the benefits of digital transformation, including improved decision-making and operational efficiency. Adopting structured approaches such as ERD and DFD facilitates effective communication among stakeholders. The integration of IS with sustainable practices reflects a commitment to environmental stewardship and ethical business conduct. Recommendations include the continued development of IS customized to meet the needs of stakeholders, fostering collaboration for innovation, enhancing digital literacy, designing sustainable IS solutions, and advocating for the adoption of IS policies. The implementation of these recommendations has the potential to drive efficiency, sustainability, and stakeholder engagement in the coffee industry.

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INTRODUCTION

The coffee industry holds significant importance in the global agricultural sector, serving as a pivotal contributor to the economies of numerous developing countries. With a reliance on coffee cultivation for their livelihoods, over 25 million smallholder farmers are involved in this industry, which stretches across continents and encompasses a multitude of stakeholders, including farmers, exporters, importers, roasters, retailers, and consumers. Given the intricacy of this industry, effective management of the supply chain is essential, and this can be greatly facilitated through the integration of Information Systems (IS).

The coffee industry is a sprawling and multifaceted global market, bringing together various parties ranging from coffee farmers to end consumers. It is crucial to create an information system (IS) that aligns with the business processes in the trade, research, and

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production activities within the coffee sector, as this aids in optimizing efficiency, ensuring traceability, improving quality control, and promoting sustainable practices[1]. This research delves into the analysis of the impact of a well-designed IS on aligning business processes within the coffee industry, with a specific focus on trade, research, and production[2].

As an indispensable component of the global economy, the coffee industry relies on complex supply chains and intricate business processes[3]. The escalating popularity of coffee, both domestically and internationally, underscores the urgency to streamline the management of coffee production, trade, and research in order to support the economic well-being of coffee farmers and ensure the long-term sustainability of the industry [4], [5].

To tackle these challenges, the creation of an information system that effectively corresponds to the business processes in the coffee industry is of utmost importance[6]. Such a system should encompass the entirety of the coffee supply chain, starting from the farm to the final consumer, while providing comprehensive support for the management of coffee production, trade, and research[7].

The coffee agro-industry consists of diverse entities, including farmers, intermediaries, traders, and the processing sector[8]. As the supply chain network is complex and highly interconnected, it becomes susceptible to various risks, like production and institutional risks[9]. To mitigate these risks, the establishment of a robust traceability system is essential, as it guarantees the authenticity and quality of specialty coffee[8], [10].

The development of a web-based coffee management information system can considerably bolster the administration, promotion, and sales processes for regional coffee cooperatives[11]. This system can harness the existing telecommunications infrastructure and the widespread use of mobile devices within local communities, thereby facilitating the seamless integration of coffee production, trade, and research data.The utilization of information technology in the management of the coffee supply chain offers numerous advantages[12]. For. Specifically, the integration of wireless sensor networks, cloud computing, and the Internet of Things (IoT) facilitates real-time monitoring of environmental conditions, crop health, and post-harvest processing[13]. This data-centric approach supports decision-making, enhances operational efficiency, and promotes sustainable growth within the coffee industry[14].

In addition, the adoption of e-commerce technology broadens the market channels available for coffee products, reduces the need for distribution intermediaries, and lowers transaction costs[15]. As a result, coffee farmers and cooperatives are empowered to reach a wider customer base, strengthen their bargaining power, and ultimately improve their livelihoods[16].

The problem of the selling information system revolves around the improvement of selling activities and competition with other market players[17]. Business organizations seek suppliers who not only offer competitive prices, quality, and performance but also demonstrate efficient order handling. To address these needs, a selling system is developed, which selects selling data from various sources across multiple computer systems and maintains records in a Selling Information Database. The primary objective of this system is to provide executive management with real-time online access to customer relationships of interest[18].

The coffee industry's supply chain is frequently hindered by obsolete trading systems, where farmers face disadvantages due to the dominance of intermediaries[19]. This study introduces a novel application based on the Google Maps API, aiming to empower coffee farmers by increasing the

visibility of their operations to potential buyers[20].

The coffee industry, an essential sector in many economies, has increasingly embraced information systems to enhance various aspects of production, quality control, and market distribution[21]. Information systems in the coffee industry encompass diverse technologies and methodologies designed to streamline operations, improve product quality, and facilitate market access[22]. These systems integrate data collection, processing, and analysis to support decision-making and optimize operational efficiency[23], [24].

A noteworthy application of information systems in the coffee industry is the utilization of digital image processing and machine learning for quality assessment and classification[25], [26]. For example, digital image processing techniques have been effectively employed to sort coffee cherries based on their degree of ripeness, thereby ensuring high-quality production standards[27]. Similarly, non-destructive methods employing near-infrared (NIR) spectroscopy and digital images have been developed to authenticate gourmet ground-roasted coffees, providing consumers and regulatory agencies with tools to prevent deceptive labeling[28]. Remote sensing technologies play a significant role in the coffee industry by assisting in the mapping of coffee agroforestry systems, evaluating changes in forest cover in coffee-producing regions, and predicting suitable habitats for coffee hybridization[29]. Utilizing satellite data and machine learning models, stakeholders are able to monitor environmental conditions, optimize land utilization, and promote biodiversity conservation[23].

Moreover, information systems contribute to the efficient management of coffee supply chains[30]. Web-based platforms and computerized systems streamline various aspects, including sales, ordering, stock management, and customer service, thereby ensuring smooth operations and safeguarding data[31]. These systems enable real-time tracking of transactions, inventory levels, and customer interactions, leading to increased responsiveness and decreased errors[32].

The integration of information systems in the coffee industry has brought about a revolution in traditional practices, presenting innovative solutions for quality control, environmental monitoring, and supply chain management[33]. Ongoing technological advancements hold vast potential for further enhancements, promising greater efficiency, sustainability, and market competitiveness in the coffee sector[34].

Establishing a territory for the introduction of an information system in the coffee industry involves several key aspects[35]:

1. User Acceptance and Willingness to Adopt: The success of implementing an information system in the coffee industry heavily relies on the willingness of end-users to adopt the system. This includes assessing user acceptance and developing suitable training programs for end-users[24].
2. Web-Based Management Systems: The development of web-based coffee management information systems allows for administrative, promotional, and sales processes to be carried out online[36]. This system can be accessed by both admins and users, facilitating transactions and management[37].
3. Location-Based Services: Utilizing technologies like the Google Maps API to create applications that help sellers and buyers find coffee sales locations. This includes functionalities such as locating farmers, checking coffee stock availability, and providing directions to the farmer's site.

4. Support for Production Productivity: Creating information systems that process data from coffee plantations to support production productivity. This involves managing raw material stocks and ensuring accurate information is accessible to all entities involved in the production process.

Mind mapping about Aligning Information Systems And Business Processes In The Coffee Industry:

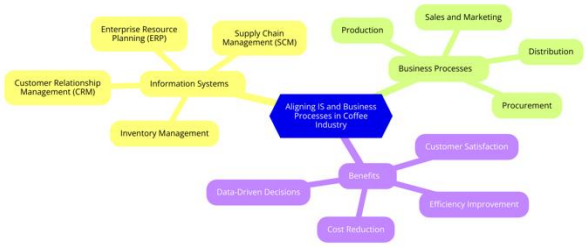

Figure 1: Mind Mapping

The mindmap diagram above illustrates the key components and benefits of aligning information systems (IS) with business processes in the coffee industry. Here is an explanation of the main nodes and their connections:

1. Aligning IS and Business Processes in Coffee Industry: This is the central theme of the mindmap, represented by a hexagon.
2. Information Systems (IS) 💻: This branch represents various information systems used in the coffee industry:
3. Inventory Management: Systems for tracking inventory levels, orders, sales, and deliveries.
4. Customer Relationship Management (CRM): Systems for managing a company's interactions with current and potential customers.
5. Supply Chain Management (SCM): Systems for managing the flow of goods and services from suppliers to customers.
6. Enterprise Resource Planning (ERP): Integrated management systems that collect, store, manage, and interpret data from various business activities.
7. Business Processes: This branch represents the core business processes in the coffee industry:
8. Procurement: The process of sourcing and acquiring raw materials and supplies.
9. Production: The process of transforming raw materials into finished coffee products.
10. Sales and Marketing: Activities related to promoting and selling coffee products.
11. Distribution: The process of delivering coffee products to customers.
12. Benefits: This branch represents the advantages of aligning IS with business processes:
13. Efficiency Improvement: Streamlining operations to make them more efficient.
14. Cost Reduction: Lowering operational costs through better resource management.
15. Customer Satisfaction: Enhancing customer experiences and satisfaction through better service and product quality.
16. Data-Driven Decisions: Making informed business decisions based on accurate and timely data.

Alignment of business processes with IT refers to the synchronization and integration of technology with the operational activities and objectives of an organization[3]. This alignment ensures that IT systems support and enhance business processes, leading to improved efficiency, productivity, and overall performance[38].

An information system can be defined as an organized system that involves the collection, processing, storage, and dissemination of data or information for specific purposes[39]. These purposes can vary, ranging from the management of sales,

ordering, stock, and sales analysis in a business context to the monitoring of plantations, prediction of diseases, or development of traceability systems in agriculture[40]. Information systems consist of components such as project management, design models, network architecture, user interfaces, and data processing algorithms[24].

In order to effectively accomplish their objectives, information systems must incorporate components such as project management, design models, network architecture, user interfaces, and data processing algorithms[41]. The documents underscore the existence of various types of information systems customized to suit different industries and applications, highlighting the critical nature of accurate data processing, efficient communication[42], and user-friendly interfaces for successful implementation and operation.

The term "information system" generally refers to a systematic process that involves the collection, processing, storage, and dissemination of information for a particular purpose. It involves the utilization of technology, individuals, processes, and data to support business operations and decision-making[43]. The following references are relevant to the topic of information systems:

Examines the significance of computer-based systems in accomplishing management objectives, with a focus on sales, ordering, stock management, and sales analysis. Outlines a project plan to automate sales transactions and enhance efficiency in managing customer orders, invoices, and reports through a system analysis and design initiative[44]. Describes a web-based platform that handles user sessions, requests, and content access, integrating with existing websites and managing content hosted on remote servers. Presents the design and development of a coffee production information system aimed at supporting productivity in farmers' groups, facilitating the management of raw materials and enhancing production activities[40].

A Selling Information System is specifically designed for the analysis and design of system development with regards to managing sales-related information within an organization. It aims to handle sales statuses, provide selling information about customers, and also manage a company's financial aspects. This system streamlines executive management by extracting customer, sales, and payment data from multiple sources across computer systems, offering online real-time access to this information[45].

Coffee (Coffea sp.) is widely consumed globally and serves as a significant commodity for producing countries. The beverage is created by infusing ground roasted coffee fruit seeds with warm water, followed by filtering, percolating, or pressing[46]. The preference for coffee stems from its pleasant taste and aroma, which positively influence its consumption. The coffee information system entails the development of a system that supports the productivity of coffee production within a farmers' group. The predominant issue addressed by the system is the lack of information regarding raw materials in the warehouse, which sometimes hinders the production process[47]. The entities involved in this system encompass the production department, the warehouse section, farmers, and farmer group officers.

The research on the coffee information system aligns with other studies on the subject by tackling similar challenges and employing comparable methodologies. For instance:

1. Addressing Production Challenges: Both studies aim to resolve concerns related to the availability of raw materials and production constraints. Effendi et al. seek to establish an information system that manages raw material stocks and aids production

efficiency, which reflects the objectives of other research in the field.

2. System Development Methodologies: The utilization of Object-Oriented system development and tools like the Unified Modeling Language (UML) is a prevalent approach in both studies. Effendi et al.[40] and Laumal et al.[48] both employ these methodologies to design and develop their respective systems.
3. Web-Based and Desktop Solutions: Laumal et al. [48] concentrate on creating a web-based coffee management information system, while Effendi et al. [40] develop a desktop-based system. Both approaches strive to enhance accessibility and the accuracy of information for stakeholders involved in coffee production and management.
4. Entity Relationship and Data Flow Diagrams: Both studies employ techniques such as Entity Relationship Diagrams (ERD) and Data Flow Diagrams (DFD) to model the data and processes within the system. Laumal et al.[48] and Effendi et al.[40] utilize these diagrams to ensure a clear comprehension of the system's structure and data interactions.

Overview of the Coffee Industry

1.1 The Global Coffee Market

The global coffee market is a lucrative industry with extensive supply chains that span across continents. Coffee stands as one of the most traded commodities worldwide, with major producers including Brazil, Vietnam, Colombia, and Ethiopia. Consumers primarily reside in North America, Europe, and Asia. The coffee industry confronts challenges such as fluctuating prices, climate change, and the demand for sustainable farming practices[49].

1.2 Key Stakeholders

The primary stakeholders in the coffee industry encompass:

- Farmers: The initial producers engaged in cultivating and harvesting coffee beans.

- Exporters: Entities that purchase coffee from farmers and vend it to international buyers.

- Importers and Roasters: Companies that import coffee beans and process them into roasted coffee.Retailers are enterprises that engage in the sale of coffee to end consumers. Conversely, consumers encompass those individuals who ultimately utilize coffee products.

Comprehending the functions and interplay between these stakeholders is of utmost importance when conceptualizing a proficient information system (IS). This article delves into the complexities of the coffee industry and examines how awell-designed IS can synergize business operations for maximized efficiency. The research will concentrate on multiple dimensions, such as the worldwide coffee market, pivotal stakeholders, the advantages stemming from IS integration, and practical case studies that demonstrate the fruitful adoption of IS within the coffee industry.

METHOD

The research utilizes the Prototyping Model, a methodology encompassing the swift creation and iterative testing of functional prototypes for novel applications. This approach enables enhanced user engagement and feedback, facilitating early identification of issues and flexibility in the design process. The key stages involved in the Prototyping Model are as follows:

1. Requirement Gathering and Analysis: Initial user and stakeholder requirements are gathered, often

being incomplete or lacking detailed specification. Conducting user research through techniques such as interviews, surveys, or usability testing of existing systems can provide valuable insights to guide the development of the prototype.

2. Quick Design: A rudimentary and expeditious system design is formulated, concentrating on the most essential features. While the design lacks specificity, it serves as a fundamental framework for the prototype.
3. Prototype Construction: The initial prototype is developed in accordance with the quick design. This initial version is typically straightforward and emphasizes the core functionalities to be demonstrated to users. It is crucial to determine the prototyping fidelity, whether employing low-fidelity sketches or high-fidelity mock-ups, based on the objectives and available resources.
4. User Evaluation: The prototype is presented to users and stakeholders for evaluation. Users interact with the prototype and provide feedback on its effectiveness, usability, and overall experience. Conducting user testing sessions where individuals engage with the prototype and offer feedback is of paramount importance.
5. Refinement: The prototype is refined based on the feedback received from users. This process may involve modifying the design, incorporating new features, or enhancing existing ones.
6. Iteration: The cycle of user evaluation and refinement is iteratively repeated. Each iteration enhances the prototype based on user feedback until it aligns with user requirements and expectations. Analyzing user feedback to identify areas for improvement and refining the prototype accordingly is crucial. These modifications may encompass alterations to the design, features, or user interface.
7. Development of Final System: Once the prototype has evolved to a stage where it satisfactorily fulfills user needs, it serves as a blueprint for the development of the final system. The final system is built in adherence to more rigorous standards, ensuring reliability, performance, and scalability.

This study uses a literature studies and field survey studies. To answer the research questions above, this study presents an overview by reviewing scientific literature published in the last 20 years.

Tabel 1. Article detail as refrences

Total number of references	Total Number of Article Based References	Total number of Official / Other Information Based Websites Reference	Articles Publication Period Included	Search Engines Used for Article Collection	Keywords for Article Search
55	45	10	2004-2024	Google Scholar, Scopus	Information System, Business Proses, Coffee

RESULTS AND DISCUSSION

Direct selling has had a significant impact on the coffee industry. By bypassing traditional distribution channels, coffee producers are able to establish direct relationships with consumers, resulting in higher profit margins and increased market

access. Direct selling also provides opportunities for coffee farmers to showcase the unique qualities and flavors of their coffee, fostering a deeper appreciation among consumers[50]. Additionally, direct selling eliminates the need for intermediaries, allowing for more transparent and fair trade practices. The key findings concerning the impact of direct selling by suppliers on information flow and profits in a bilateral monopoly setting are as follows:

Direct selling by the supplier has a fundamental impact on information flow through incentivizing the supplier to share the signal from market access with the retailer at no cost, while also obtaining the retailer's signal. This leads to complete information flow and transparency throughout the system. The supplier benefits more from direct selling as a result of this enhanced information flow. However, the retailer experiences a smaller increase in profits due to the supplier's heightened responsiveness and constrained operational flexibility.

The supplier is always inclined to engage in direct selling, as it grants them greater control over the selling process and consumer information. Direct selling transforms information flow by enabling the supplier to freely share its signal with the retailer, while also offering compensation to acquire the retailer's signal, thus achieving system-wide transparency of information.

Direct selling improves information flow in order to achieve system-wide information transparency, which has varying effects on the profits of the retailer and the overall system. While it has the potential to enhance system profit, it does not always result in benefits for the retailer.

Direct selling allows suppliers to have real-time access to consumer data, which has a positive impact on operations and decision-making. This access to consumer information, often facilitated through technology partnerships, affects the availability of signals among channel parties and influences operations.

The information effect of direct selling can be detrimental to retailers, as suppliers become more responsive in terms of wholesale pricing and direct selling. This reduces the retailer's flexibility in ordering and results in a loss of profit. However, the overall profit of the system improves as suppliers implement direct selling, depending on the variable cost of managing direct sales.

Direct selling benefits the system either by relying on retailing to generate revenue and lowering wholesale prices to mitigate the issue of double marginalization, or by shifting selling to its channel, which leads to disintermediation[51]. These benefits are enhanced by the information effect of direct selling, as it streamlines decision-making through improved information flow.

FINDING

The successful implementation of an Information System (IS) in the coffee industry has the potential to revolutionize traditional practices by providing innovative solutions for quality control, environmental monitoring, and supply chain management. Aligning business processes with IS can result in increased efficiency, improved quality, sustainability, and transparency.

Increased Efficiency

Integrating IS with business processes brings significant advantages in terms of streamlining operations and reducing bottlenecks. Automating repetitive tasks reduces the need for manual labor and minimizes errors, leading to faster and more accurate processes. For example, automating inventory management and order processing ensures optimal stock levels and prompt order fulfillment, reducing delays and enhancing customer satisfaction.

Improved Quality

IS enhances the ability to monitor and control quality at every stage of the supply chain. Real-time data from various sources, such as wireless sensor networks and Internet of Things (IoT) devices, provides valuable insights into environmental conditions, crop health, and post-harvest processing. This data-driven approach facilitates decision-making and ensures consistent maintenance of quality standards. For instance, utilizing digital image processing and machine learning techniques can enable the classification of coffee cherries based on ripeness, ensuring that only the highest quality beans are selected for processing.

Sustainability

Sustainability is a pivotal concern within the coffee industry, and information systems (IS) can bolster sustainable practices by monitoring environmental impact, advocating for fair trade, and promoting organic farming. For example, IS can track carbon footprint, water usage, and biodiversity, assisting stakeholders in adopting more sustainable practices. Moreover, e-commerce platforms can diminish distribution intermediaries, thereby reducing transaction costs and empowering farmers to access a wider customer base, ultimately fostering fair wages and improved working conditions[51].

Transparency

Enhanced visibility within the supply chain cultivates trust among stakeholders. IS can furnish detailed traceability of coffee products, tracing their journey from the farm to the cup. This ensures that consumers and buyers have access to information regarding the origins and quality of the coffee. Blockchain technology, for instance, can generate unalterable records of each transaction, heightening traceability and mitigating the risk of fraud. This transparency not only engenders consumer confidence but also opens up new markets that require stringent traceability standards.

Market Responsiveness

The ability to swiftly adapt to market fluctuations and consumer preferences is imperative within the competitive coffee industry. Real-time analytics offered by IS allow stakeholders to promptly respond to market trends, adjust production levels, and develop new products that align with consumer demands. For instance, data on consumer preferences and sales patterns can inform marketing strategies and product development, guaranteeing that coffee products remain competitive and appealing to the target market.

Case Studies

Case Study: Coffee Growers Cooperative

A cooperative of small-scale coffee farmers implemented an IS to enhance their operations. The system encompassed mobile applications that enabled farmers to record data on cultivation practices and harvest yields. This data was integrated into a central database accessible to all cooperative members and buyers. The system facilitated improved crop management, more accurate yield forecasting, and furnished buyers with transparency regarding the origins and quality of the coffee. Consequently, farmers were able to optimize their cultivation practices, leading to increased yields and higher-quality coffee. The transparency afforded by the system also fostered trust with buyers, resulting in higher prices for the coffee produced by the cooperative[52].

Case Study: Coffee Exporter's Traceability SystemAn IS was developed by a prominent coffee exporter with the aim of improving traceability within their supply chain[52]. This system made use of blockchain technology to record every transaction made from the farm to the point of export. Each batch of coffee was

assigned a unique identifier, enabling buyers to trace its origin. The implementation of this traceability system resulted in enhanced trust from international buyers and provided access to new markets that prioritize stringent traceability standards. In addition, the system helped the exporter adhere to various regulatory requirements, mitigating the risk of legal issues and bolstering the company's reputation in the marketplace[53].

A case study revolves around a research institution specializing in coffee genetics and cultivation practices. In order to support their research efforts, the institution developed an IS to collect and store data from diverse experimental farms. This data encompassed variables such as soil conditions, weather patterns, and crop performance. Researchers utilized this information to create new coffee varieties and optimize farming techniques. Moreover, the system served as a knowledge base, granting farmers access to best practices. Through this collaborative approach, knowledge sharing and innovation were fostered, resulting in the emergence of more resilient and high-yielding coffee varieties.

When implementing an IS, various challenges must be considered along with their respective solutions. One major hurdle lies in the cost associated with the initial investment in technology and infrastructure, which can act as a significant deterrent for small-scale farmers and cooperatives. The implementation of an IS necessitates substantial financial resources, which may not be easily accessible to all stakeholders.

Another challenge arises from the limited technological proficiency among small-scale farmers. Their limited tech skills can impede the effective utilization of an IS. Given that many farmers may not be familiar with digital technologies, adopting and making use of new systems can prove to be quite problematic for them.

Moreover, the issue of data security is of utmost importance. Safeguarding sensitive information is crucial, particularly when relying heavily on digital systems. The risk of data breaches and cyber-attacks increases as digital systems become more pervasive. Consequently, measures must be taken to address and mitigate these concerns.

The integration of information systems (IS) with existing systems and processes can be a complex task. This complexity arises from the fact that many stakeholders already utilize different systems, making it challenging to achieve seamless integration and data exchange[54].

Scalability: The ability of the IS to adapt to various sizes and types of operations is crucial for its widespread adoption. It is essential for the IS to possess the necessary flexibility to cater to the needs of both small-scale farmers and large exporters.

Solutions and Best Practices

Training and Support: The provision of training programs aimed at enhancing the digital literacy of farmers and other stakeholders is of paramount importance. Workshops, online courses, and hands-on training sessions can significantly contribute to the stakeholders' comfort and proficiency in utilizing digital technologies.

Affordable Technology: The utilization of cost-effective technologies, such as mobile applications and cloud-based platforms, can alleviate the financial burden associated with implementing an IS. These technologies offer scalable solutions that can be tailored to the requirements of diverse stakeholders.

Data Security Measures: The implementation of robust security protocols and regular audits is vital to safeguard sensitive information. Encryption, access controls, and continuous monitoring represent integral components of a comprehensive data security strategy.

Standardization: The development of industry standards pertaining to data formats and processes is instrumental in ensuring interoperability. Standardization facilitates seamless data exchange and integration, thus enhancing the compatibility of different systems.

Scalable Solutions: The design of flexible systems capable of scaling up or down based on the size and requirements of the operation is of utmost importance. Modular designs and cloud-based solutions offer the necessary flexibility to accommodate the diverse needs of various stakeholders.

There are Future Trends and Innovations for coffee industry:

Emerging Technologies

Artificial Intelligence (AI): AI can augment predictive analytics for yield forecasting and quality control. Machine learning algorithms can analyze extensive datasets, identify patterns, and make accurate predictions, thereby enabling stakeholders to make well-informed decisions.

Internet of Things (IoT): IoT devices can gather real-time data on environmental conditions, thereby enhancing crop management. Sensors can monitor parameters such as soil moisture, temperature, and other relevant factors, thereby providing valuable insights for optimizing irrigation and fertilization practices.

Blockchain: Blockchain technology can provide immutable records for traceability and certification purposes. This technology ensures that each transaction is securely and transparently recorded, thereby enhancing trust and compliance with regulatory requirements.

Drones and Satellites: These technologies can monitor vast plantations and provide data on crop health and growth. By employing high-resolution imagery and remote sensing, issues can be detected at early stages, enabling timely interventions and better resource management.

Sustainable Practices

Sustainability is acquiring increasing importance within the coffee industry. IS can support sustainable practices by:

Monitoring Environmental Impact: Tracking parameters such as carbon footprint, water usage, and biodiversity can enable stakeholders to adopt more sustainable practices and reduce their environmental impact.

Promoting Fair Trade: Ensuring fair wages and improved working conditions for farmers. IS can enhance supply chain transparency, thereby ensuring compliance with fair trade standards and promoting social sustainability.

Encouraging Organic Farming: Providing data and resources for organic farming practices. IS can furnish information on organic farming techniques, assisting farmers in transitioning towards more sustainable practices and meeting consumer demand for organic products.

The design of an information system that aligns with business processes in coffee trade, research, and production is vital for the industry's growth and sustainability. An effective IS can enhance efficiency, improve quality control, ensure traceability, and support sustainable practices. By integrating technology with traditional business processes, the coffee industry can better navigate the challenges it faces and capitalize on emerging opportunities. As the industry continues to evolve, the role of information systems will become increasingly central, driving innovation and fostering a more transparent, efficient, and sustainable coffee supply chain.

The study's findings suggest that digital mapping technologies can play a crucial role in transforming agricultural supply chains. The

successful implementation of the coffee trade information system demonstrates the potential benefits of such technologies in enhancing market accessibility and efficiency. Future research should explore the scalability of the system and its applicability to other agricultural sectors[55].

The advancements in coffee research and production have led to significant improvements in the quality and efficiency of coffee production. Understanding the physicochemical properties, optimizing production systems, recognizing the economic impact, and leveraging technological innovations are crucial for the continued growth and sustainability of the coffee industry. a student report, research on an information system for selling coffee using Google Maps, patent application publications, project reports, a web-based data information system for communication product selling.

CONCLUSION

The significance of integrating information systems in the coffee industry to enhance efficiency, transparency, and decision-making processes. By focusing on web-based and desktop solutions, utilizing entity relationship and data flow diagrams, and addressing production challenges, the studies showcased in the journal contribute to streamlining operations and improving stakeholder engagement within the global coffee market. The Prototyping Model methodology employed in the research emphasizes the iterative testing of functional prototypes, enabling early issue identification and user feedback for system optimization. Furthermore, the emphasis on scalability and the provision of training programs underscore the importance of adapting information systems to cater to diverse stakeholders and enhancing digital literacy within the industry.

Suggestions:

Continued Research and Development: Encouraging further research and development in information systems tailored to the specific needs of stakeholders in the coffee industry can lead to innovative solutions that address evolving challenges such as climate change and market fluctuations.

Collaboration and Knowledge Sharing: Facilitating collaboration among researchers, industry experts, and stakeholders can foster knowledge sharing and the implementation of best practices in information system integration.

Capacity Building: Investing in training programs and support initiatives to enhance digital literacy among farmers and other stakeholders is crucial for maximizing the benefits of information system integration.

Sustainability Focus: Emphasizing sustainable practices in information system design and implementation can contribute to the long-term viability of the coffee industry and support environmentally friendly production methods.

Policy Advocacy: Advocating for policies that support the adoption of information systems in the coffee sector can create an enabling environment for technological advancements and industry growth.

By implementing these suggestions stakeholders in the coffee industry can harness the power of information systems to drive efficiency, innovation, and sustainability in coffee production and management.

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