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SYSTEMS FOR STRATEGIC SALES INFORMATION MANAGEMENT: THE CASE OF THE COCOA PRODUCTION SECTOR IN COLOMBIA

Sistemas para la gestión estratégica de la información de ventas: caso sector producción de cacao en Colombia

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ABSTRACT

In the context of technologies affecting small and medium-sized rural enterprises in Colombia, this project addresses a critical need identified in a cocoa-producing SME located in the municipality of El Peñón, Santander, comprised of farming families with limited technological capabilities. The company faces difficulties in managing sales and profitability information, which impacts its strategic decision-making, operational efficiency, and sustainability. In response, the main objective of this project is to develop a functional web prototype to digitize and optimize these processes through accessible tools such as Google Apps Script and Google Sheets. The work is structured as an Intervention Project, divided into two main phases: diagnosis of the technological and organizational situation, and a proposed solution through the design, development, implementation, and evaluation of the prototype. The methodology combines qualitative and quantitative techniques, such as interviews, direct observation, modeling with UML diagrams, and validation with real users. Among the most significant results are the creation of a functional cloud-based system that reduces registration errors, enables the generation of strategic reports in less time, and centralizes sales and cost information on a single accessible platform. Furthermore, a significant economic return is projected, with a Return on Investment (ROI) of 28.57% in the first year, along with a positive social impact by strengthening the technological autonomy of the SME. The project also includes a strategic proposal for replication in other SMEs. As a general conclusion, it is highlighted that the incorporation of simple

technological solutions, adapted to the rural environment, improves the operational efficiency of small enterprises.

RESUMEN

Palabras clave:
Digitalización, productividad, sostenibilidad

En el contexto de las tecnologías que afectan a las pequeñas y medianas empresas rurales en Colombia, este proyecto aborda una necesidad crítica identificada en una pyme cacaotera ubicada en el municipio de El Peñón, Santander, conformada por familias campesinas con limitadas capacidades tecnológicas. La empresa enfrenta dificultades para gestionar la información de las ventas y rentabilidad, lo que afecta su toma de decisiones estratégicas, eficiencia operativa y sostenibilidad. Como respuesta, el presente proyecto tiene como objetivo general desarrollar un prototipo funcional web que permita digitalizar y optimizar estos procesos mediante herramientas accesibles como Google Apps Script y Google Sheets. El trabajo se estructura como un Proyecto de Intervención, dividido en dos fases principales: Diagnóstico de la situación tecnológica, organizacional, y propuesta de solución mediante el diseño, desarrollo, implementación y evaluación del prototipo. La metodología combina técnicas cualitativas y cuantitativas, como entrevistas, observación directa, modelado con diagramas UML y validación con usuarios reales. Entre los resultados más importantes se encuentran la creación de un sistema funcional en la nube que reduce los errores de registro, permite generar reportes estratégicos en menor tiempo y centraliza la información de ventas y costos en una única plataforma accesible. Además, se proyecta una rentabilidad económica significativa, con un ROI (retorno sobre inversión) del 28.57% en el primer año, así como un impacto social positivo al fortalecer la autonomía tecnológica de la pyme (pequeña y/o mediana empresa). El proyecto también incluye una propuesta estratégica de replicabilidad para otras pymes. Como conclusión general, se destaca que la incorporación de soluciones tecnológicas simples, adaptadas al entorno rural que mejora la eficiencia operativa de las pequeñas empresas.

Introduction

In an increasingly competitive economic environment, small and medium-sized enterprises (SMEs) in the agribusiness sector face the challenge of adopting technological tools to optimize their processes and increase their profitability. The cocoa sector in the department of Santander, Colombia is no stranger to this reality. Many of the companies involved in the processing and marketing of cocoa derivatives still manage their information through manual means or basic tools such as Excel, which significantly limits their capacity for analysis and control and strategic decision making. Being the specific objectives of the research: To identify good practices in the use of ICTs in agribusiness SMEs, evaluate the effectiveness of the prototype in terms of improved decision making and explore the applicability of the model in similar rural contexts. This is in order to resolve the following questions: What impact does the use of the functional prototype have on the sales management and profitability of a cocoa SME in Santander, What are the best practices in the use of information technology (ICT) in similar agroindustrial SMEs, To what extent does the functional web prototype contribute to improve the strategic decision making of the cocoa company, How applicable is the proposed model in other rural SMEs with similar conditions.

Against this backdrop, there is a need to implement IT solutions that facilitate the efficient management of information related to cocoa production sales and profitability. This work focuses on the construction and validation of a functional web prototype, developed with Google Apps Script, a JavaScript language that allows to automate and extend the functionalities of the Google Workspace application (cloud toolset). This environment facilitates the rapid development of web solutions integrated with Google Sheets tools (spreadsheets), which will be the primary data storage medium for this project. Among the advantages of using Google Apps Script are its easy integration with Google services such as Gmail, Calendar and especially Google Sheets. And its rapid and accessible deployment from the cloud which reduces the need for additional infrastructure, thanks to these features, the proposed solution will be a practical, accessible and scalable tool.

The objectives and purpose of the project, the frame of reference, the content and scope, the expected results and the description of the specific case will be presented. The project is aimed at providing technological tools to farmers in the region to strengthen their decision-making capabilities in relation to the production and marketing of their cocoa products, allowing them to have greater control over profitability and improve market strategies

In addition, they address the strategic aspects of the project such as digital transformation, technological tools and their barriers in rural environments, including justification, global market analysis, the innovative nature of the proposal and its contribution to sustainable development objectives.

Next, the general design of the functional prototype, the technologies used, the functionalities of the system are detailed. Subsequently, the research methodologies such as the approach, strategy, data collection and analysis, as well as the validation of the prototype are presented. The results obtained are also analyzed, such as user validation, improvement in sales management and profitability, identification of opportunities, limitations observed, and the conclusions obtained and the bibliographies used as theoretical and methodological support for the work are presented. Finally, this project is aligned with the objectives of the Master in Strategic Management in Information

Technology, by demonstrating how a properly designed, strategically implemented and socially contextualized technological solution can have a remarkable impact on business management, operational efficiency and digital transformation of SMEs in the agribusiness sector.

Method

Type and Focus of Research

The current project adopts an applied research methodology that has a mixed approach (qualitative and quantitative), oriented to the ongoing validation of development. Its main objective is to create a functional prototype that meets the specific needs of small and medium agro-industrial enterprises in Santander. This methodology integrates analysis, design, development and evaluation techniques in a continuous improvement cycle, allowing the system to be adapted to real conditions and obtaining direct feedback from users. (FUNIBER, 2024)

The process begins with the identification and gathering of requirements, where the needs and characteristics of the business are recognized, allowing the functional scope of the system to be clearly established. This is followed by the UML design phase, where processes and use cases are modeled to ensure that the prototype is correctly structured.

The prototype development is carried out in iterative phases between months 2 and 4, using accessible technologies such as Google Apps Script and Google Sheets. Each iteration includes testing and validation cycles with real users, which ensures that adjustments and improvements are adapted to the specific conditions of the sector and the degree of technological adoption of the organization.

At the same time, additional research is being conducted on information and communication technologies (ICT) in agribusiness SMEs, providing a theoretical framework and best practices to optimize the system.

Finally, in the last stages of the project, the prototype is evaluated and a strategic model for technology management in similar SMEs is proposed, ensuring that the results are applicable and scalable to other contexts. In other words, each activity is organized with specific objectives, assigned resources and determined times, which allows for detailed monitoring of progress and fulfillment of objectives. The iterative nature of the development and validation facilitates the inclusion of continuous improvements, thus increasing the quality and functionality of the prototype and ensuring its relevance to the beneficiary SME. (FUNIBER, 2024)

Methodological Strategy Applied

The methodological strategy applied in an SME (small and/or medium-sized enterprise) in the municipality of El Peñón, Santander, is summarized in the collection and analysis of information that will be developed in three main phases: initial diagnosis, pilot application of the prototype, and final validation. Each incorporates different tools and techniques that will be implemented sequentially in the rural cocoa-producing SME. (FUNIBER, 2024)

Data Collection Techniques

For the construction, evaluation and validation of the proposed technological proposal, various information gathering techniques will be used, both qualitative and quantitative, which are adapted to the rural context of the SME and the actors involved. (FUNIBER, 2024):

Semi-Structured Interviews

- *Objective*: Collect qualitative information on current sales and cost management processes, the use of digital tools, information needs and technological barriers perceived by key SME stakeholders.

Participants: Members of farming families in charge of production, marketing and basic administration.

Usage: This technique will allow to understand in depth the routines, problems and expectations of the users, which will guide the design of key functionalities of the web prototype.

Instrument: Interview Guide

Direct observation of the operating process

- *Objective*: Identify how sales, cost and profitability information is currently recorded and identify potential inefficiencies or risks of data loss.

Usage: It will help validate the existing technology gap and document the manual processes that will be automated by the technology proposal.

Instrument: Observation Guide

Documentary review

- *Objective*: Analyze previous records, such as scattered physical notebooks or notes, to establish a baseline of the current state of information management in the SME.

Usage: This review will make it possible to define indicators of change, such as the percentage of records digitized or the frequency of errors in data consolidation.

Prototype Pilot Testing (Usability Test)

- *Objective*: Validate the functionality of the web system in a real environment and with end users.

Usage: Measure indicators such as report generation time, data entry error rate and user perception of usefulness.

Instrument: Usability evaluation form

Data Collection and Analysis Plan

Phase 1: Initial diagnosis (Week 1 - Week 2)

Technique: Semi-structured interviews and direct observation of the operational process.

Objective: To understand the current state of information management (sales, costs, profitability) and operational practices in the SME.

Activities:

Interviews with 2-3 key members of the SME.

Structured observation of the sales recording and reporting process.
Systematization of notes and transcriptions.

Phase 2: Prototype pilot test (Week 3 - Week 4)
Technique: Usability test of the functional web prototype.
Objective: Evaluate the ease of use, comprehension, usefulness and necessary improvements of the system.

Activities:

Initial training of users on the prototype (1 day).
Application of the usability test while users interact with the system.
Record of comments, times, difficulties and recommendations for improvement.

Phase 3: Information analysis (Week 5)
Analysis techniques:
Qualitative: Content analysis of interviews and observations. Thematic categorization (perceptions, barriers, suggestions, etc.).
Quantitative: Descriptive statistical processing of the usability test (percentage of understanding, errors, times, etc.).

Activities:

Systematization of findings.
Identification of usage patterns, strengths and areas for improvement.
Development of recommendations for prototype improvement and future implementation. (FUNIBER, 2024).

Indicators to Measure Impact and Usability

To measure the ease of use and the effect of the functional web prototype on the sales and profit management of the SME under study, indicators were established that are aligned with the goals of the research. These include both the simplicity of the system and the operational and strategic modifications that arose after its implementation. Below is a table with the suggested indicators, their connection to the project objectives and the evaluation techniques used. The following indicators are used to evaluate both the usability and impact of the prototype. Some directly measure user interaction with the system, while others reflect changes in the operational and strategic management of the SME

Results

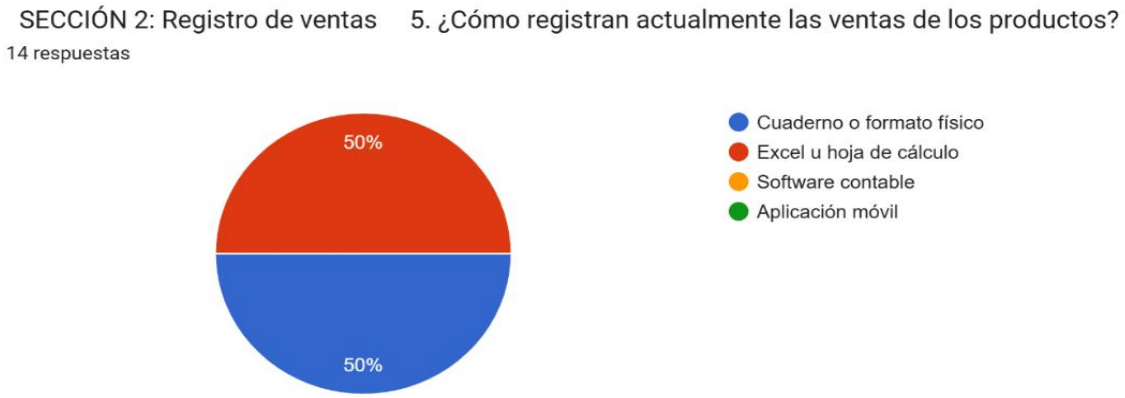
Information Analysis

Phase 1. Initial diagnosis: Application of interviews to key members of the SME, where a structured observation of the sales registration and reporting process is made.

Systematization of notes and transcriptions. According to the survey conducted, 50% of the information recorded on product sales is done in notebooks or sheets and 50% is saved in Excel. See Figure 1.

FIGURE 1

How do you currently record product sales?

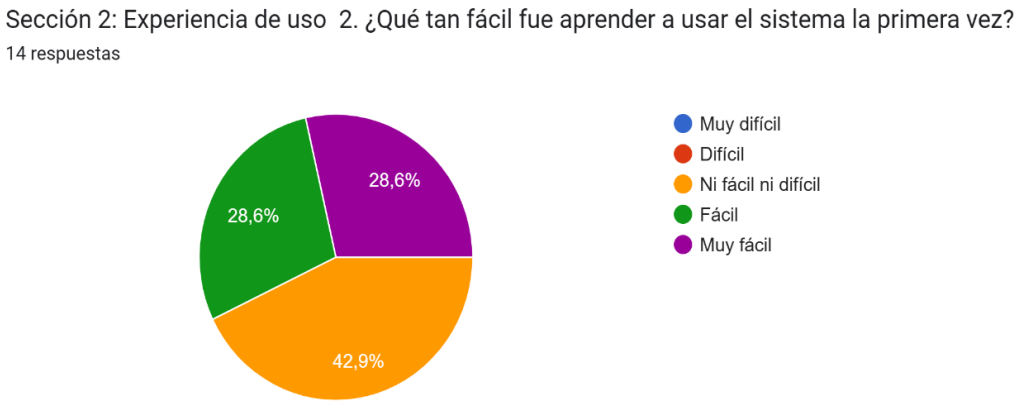


Note. Own elaboration

Phase 2. Prototype pilot test, usability test: Initial training of users on the prototype, application of the usability test while users interact with the system. Therefore, a record is made of comments, times, difficulties and recommendations for improvement. See Figure 2

FIGURE 2

How easy was it to learn how to use the system?



Note. Own elaboration

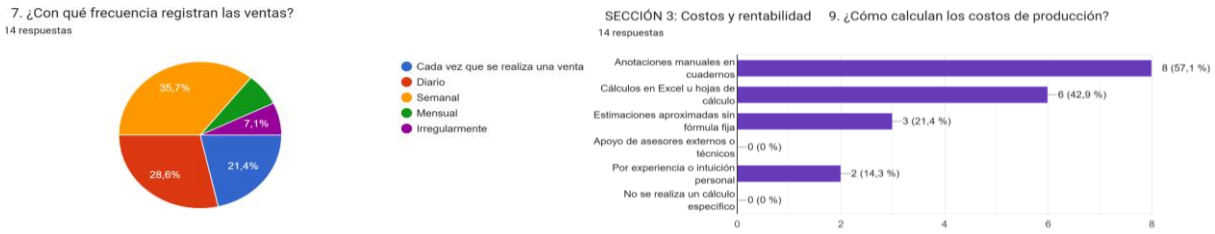
Phase 3. Information analysis

The periodicity with which sales are recorded differs: 35.7% do it every week, 28.6% record it every day and only 21.4% document it after each transaction. A smaller group does so on a monthly or irregular basis. Regarding the calculation of production costs, the vast majority prefer to keep handwritten notes in notebooks (57.1%) and use Excel for their calculations (42.9%), although there are also some people who rely on estimates without a defined formula (21.4%) or who trust their own judgment (14.3%).

Neither the use of technical advice nor the total lack of calculations is observed in this context. See Figure 3

FIGURE 3

Diagnosis of sales record frequency



Note. Own elaboration

The majority of respondents (14 out of 14) indicate that they do not have a defined tool to determine if a sale was successful, although some mention using Excel or express the need for software to help them with this analysis. The main difficulties in calculating profitability include lack of appropriate tools or formats (64.3%), lack of accounting knowledge (50%) and difficulty in grouping information (42.9%). In addition, 50% say that the current system is not sufficient to manage information, while 35.7% believe that it works only partially. See Figure 4

FIGURE 4

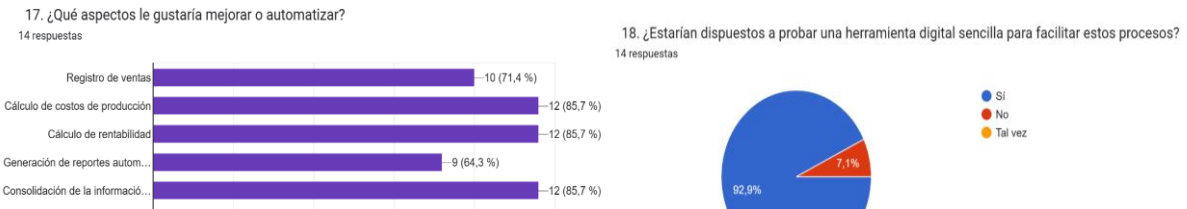
Diagnosis tools and difficulties

Note. Own elaboration

The elements that small and medium-sized companies most want to improve or automate are production costing, profitability and data collection, each with 85.7%. This is followed by sales registration, with 71.4%, and automatic report creation, with 64.3%. Reminders or alerts are also mentioned, with 57.1%, and the possibility of remote access from cell phones, with 50%. In addition, 92.9% of respondents are open to trying a simple digital tool, indicating a strong interest in digital transformation. See Figure 5

FIGURE 5

Diagnosis of employee opinion

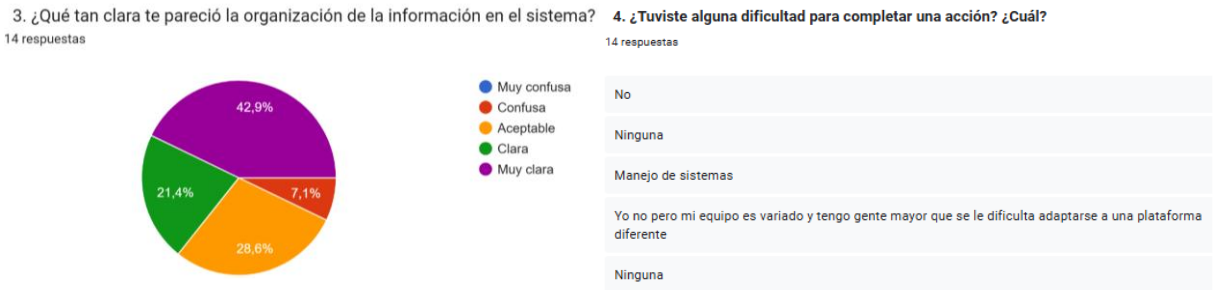


Note. Own elaboration

After the implementation of the functional web prototype, its usability was evaluated and it was observed that: 42.9% of respondents thought that the way the information was organized in the system was very clear, 21.4% considered it clear, 28.6% saw it as acceptable and only 7.1% found it confusing. Regarding difficulties, the majority said they had no problems, although some (approximately 35%) pointed out specific inconveniences such as the use of the system, difficulties of the equipment to adapt and finding specific functions such as the profitability summary. See Figure 6.

FIGURE 6

Usability test on the information

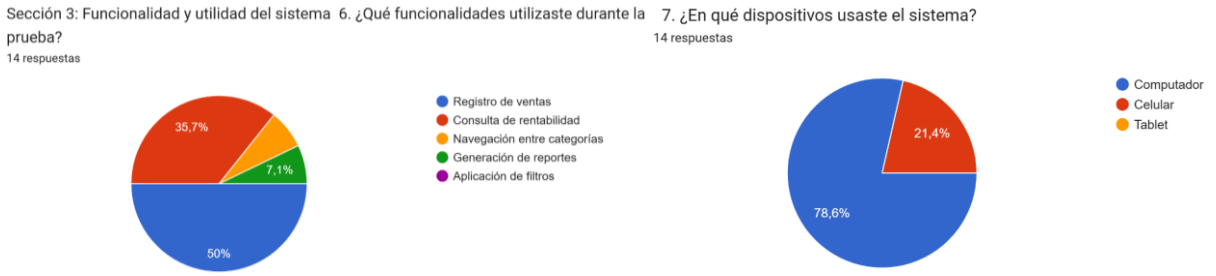


Note. Own elaboration

During the system evaluation, half of the participants made use of the sales registration function, while 35.7% used the profitability query option. A further 7.1% explored navigation between categories and another 7.1% tested the creation of reports. No use of the filter application function was observed. In addition, regarding the devices used to access the system, 78.6% accessed it from a computer, while 21.4% accessed it from a cell phone. The use of Tablets was not recorded. See Figure 7

FIGURE 7

Frequency of use



Note. Own elaboration

The majority of users (71.4%) performed important system tasks (registration or query) within 1 to 2 minutes, and 21.4% did so in less than 1 minute, showing that it is fast and easy to use. As for its usefulness, 35.7% saw it as very useful, 28.6% considered it quite useful and another 28.6% found it useful. In addition, 57.1 % strongly agreed that the prototype helps improve decision making, and 28.6 % agreed, highlighting its strategic importance. See Figure 8

FIGURE 8

Improved sales management and profitability

Note. Own elaboration

what impact does the use of the functional prototype have on the sales management and profitability of a cocoa SME in Santander?

The impact of the functional web prototype has been positive and significant in several respects:

- Facilitation of sales registration: Prior to the prototype, 100% of sales were recorded in Excel or physical notebooks. Next, 92.9% of users highlighted the digital registration as very useful, with the experience described as "intuitive and easy to use" by 64.3%.
- Improved profitability calculation: 85.7% of users consider the system useful or extremely useful for sales and profitability management. In contrast, before the prototype, only a few users calculated profitability with Excel or intuition, and 28.6% did not even measure it.
- Reduction of effort and time: 71.4% completed tasks in less than 2 minutes, and 57.1% indicated that little or no effort was required.
- Multiplatform accessibility: 78.6% accessed from a computer, and 21.4% from a cell phone, showing adaptability to different devices, although visual limitations were also reported in cell phones.

What are the good practices in the use of information technology (ICT) in similar agribusiness SMEs?

Based on the results obtained in the cocoa SME before and after implementing the prototype, the following good practices are identified, supported by participation percentages:

- Prior to the prototype, 100% of respondents recorded sales in non-specialized tools: physical notebooks (50%) or Excel (50%). This shows that many rural SMEs start their digitization processes with basic tools, a good practice if done in a structured way
- After implementing the prototype, 92.9% of users rated the sales register positively, and another 92.9% highlighted the automatic profitability calculation as a useful feature. This demonstrates that data centralization allows for more efficient management, minimizes errors and favors decision making.
- The evaluation of the system included operators, assistants, owners and managers. This diversity of roles is reflected in the variety of responses: for example, 64.3% rated the experience as intuitive and easy to use, while 21.4% requested additional training. Involving all users in the validation of the system is a good practice to achieve technological ownership.
- The system was used on computers (78.6%) and cell phones (21.4%). Although there were comments about visual difficulties on cell phones (7.1%), this multiplatform adaptation is essential in contexts where access and connectivity levels vary significantly.
- Prior to the prototype, 92.9% expressed willingness to try a simple digital tool. This shows that, even in rural areas, there is an openness to technological change if the tools are simple, accessible and adapted to their processes.
- In the pre-prototype stage, 85.7% expressed a desire to automate cost and profitability calculations, and 64.3% expressed a desire to generate automatic reports. The system implemented responded to these needs, indicating that aligning development with real requirements is key to success.

To what extent does the functional web prototype contribute to improve the strategic decision making of the cocoa company?

The prototype has a high potential to strengthen decision making:

- 57.1% of users strongly agree that the system facilitates decision making.
- The most valued modules - sales registration (92.9%), automatic profitability calculation (92.9%), and visual reports (64.3%) - provide key data that were not previously rigorously analyzed.
- The organization of information was rated as clear or very clear by 64.3% of users, which allows for a more orderly view of the business.
- Before the prototype, more than 64.3% reported a lack of adequate tools, and 50% expressed difficulties due to lack of accounting knowledge, barriers that are now mitigated with the use of the system.

How applicable is the proposed model in other rural SMEs with similar conditions?

The model is highly replicable in other rural SMEs, for the following reasons:

- Low-cost technology: Based on Google Apps Script and Google Sheets, free and accessible tools.

- Simplicity and flexibility: The design was considered intuitive by most users. 92.9% would be willing to use similar digital tools.
- Common conditions in the sector: Many agribusiness SMEs face the same barriers: manual management, lack of data consolidation and absence of systems for profitability.
- Interest in going digital: 85.7% of users want to automate aspects such as costing, reporting and consolidation of sales + expenses.

Discussion and Conclusions

This project revealed that rural agro-industrial SMEs, such as the cocoa company under study, face significant limitations in the strategic management of information, according to a survey of the people working on the farm. The implementation of a web prototype, based on Google Apps Script and Google Sheets, proved to be a viable and accessible alternative to digitize key processes such as sales registration, profitability calculation and automatic report generation with a percentage of 92.9%.

The development and validation of the functional web prototype satisfactorily fulfills the general objective and optimizes the sales management and profitability of a rural SME in Santander, facilitating technological tools for strategic decision making. In terms of objectives, the marketing process was analyzed and functional requirements were gathered to design UML diagrams to model key processes; subsequently, the prototype was developed using Google Apps Script and Google Sheets, executing functional tests that were validated by the real user with a 92% acceptance rate. The results show a positive impact: the digital sales register and the automatic calculation of profitability were valued as useful by 92.9% and 85.7% of the users, good practices in the use of ICTs in agribusiness SMEs, and a replicable strategic model of technological adoption was proposed, supported by the interest of the respondents in using similar digital tools. Otherwise, the objective not only met the stated objectives, but also demonstrated an effective solution and application in rural contexts with similar technological needs.

As described in Chapter 5, "companies that do not embrace digitization face significant risks of operational obsolescence and market foreclosure." (Sandoya & Franco,

2024). The developed system improves sales and profit processes, thus ensuring better strategic decision making within the organization by 92.9%.

From an economic point of view, the ROI is positive, indicating that for every peso invested, a return of 28.57% is generated. In addition, as no investment is required in the following years, the ROI is expected to exceed 50% per year after the second year. This profitability was estimated based on the real savings of an SME owned by Don José Santos Florez, a cocoa farmer in the municipality of El Peñón, Santander, Colombia. In addition, the project aligns with several Sustainable Development Goals (SDGs), such as decent work and economic growth (SDG 8), industry, innovation and infrastructure (SDG 9), and reducing inequalities (SDG 10).

Recent studies indicate that technology investments in the agri-food sector can offer a return of more than 20% in productivity and operational efficiency, especially if they are designed for rural areas with low levels of digitization. (FAO, 2021). And highlighting the results obtained in the surveys, 50% use it to record sales and 35.7% use it to check profitability.

The model proposed in this research is based on the use of accessible digital tools, such as Google Apps Script and Google Sheets, which makes its development and technical adoption easier in rural areas or areas with scarce technological resources. These tools allow the creation of a functional web solution that can be adapted and scaled to strategically manage the sales and profitability of cocoa-producing SMEs in Santander, Colombia. It is not necessary to have physical servers or advanced technology, since it can be implemented directly in the cloud, using free or low-cost platforms, which significantly reduces the technical barriers for its implementation. In addition, it can operate on devices that are already in use in organizations, such as laptops or cell phones with Internet access, thus reducing the initial investment.

The development will be carried out by a technical team with expertise in Google Workspace, and allows SME personnel to participate in the validation and testing stages, which fosters technological appropriation and facilitates knowledge transfer. Initially, the system is launched in a test environment to validate its main functions, such as recording sales, calculating profitability per lot of cocoa, and creating strategic reports (PDF) to assist in decision making.

The solution has been designed in a modular way, which enables the future integration of additional functions such as inventory control, product traceability, or price prediction, thus ensuring its sustainability and capacity to evolve in the medium and long term.

Recommendations

Recommendations for the successful implementation of the solution or derived from the Implementation performed: The scheme of use of the functional model for the strategic management of information in small and medium-sized cocoa companies is based on its initial use as an internal resource. "companies that do not embrace digitization face significant risks of operational obsolescence and market foreclosure." (Sandoya & Franco, 2024). This seeks to improve sales and profit processes, thus ensuring better strategic decision making within the organization. Its creation with accessible tools such as Google Apps Script and Google Sheets allows it to be implemented quickly, with a low cost and easy adjustment for other SMEs that have similar characteristics according to the survey conducted.

The strategy of use includes the development of complete technical documentation, training for users and the development of an implementation kit to

facilitate its replication in other rural organizations with technological limitations. There are also plans to promote the prototype through people close to the farm, which will help consolidate its presence in the region's agroindustrial sector. SMEs are forced to innovate their processes. "The traditional SME business model is challenged by the pressure of digitalization imposed by competitors." (Do, Villagra, & Pandolfi, 2023). This plan not only covers its current use, but also foresees the advancement of the prototype towards improved versions that include new features, such as traceability and sophisticated analysis, which would increase its attractiveness and application in the market.

Prototype validation is expected to take 3 to 6 months and the first external pilots are expected to start within 7 months after implementation in the SME. Risks of resistance to change or limitations to rural connectivity are identified and will be addressed in meetings and workshops with families. The application of the results of this project focuses on establishing the prototype as a flexible and scalable option for small and medium-sized agricultural enterprises that have limited access to advanced technology. The strategy is based on a technology transfer model that facilitates the replication of the system in other locations with similar characteristics, prioritizing sustainability, ease of use and significant impact on business decision-making.

First, we plan to validate the prototype in the pilot cocoa company, which will generate data collection on success stories, impact metrics and user feedback. This information will be critical to guide future product improvements and develop a value proposition for potential users or strategic partners. (Kamal-Chaoui, 2021). Later, the result could become a consulting service or a digital solution aimed at producer associations, rural development NGOs and government agencies.

There is a commercial approach based on three fundamentals: clear identification of potential users such as small producers, cooperatives and rural organizations. Another approach would be effective promotion channels such as agroindustrial fairs, universities, rural incubators and technological innovation networks.

Value proposition focused on ease of implementation, low cost and alignment with the Sustainable Development Goals (SDGs), according to information obtained in a survey of small business managers, 57.1% of respondents said that the system facilitates decision making. In addition, documentation of the process in the form of manuals and commercial presentations will be encouraged, which will increase the possibility of licensing the system or applying for innovation and rural entrepreneurship competitions. (World Bank Group, 2024).

From a social point of view, this solution helps bridge the digital divide by using accessible technologies such as Google Sheets and Apps Script, providing access to technological tools in rural areas where information and communication technologies are scarce. It also reinforces community empowerment by providing training and allowing producing families to take ownership of the system. In addition, it generates new local employment opportunities due to the support, adjustment and maintenance of the system.

It should be noted that one of the limitations is Internet connectivity in rural areas, which represents a technical obstacle for continuous access to the web solution, especially when real-time data synchronization is required. To mitigate this situation, it is suggested to implement a strategy of temporary offline use with backup in local synchronized spreadsheets or access to reduced versions of the system. Likewise, resistance to change on the part of users, especially in family businesses with traditional practices, where there may be distrust towards digitalization. This limitation can be overcome through participatory training processes, progressive validation of the system and socialization of short-term benefits. As stated in the project, risks of resistance to change or limitations to

rural connectivity are identified and will be addressed in meetings and surveys. Next, low digital literacy, especially in older members of the community, which may limit the autonomous use of the system. To counteract this barrier, the creation of simple and visual training materials is recommended, as well as accompaniment by rural youth trained in digital technologies.

In turn, the limitations in technological infrastructure. In other words, many SMEs do not have adequate or well-maintained computer equipment. The proposal is partially adaptable by using tools such as Google Sheets and Apps Script that require low technical capacity, but it may be necessary to provide basic equipment or partnerships for technological equipment. In addition, the lack of sustained funding to scale the prototype to more complete versions (with traceability, prediction, inventories). According to the (FAO, 2021), technological investments in rural areas must be accompanied by financing programs that support the sustainability and evolution of the system.

As a future project that would give continuity to the proposal would be a plan to industrialize the prototype that presents a long-term perspective, where the system advances from a basic functional development to achieve a solid, adaptable and commercially viable solution for different entities in the agro-industrial sector. This progress will require strategic investments to increase the impact of the system at regional and national levels.

The phases of the industrialization plan are: technical and operational consolidation, which will prioritize the strengthening of the core system through: improvements in the backend and automation of internal processes, increased cyber security and data protection, and the addition of features such as batch traceability and advanced reporting. Also, scalability and customization (medium term). (Kamal-Chaoui, 2021). For this reason, there are plans to develop versions suitable for various agro-industrial subsectors, such as coffee, fruits and dairy products, including integrations with traceability and certification systems. This will include: investments in the creation of specialized software, hiring UX/UI experts, development and support, and collaborations with educational institutions to teach technical skills to end users.

On the other hand, commercialization and expansion (long term), which is the business model will be transformed into an offering that includes: SaaS tiered subscriptions, consulting and tailored implementation and license sales to rural communities.

The success of this model will depend on the availability of additional sources of financing, such as funds for rural development and technological innovation, international cooperation programs and calls for applied research and technology transfer.

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