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# DIGITAL ALTERNATIVE FOR THE SUPPLY OF AGROECOLOGICAL PRODUCTS: PROPOSAL FOR THE ALTERNATIVE, CULTURAL AND ARTISANAL MARKET; EL COOPERATIVO

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## ABSTRACT

In Mexico, venues known as tianguis (open air markets) and alternative markets have emerged, offering agroecological and organic products that are beneficial for both human health and the environment. The "El Cooperativo" Alternative, Cultural, and Artisanal Tianguis located in Texcoco, Mexico represents a prime example of this type of venue. However, despite its significant presence on social media, producers have expressed a desire to expand the dissemination of information related to their businesses and products. Therefore, this project aimed to promote the development of a customized web-based information system that by using technological tools would enable the storage and display of detailed information about producers, products offered and recreational activities. Subsequently, semi-structured interviews, data analysis using coding methods, requirements analysis and web development were employed to create the system. As a result of the research, a trial version of the system was created, centralizing real information about the Tianguis, such as its history, location, and contact information. The sections corresponding to events, producers, and products were simulated, as this was the most complex part of the system due to the data processing involved. Based on the trial version, it was concluded that the system may represent a viable alternative for promoting the Tianguis, although its implementation and continuity will depend on the organization, training, and participation of the producers.

**Keywords:** alternative dissemination, digital communication, agroecological market.

## INTRODUCTION

Over the last two decades, alternative markets or tianguis have emerged, serving as exchange venues that benefit various stakeholders, including producers, distributors, processors, and consumers. These markets were established based on environmental values and as an alternative to the conventional agri-food system (Roldán *et al*., 2018). The "El Cooperativo" Alternative, Cultural, and Artisanal Tianguis is located in the municipality of Texcoco, State of Mexico, in the town of El Cooperativo and is open on weekends from 9:00 am to 3:00 pm. This market has been offering an alternative consumption model based on chemical-free products for over 15 years (data provided by the delegate of El Cooperativo in February 2024), promoting fair trade and healthy consumption

through the sale of artisanal and sustainable products. The most prominent products include fruit, vegetables, meat, dairy products, eggs, baked goods, honey, coffee, cacao, oils, amaranth, biodegradable cleaning products, beauty products, and handicrafts. The market has 138 vendors, 72 of whom are producers (data obtained from the attendance list provided by the delegate in March 2024), and 25% of them consider the market their most important sales outlet. To promote their products and attract more people to the market, they use social media platforms such as Facebook, Instagram, a YouTube channel, and TikTok. Facebook and Instagram have the highest user interaction and the most posts from the page administrator; Facebook stands out with 4,500 followers and Instagram with 759 followers and 258 posts (data consulted on the official social media accounts, 2024). Despite their efforts to consistently and regularly post updates on their social media, producers believe they are not generating the necessary exposure for the wide variety of products they offer, and they perceive this as the reason for low customer traffic. To improve the visibility of all their products, businesses, and activities, we propose the implementation of a web-based information system. Information obtained through information systems (IS) is indispensable for any organization, as its effective management allows them to achieve high levels of competitiveness and consequently success. A system can be defined as a set of processes, operated through a database, to collect, process, and display information that supports an organization's decision-making (Vega *et al*., 2017). Today, most people have internet access, granting them access to an infinite amount of information and making it an essential means of communication. The appropriate application of web development tools and processes made it possible to centralize some of the market information and create an option to view the entire range of products and events organized by the market. The authentic information contained in the system includes its history, location, and contact details, whereas the event sections and detailed descriptions of producers and products represent simulated data. This was undertaken for testing purposes, as this represented the most complex part of the system.

The objective of this research was to develop a proposal for a customized web information system for the Tianguis "El Cooperativo", applying technological tools that make it possible to store and display more detailed information.

## THEORETICAL FRAMEWORK

The word tianguis comes from the Nahuatl word Tianquiztli, which means market; a local or regional venue where different types of products were exchanged in pre-Hispanic times (Paré, 1975). According to García *et al*. (2016), currently, tianguis and alternative markets in Mexico are recognized as socio-

environmental innovation programs that recreate the tradition of the ancient tianguis and are part of the evolution of agri-food systems. These venues not only allow for the exchange of products but also for sharing diverse information related to health, environment and the consumption of healthy foods, in addition to fostering social relationships that strengthen various bonds. Pardo and Durand (2018) emphasize that alternative tianguis promote closer ties between producers and consumers, who share the same interests and that these venues do not necessarily signify opposition to the food industry. In this sense, over the last two decades, exchange venues known as alternative markets or tianguis have promoted a variety of participants including producers, market salesmen, processors and consumers, who came together because of shared environmental values and offering an alternative to the conventional agri-food system (Roldán *et al*., 2018).

**Sale of organic and agroecological products**

Open-air and alternative markets are primarily known for offering agroecological and organic products. Thus, agroecology forms the basis of these products. According to Gliessman (2006: 23), agroecology is defined as "the application of ecological concepts and principles to the design and management of sustainable food systems." Likewise, various non-governmental organizations (NGOs) have promoted agroecology as a strategy, considering it an environmental technological innovation that more directly addresses the needs of the disadvantaged rural sector (Altieri and Yurjevic, 1991). Therefore, agroecological products derive from practices that promote sustainable production systems based on the integrated management of the agroecosystem, for which interactions between soil, water, biodiversity, and producers are essential for generating more natural foods (Gliessman, 2002). These products are obtained through techniques free of agrochemicals, hormones and antibiotics, which generate benefits for both the health of consumers and the environment, by contributing to soil fertility and strengthening the natural resistance of crops and livestock (Domínguez, 2023). Regarding organic products, the National Service for Agrifood Health, Safety and Quality (SENASICA, 2023: 1) states that "Organic foods are obtained from animals, plants, their products and byproducts, and are processed and manufactured in an environmentally friendly manner." Notably, for a product to be labeled organic, it must have organic certification, regulated in Mexico by the Ministry of Agriculture through SENASICA, which ensures the integrity of organic products from Mexico. Similarly, the Ministry of Agriculture and Rural Development (SADER, 2016, formerly SAGARPA) establishes that to be marketed as organic, products must comply with the standards established

in the Organic Products Law and bear the "ORGANIC SAGARPA MEXICO" seal, or have the Participatory Organic Certification System (SCOP), designed for small producers or families, who produce and sell their products directly to consumers in venues that include open-air or traditional markets (SENASICA, 2021).

Organic products, while also avoiding the use of agrochemicals and seeking more sustainable practices, differ in that they are regulated by specific certifications that guarantee compliance with certain standards and tend to focus on technical and commercial criteria. In contrast, agroecological products, based on agroecology take an approach that combines broader economic, scientific, and social principles. They do not necessarily require certification, as they rely on trust between producer and consumer. Finally, both models promote alternatives to conventional agriculture, but agroecology incorporates a holistic approach that considers other relevant aspects such as social equity, efficiency, local knowledge and food sovereignty (IPES-Food, 2022).

**Digital tools applied in open-air and alternative markets**

The COVID-19 pandemic was a catalyst that forced various groups to implement digital platforms. In particular, alternative markets or street markets were forced to close their physical venues and adopt digital methods to continue operating. For example, in the case of the Tlaxcala street market, some producers responded to this situation by creating a digital network called "Conscientious Consumption" to enable online orders, which made it possible to increase participation by 30%, in terms of both producers and consumers (Collin and Aguilar, 2021).

Similarly, García and Roldán (2023), in their research on the Puebla Alternative Market (Tianguis Alternativo de Puebla, TAP), indicate that producers and interested parties organized themselves to implement a digital platform focused primarily on selling products. This initiative arose in response to pandemic restrictions and the demand for agroecological and organic foods from health-conscious consumers. As a result, the use of the platform directly contributed to a significant increase in sales. For their part, Gracia and Guizar (2023) note that the Agro-Food Initiatives of the Popular, Social, and Solidarity Economy (Iniciativas Agroalimentarias de Economia Popular Social y Solidarias, IAEPSS), which brings together alternative organizations and collectives from Jalisco and Michoacán, showed great interest in incorporating digital tools to improve their outreach.

Therefore, a project was launched to develop a digital platform and mobile application called Eco-Solidarity Food Networks (Redes Alimentarias Ecosolidarias, REDAL). This project enabled integrating virtual spaces that

they believed could facilitate the processes of food production, collection, distribution, consumption, and knowledge sharing in which these initiatives are embedded. They emphasize that, although there are few platforms of this type in Mexico, there is growing interest in their implementation.

Currently, some open-air markets and street markets belonging to the Mexican Network of Organic Open-Air Markets (Red Mexicana de Tianguis y Mercados Orgánicos, REDAC) (Schwentesius and Gómez, 2015), along with other spaces located through various online sources, have websites for disseminating basic information such as opening hours, location, contact details, producers, and product sales. In this context, data generation is now exponential, making information obtained through information systems indispensable for any organization, as adequate management enables greater competitiveness and consequently increases the chance of success. Regarding the definition of an information system (IS), various approaches to the concept are evident, but the most relevant is that of Vega *et al*. (2017), who define an IS as a set of processes, operated through a database to collect, process, and display information that supports decision-making, in a company or business.

Additionally, Hernández (2003) explains that data constitutes the raw material of information systems and that in order to obtain useful information from them, they must be stored, processed and transformed; furthermore, a feedback process is essential to evaluate the usefulness of the output information.

Based on the above, it became apparent that some tianguis and markets implemented their own websites, while others share their information on the same digital platform. In total, 15 markets and tianguis were identified as having a digital presence (Table 1), demonstrating the key role of digital tools in strengthening local supply chains.

## METHODOLOGY

This study focused on the El Cooperativo Alternative Cultural and Artisanal Market, as shown in Figure 1. This is located at Calle Igualdad 12, El Cooperativo, C.P. 56225, municipality of Texcoco, with approximate geographic coordinates of 19°29′10″N 98°52′58″W (Google Earth). It has been held every weekend for the past fifteen years, from 9:00 a.m. to 3:00 p.m. Its objective is to offer an alternative consumer option based on chemical-free, sustainable, and ecological products.

Currently, the market hosts 123 vendors on Saturdays and 81 on Sundays. In the food area, 14 businesses participate on Saturdays and 15 on Sundays. Of the total participants, including both days, 72 are producers. The market's long history and the number of producers it attracts are the main reasons it was chosen as a case study.

**Table 1.** Mexican tianguis and markets with websites.

| Name of alternative market or tianguis | Url | Location |
|---|---|---|
| Alternative markets of Tlalpan and Xochimilco | https://mercadoalternativo.org/ | CDMX |
| Green Capital Producers Market | https://mercadodeproductores.com.mx/ | CDMX |
| Bosque de Agua Juriquilla and Alamos-Querétaro Tianguis | https://bosquedeagua.org.mx/ | Querétaro |
| Bosque de Agua Contadero and Narvarte Tianguis | https://bosquedeagua.org.mx/ | CDMX |
| Bosque de Agua Metepec Tianguis | https://bosquedeagua.org.mx/ | State of Mexico |
| El 100 market | https://mercadoel100.org/ | CDMX |
| El 100 market | https://tienda.mercadoel100.org/ | CDMX |
| Alternative Market Puebla | https://tianguisvirtual.mx/ | Puebla |
| ECOplaza Chapingo | https://www.ecoplaza.com.mx/ | State of Mexico |
| Tianguis for Organic produce San Miguel Allende | https://tosma.net/ | State of Mexico |
| Bio-regional Market Coatl | https://coatlorganicos.blogspot.com/ | Veracruz |
| Mauilli Teotzin Market | http://mercadomacuilli.com/ | Yucatán |

Source: self-elaborated using data from Schwentesius and Gómez (2015), Google maps, Facebook, and Assemblies (2024).

The vendors set up their stalls in an open area along the street. However, the number of vendors can vary depending on the day, as not all of them


Source: self elaborated based on INEGI and Google Maps (2024).
**Figure 1.** Map showing Tianguis location.

participate on Saturdays and Sundays or attend frequently. They offer healthy food, handmade items and sustainable products, as well as community workshops and cultural activities that serve as an educational hub and a context to reflect on environmental stewardship. The people who attend are local families, students, and conscientious consumers, making it a thriving space for economic, cultural, and social interchange.

Subsequently, according to Washizaki (2024) an elicitation technique known as "interview" was used to obtain information that established the project's founding. Two types of semi-structured interviews were conducted, one for producers and one for consumers, depending on the group of informants. Interviews were based on a digital form created in Google Forms to gather opinions and perceptions about the implementation of a website from participants in the tianguis. Interviews were conducted in person on the market's operating days; Saturdays and Sundays, over a two-month period. The days and times of the interviews were alternated, as some producers only attended one of the two days. In the case of producers, interviews began with those who had been at the market the longest, and subsequently continued on a rotating basis according to each producer's availability. Of the total number of producers identified at the market, 25 interviews were conducted. Interviews were also conducted with 60 customers present during the fieldwork. This number was determined based on participant availability and data saturation point, meaning the point at which responses began to manifest repeated information. Although there is no official record of the number of visitors, a constant flow of people was observed during data collection. Based on these direct observations, an average attendance of approximately 300 people per day was estimated.

In order to analyze qualitative data obtained from the interviews, we used the coding method proposed by Urbano (2016), which involves a process for which a key word is assigned in order to group together and organize into categories, any data collected; subsequently graphs were elaborated using the generated categories, to illustrate this information more clearly.

To continue developing the web information system, the web development method described in EBIS Business Techschool (2023) was used as a basis:

1. Planning. Stage, when objectives, target audience: clients, producers and administrator, as well as functional and non-functional requirements, were defined.
2. Design. Stage during which, work was undertaken concerning the design of user interfaces (UI) and user experience (UX), generating prototypes to define visual aspects.

3. Development. Stage during which website performance was established, using programming languages such as HTML 5, CSS 3, JavaScript and frameworks such as Bootstrap V5.3 and SweetAlert2.
4. Testing. Stage during which we ensure that the system functions correctly, in accordance with the stated requirements.
5. Deployment. Stage when the website was published, making it accessible to end users.

The development of the web information system was divided into two main areas of web development: FrontEnd and BackEnd. Each area undertakes specific roles and uses tools that combined, form part of robust, functional, and modern web applications (Celi *et al*., 2023). FrontEnd refers to the development of user experience (UX) and user interface (UI), as these are the primary factors for attracting and retaining users (Allanwood and Beare, 2022). BackEnd refers to the server logic that is the database and communication between the server and the browser. It is responsible for the performance that the end user does not perceive, such as databases, user authentication, request processing and others (Celi *et al*., 2023).

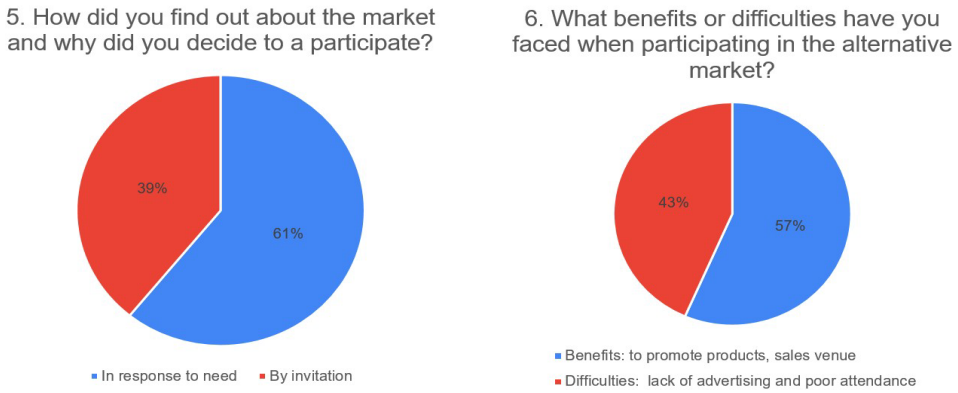
## RESULTS

### Analysis of producer data

For the interviews conducted with the producers, 17 questions were asked. Questions 5 through 16 were used to gather information about the current state of product promotion, producers' willingness to implement a website, and the formulation of requirements. Answers to remaining questions provided general information about the producers.

Figure 2 shows that 61% of producers interviewed participate in the "El Cooperativo" tianguis out of necessity, as they require a sales outlet for their products, while 39% were motivated to participate by invitation from family or friends, who already participate in the market. Both motivations play an important role, as they represent channels that attract more interested participants. 57% of the producers mentioned that the main benefit is promoting their products and having a sales outlet, suggesting that the Alternative Cultural and Artisanal Market (TACA) is an important place to showcase products and generate sales. However, the main difficulty they identified was lack of advertising for the market and low attendance. This indicates that the market still faces challenges in terms of reach and visibility.

Most producers use social media. Figure 3 shows that Facebook (38%) and WhatsApp (24%) are the most used social media platforms for communication, distribution, and promotion of their products. However, data indicate that their

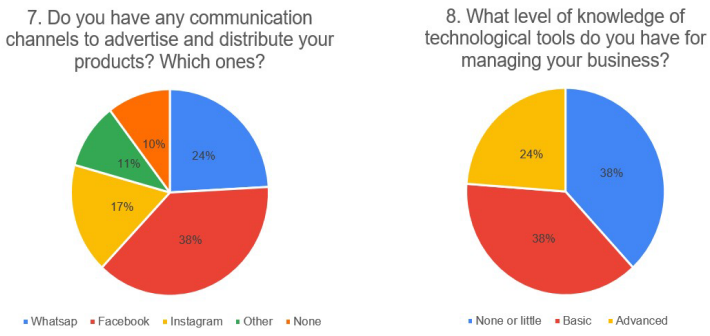



Source: self-elaborated.
**Figure 2.** Producers opinions regarding the reasons for participating in TACA and the benefits and difficulties of belonging to TACA.

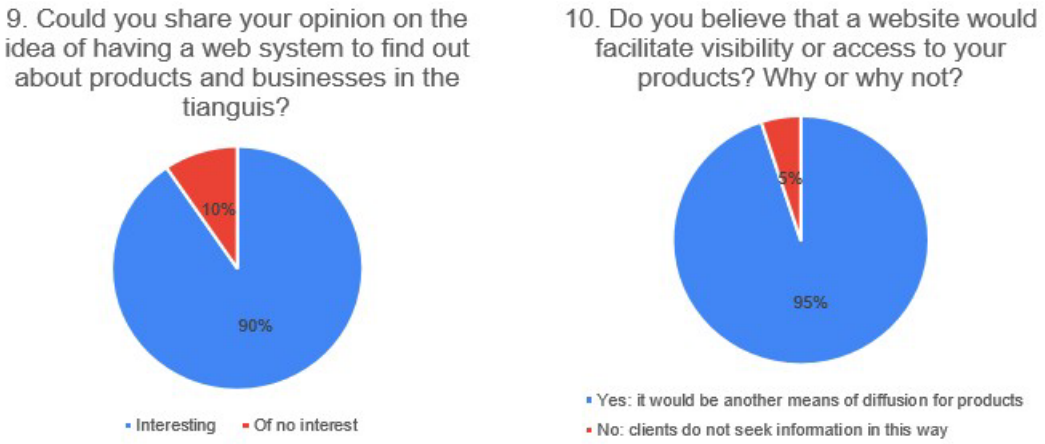
level of knowledge and experience in using technological tools for business management is limited, as 38% of producers report a basic level of experience and another 38% indicate having little or no knowledge.

There is significant interest among producers for having a web-based system to access information about TACA products and businesses, as shown in Figure 4. Most believe it would increase product visibility and facilitate access, with the expectation that implementing the website could attract new customers. However, 5% indicated they were not interested in this option, as they believe customers, especially older adults, would not seek information through this medium.

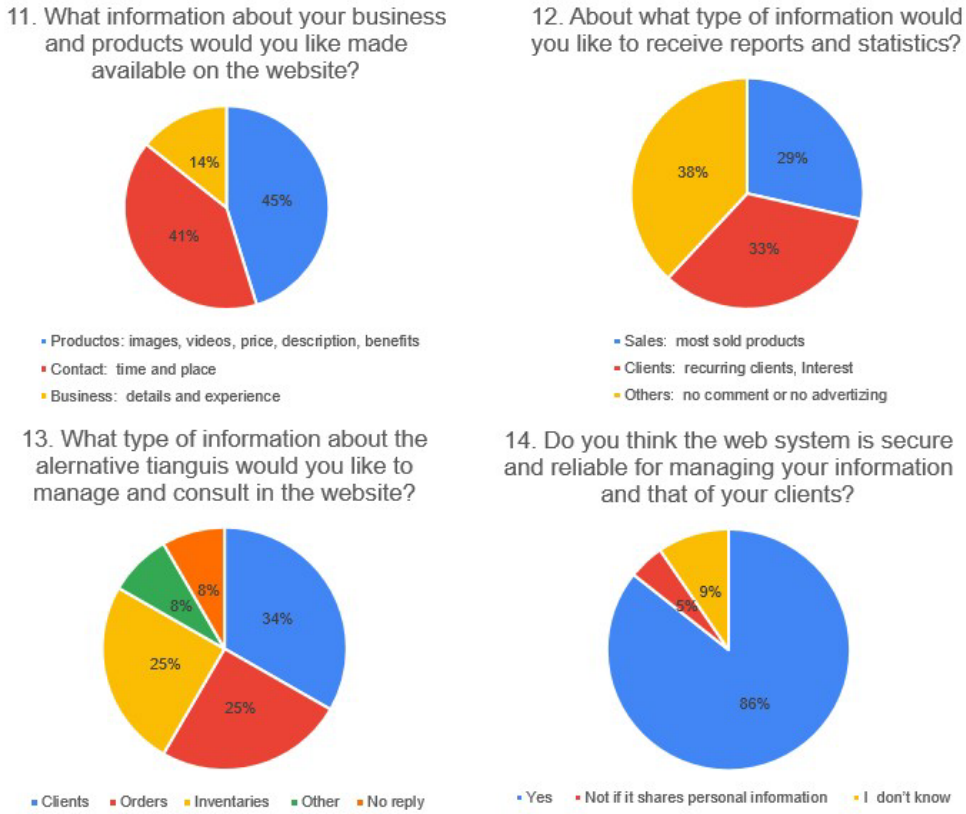
Producers preferences, regarding the information they wish to disseminate and manage in a web system can be sectioned as follows and presented in Figure 5, grouped as follows:




Source: self-elaborated.
**Figure 3.** Producers' opinions regarding communication channels and level of experience in technological use.




Source: self-elaborated.
**Figure 4**. Producers' opinions on creating a web system and the ease of visibility and access to products.




Source: self-elaborated.
**Figure 5**. Information that market vendors want to see and opinions on the reliability of a website.

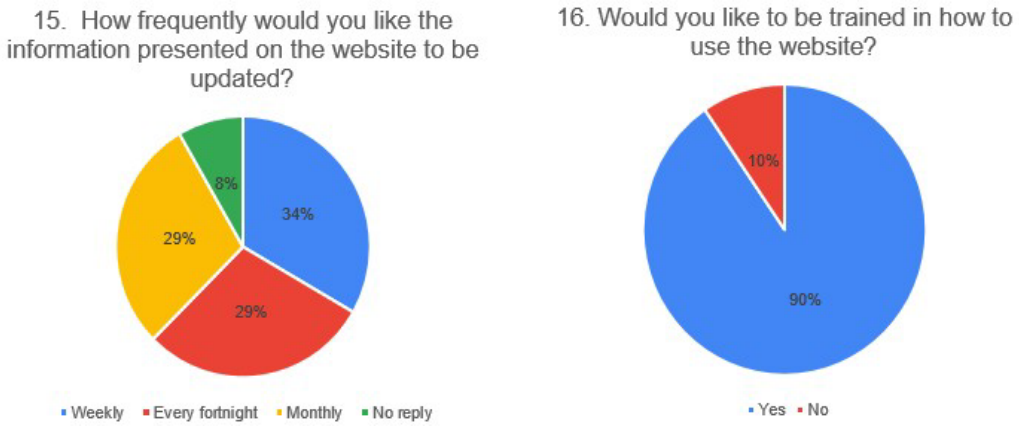
- Products: There is strong interest in disseminating detailed information about their products, including data such as price, description, benefits, and multimedia content in the form of videos and images.
- Clients: They wish to access information about their customers, especially the most frequent ones and their interests.
- Sales: They are interested in obtaining sales information, as they want to know which products customers interact with most.

They also want to showcase detailed information about their businesses so that the public can learn about their experience and history; producers are confident that the website will be secure, as long as no personal information is shared.

Answers to final questions generated the graphs shown in Figure 6. These graphs indicate that producers expect their information to be kept up-to-date, and although there opinion is divided equally, there is a slight preference for weekly updates. Furthermore, producers are willing to receive training, which opens the door to providing learning resources and the necessary support for them to become familiar with the system. This familiarity would be essential for them to take full advantage of its potential.

## Analysis of client data

The responses to the 15 interview questions administered to the different customer groups were analyzed. Pie charts were used to illustrate the final data and show the percentages for each category.



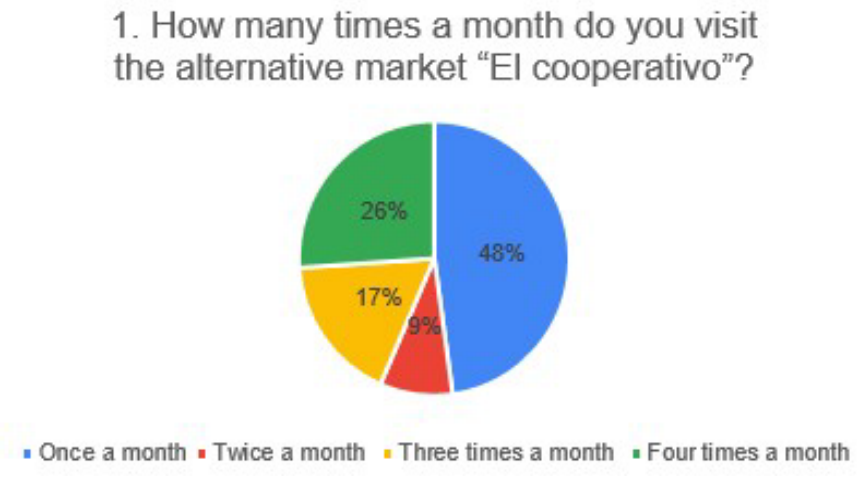

Source: self-elaborated.

**Figure 6.** Frequency of information updates and willingness to receive training.

Figure 7 indicates that this Tianguis has established a regular frequency for visits from its customers, with the majority of those interviewed stating that they visit the Tianguis at least once a month (48%) and a significant portion twice a month (26%). A minority attend more frequently, suggesting that more effective strategies are needed to increase the percentage of visits to the Tianguis. Furthermore, it became apparent that the products most in-demand are fruits and vegetables, followed by handicrafts and prepared foods, indicating that the Tianguis is considered a place to purchase fresh produce and support local producers, as indicated in Figure 8.

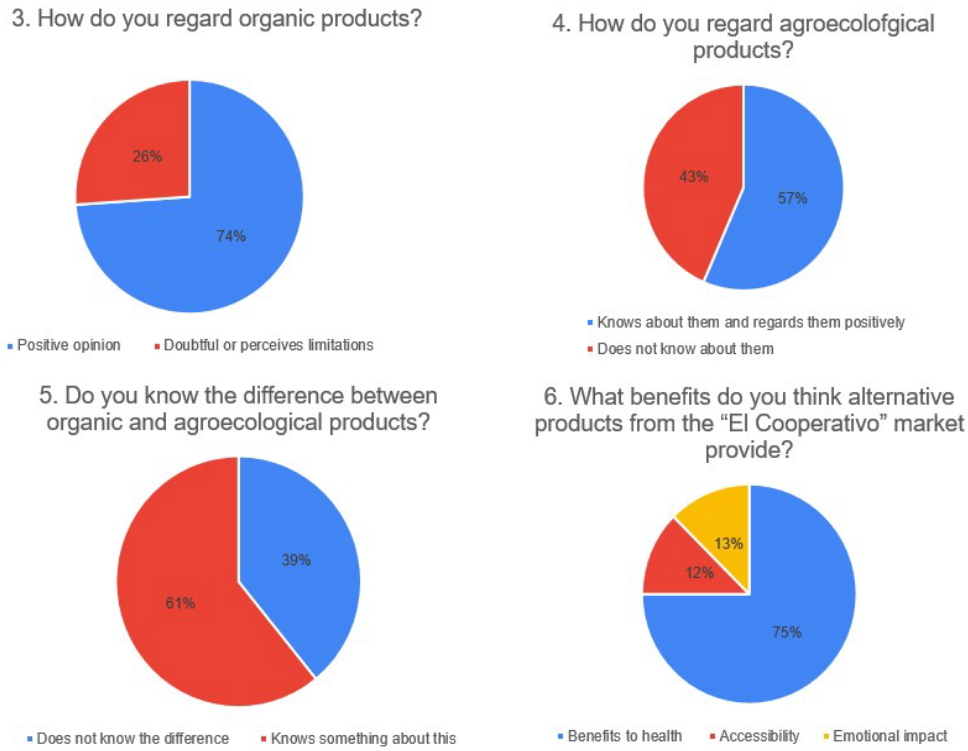
The customers interviewed expressed acceptance and preference for organic and agroecological products. Most considered them positive; perceiving them as healthy, although there is some confusion regarding the difference between organic and agroecological products. Concerning both types of products, the consensus perceives these to represent a healthier and more environmentally friendly consumption alternative. These factors, along with the accessibility and emotional impact they offer, are the other main reasons why customers visit the "El Cooperativo" open-air market (Figure 9).

Figure 10 indicates that a significant number of customers purchase products categorized as organic and agroecological, primarily at the Tianguis el Cooperativo (open-air market), reaffirming its established position as a go-to place for acquiring these types of products. Other establishments, such as certain tianguis in Mexico City and health food stores, are also mentioned. 52% have searched online for these products at other establishments, followed by 13% through social media, while 31% have not undertaken any searches,

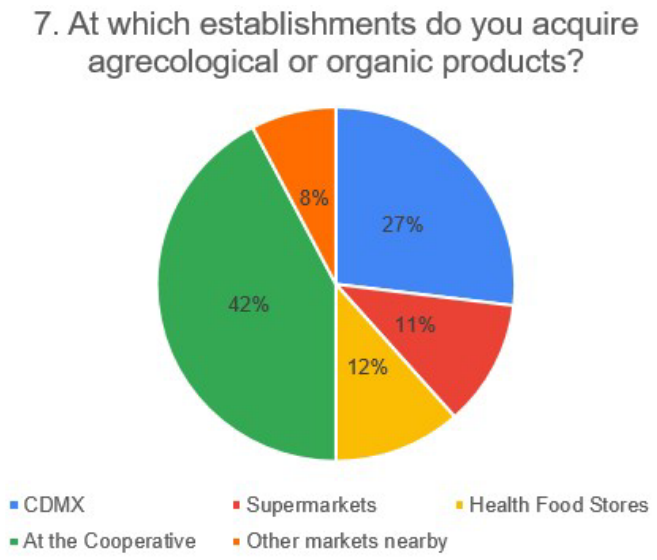



Source: self-elaborated.
**Figure 7.** Client opinion on visits to the tianguis.


Source: self-elaborated.
**Figure 8.** Products most in demand from customers.



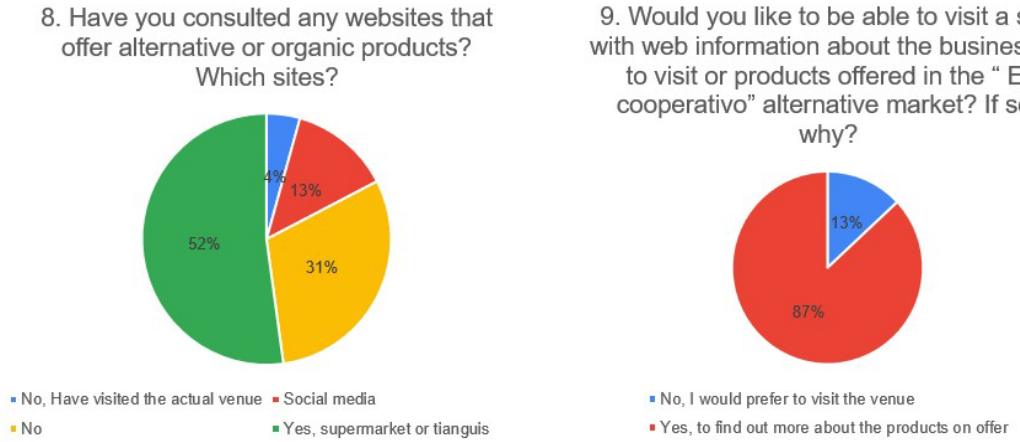

Source: self-elaborated.
**Figure 9.** Customer opinions on organic and agroecological products.



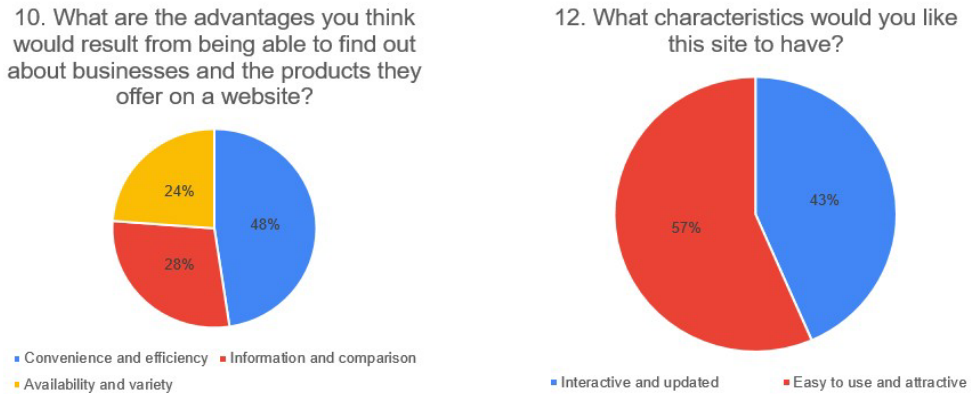

Source: self-elaborated.
**Figure 10.** Establishments for purchasing organic or agroecological products.

and 4% prefer to visit the location where the products are sold. Although a limited percentage of customers search online for these products, 87% would like to be able to find information about the products and businesses at the Tianguis el Cooperativo on a website (Figure 11).

Among the advantages that customers consider when consulting information about the open-air market are convenience and speed, which are presented in Figure 12. This would mean they could identify which products are available



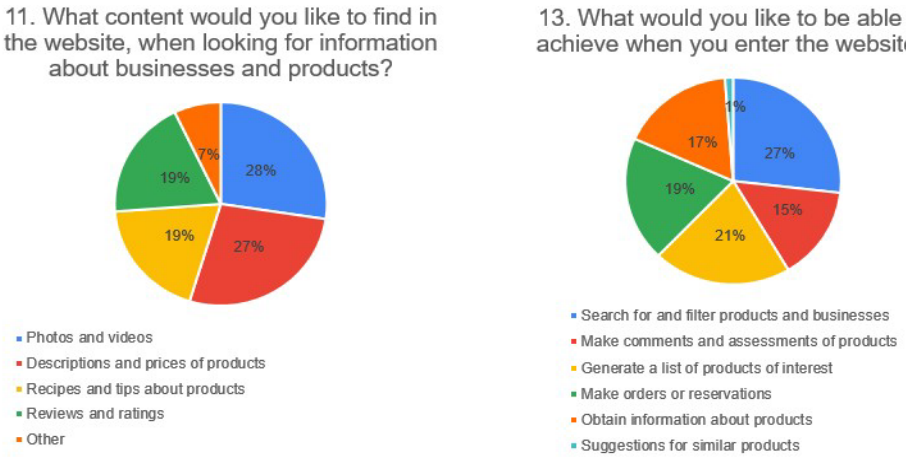

Source: self-elaborated.
**Figure 11.** Opinion on website consultation and acceptance for a TACA web system.




Source: self-elaborated.
**Figure 12.** Advantages and characteristics of the web system.

and obtain detailed information, as well as compare prices and the variety of products offered at the market, which they are sometimes unaware of. A portion of those interviewed (57%) would prefer the system to be easy to use and attractive, and 43% would prefer it to focus more on interactivity and information updates.

Figure 13 shows the categories of content types that users would like to find. It reveals that they express interest in information presented through photos and videos, suggesting they value the visual aspect, followed by detailed descriptions and prices, which are important for making a more informed purchase decision. Customers also show interest in other types of information, such as user reviews and ratings, to complement the information provided by




Source: self-elaborated.
**Figure 13.** Type of content and activities people would like.

producers and increase confidence, thus improving decision-making. Finding information such as recipes and product tips is also considered supplementary, as is finding data such as the nutritional value of products, recreational activities related to the market, and the location of stalls. Customers believe that to improve their experience on the website, they would like to be able to search for and filter products, as this would allow them to find what they are looking for more easily and quickly. They would also like to be able to create a list of products of interest, demonstrating their interest in planning their purchases in advance. Likewise, procedures for placing orders and reservations, as well as commenting on and rating products are important for customers.

## Development of the web information system

The information from all graphs that were generated facilitated the drafting of functional requirements (Table 2), which form the basis for the methodological development of the web information system and which describe the procedures that the system will accomplish in response to according to stated requirements. Non-functional requirements were also described, which define the criteria to be used to evaluate the system's performance (Table 3). That is, unlike functional requirements, which describe what the system should do, non-functional requirements specify what form the system should take (Washizaki, 2024).

**Table 2.** Definition of functional requirements for each participant.

| Actor | Code | Category | Function |
|---|---|---|---|
| Administrator | RQA1 | Accessibility | 1.1. Access only to basic producer information.<br>1.2. Access to requests. |
| | RQA2 | Interaction | 2.1. Access to edit information about the TACA (principal page) |
| | RQA3 | Management | 3.1. Post in the events section with the option to edit or delete.<br>3.2 abc of producers active in the tianguis. |
| Internal participant (producers) | RQUI4 | Management | 4.1. Abc of their products.<br>4.2. Change or delete product images.<br>4.3. Edit information displayed on own profile.<br>4.4. Access to information from customers interested in their products.<br>4.5. Compilation of comments.<br>4.6. List of products with comments and ratings. |
| | RQUI5 | Interaction | 5.1. Display links to social media pages or videos.<br>5.2. Modify the alert notification to update information. |
| | RQUI6 | Accessibility | 6.1. Access only to your seller profile. |

**Table 2.** Continuation.

| Actor | Code | Category | Function |
|---|---|---|---|
| External participant (customers) | RQUE7 | Interaction | 7.1. Navigation between the information displayed on the main page, producers and forms.<br>7.2. Leave comments about products or producers (registration required). |
| | RQUE8 | Accessibility | 8.1. Access to the form to request entry to taca |
| | RQUE9 | Management | 9.1. Rate and review products.<br>9.2. Product search and filter.<br>9.3. Contact with producers through the system.<br>9.4. Add comments directed at the market.<br>9.6. Add products to cart.<br>9.7. Sending and downloading shopping list. |

RQA, management requirement, RQIU, internal user requirement, RQUE, external user requirement.
Source: elaborated by the author using interview data, 2024.

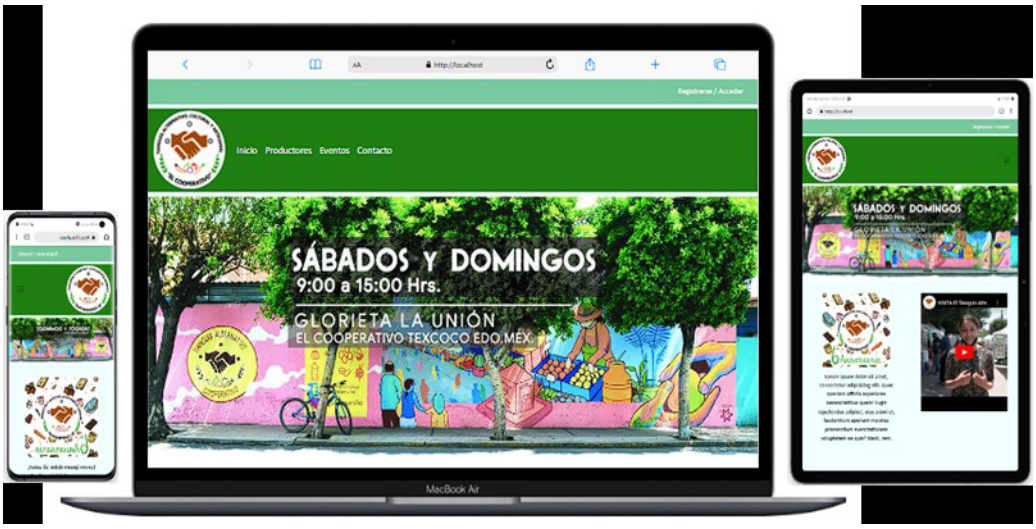
To improve understanding, these requirements were presented in tables that broke down functions according to each actor identified. A key was assigned to define the requirements for actors in the system: the administrator assigned the RQA password and internal users, who consist of producers, who have the RQUI password and external users, who are clients who have the RQUE password.

Figure 14 indicates that users can access the system via mobile devices, tablets, or laptops. During systems development, a browser extension (Mobile

**Table 3.** Definition of non-functional requirements.

| Non-functional Requirement | Definition |
|---|---|
| Performance | It must be capable of performing the tasks for which it is designed (fulfilling functional requirements). |
| Reliability | It must be reliable; it should not contain errors or bugs that cause it to malfunction; it must produce the correct results for each task assigned to it; as designed. |
| Applicability | It should be easy to use and understand, so that its presentation is straight forward and will provide user assistance when needed. |
| Capacity | It must be able to handle multiple requests simultaneously and provide a swift response. |
| Accessibility | Accessible to all users (from any smart device connected to the internet) |
| Security | It must have the necessary security measures in place to protect any data that is processed and generated, as well as to prevent cyberattacks. |
| Compatibility | It must be compatible with different web browsers (the programming should permit access from any browser). |
| Adaptation | It should adapt to different screen sizes, meaning that users can view the system from any device (cell phones, tablets, laptops). |
| Up-to-date | It should be easy to update, without causing any interruption (applies to the administrator or user). |

Source. self-elaborated, using Washizaki (2024).




Source: elaborated by the author based on the information system generated.
**Figure 14.** Responsive web information system.

Simulator: Responsive Testing Tool) verified that the system was responsive, meaning that the information displayed to the user could be viewed on different screen resolutions. This was achieved by implementing the `display: flex` and `display: grid` properties of Cascading Style Sheets (CSS) on selected items, allowing the generated interfaces to dynamically adapt to different screen sizes.

To access other system capacities, such as adding comments, generating shopping lists, or performing ABC (addition, deletion, and modification) of producers or products, access control was implemented for each user. To do so, users must access the login form, where they enter their email address and password. The system uses this information to verify the user's credentials. The user's data is stored in the database and is consulted to determine their access level: an access level of 1 corresponds to administrator, 2 to customer, and 3 to producer.

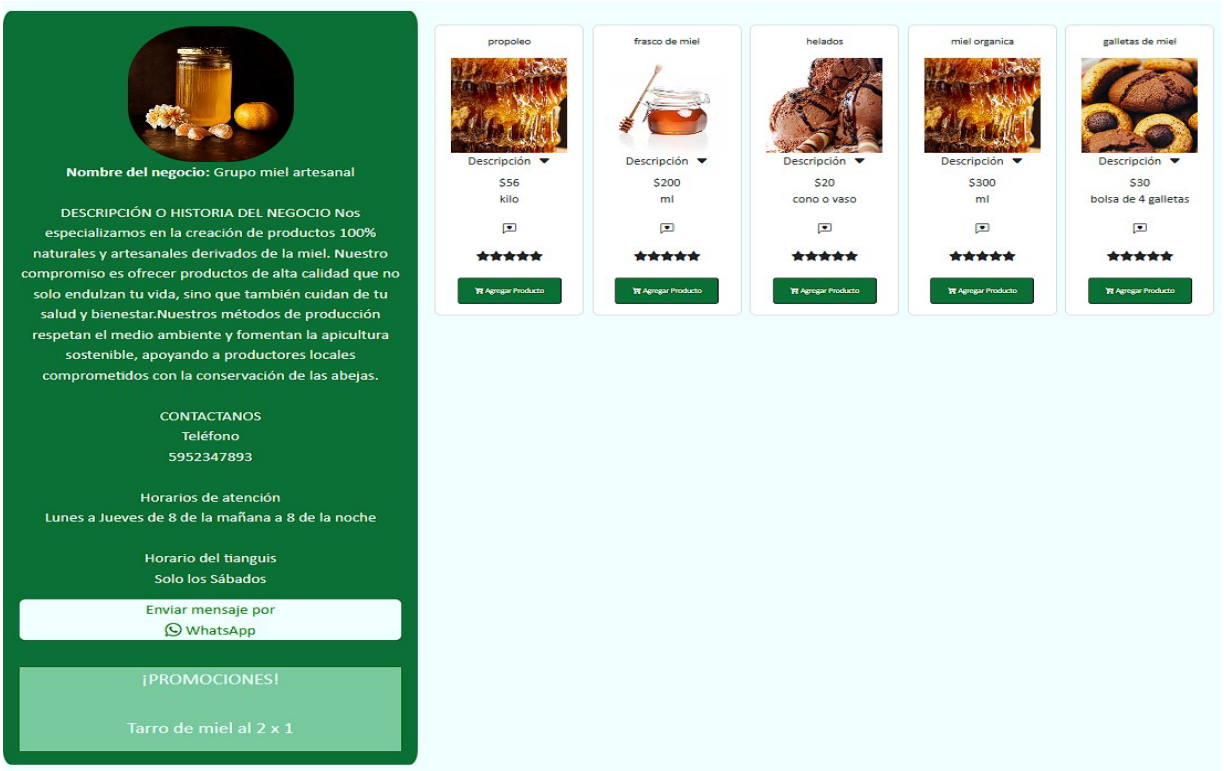
When an administrator logs in, entry data is verified. If correct, they are redirected to the administrator page, which displays a table with simulated data for producers who have a stall in the market. The Edit Producers, Edit Events, and Edit Main Information buttons are also displayed, allowing them to perform actions such as adding, deleting, or editing. A pop-up window opens, showing the fields to be filled in, followed by the procedures to be carried out, prompting the user to confirm to continue. When a producer logs in, their data is verified, and they are redirected to their profile, as shown

in Figure 15. There, they will find the Edit Profile and Edit Product buttons. Selecting each button opens a pop-up window where they can edit the profile and add, delete, or edit products.

In the case of a customer, they can browse the different pages of the website and view the information, but if they need to carry ot procedures such as leaving comments or rating the market or the products, saving products to their cart or generating a shopping list, they need to register and log in. Figure 16 shows an example of how a registered user leaves a comment about the market and sees an alert saying "Comment submitted successfully," as the user was logged in. Otherwise, the message "You must log in to add a comment" would be displayed.

## DISCUSSION

The identified open-air markets and street markets, which have a digital presence through websites or shared platforms, demonstrate a growing trend toward incorporating information systems into short supply chains. This




Source: elaborated by the author based on the information system generated.
**Figure 15.** Producer profile interface.


Source: elaborated by the author based on the information system generated.
**Figure 16.** Submitting a comment from a registered user.

aligns with the findings of García and Roldán (2023) regarding the Puebla Alternative Market, where the implementation of a digital platform not only enabled businesses to maintain operations during the pandemic but also generated additional economic benefits for participants.

The proposed web information system is expected to expand the visibility of producers at the "El Cooperativo" alternative market and ensure that their activities continue, even in precarious scenarios.

Similarly, Gerritsen *et al*. (2021), in their study, reported an increase in the use of social networks and home delivery services by producers in Jalisco during the pandemic, indicating that the use of social networks provides an alternative means of communication, but the development of websites and collective platforms would represent a further step towards the systematization of information.

In similar vein, Bustamante (2016) states that the sustainability of producers, depends largely on their market connections becoming diversified.

The research findings support this idea, as the digital presence of open-air markets not only serves as an additional means of connection but also helps reduce dependence on physical venues, thus strengthening their self-sufficiency. Similarly, the case Agri-food Initiatives of the Popular, Social and Solidarity Economy (IAEPSS), documented by Amalia *et al*. (2023), aligns with these observations regarding the growing interest in digital platforms.

However, while REDAL was conceived as a mobile application specifically designed for food networks, digitalization of tianguis and traditional markets has not been uniform. Some have adopted digital tools more extensively, while others have only just begun or use simpler methods. This indicates that not all open-air markets have the same technological capacity or implement the same procedures.

Therefore, an opportunity to standardize processes emerges, that is to create common procedures, guidelines or systems that allow all markets to digitize in a more organized and efficient manner, reducing the gap between the most advanced and the least developed.

In accordance with this, Franco *et al*. (2022) argue that markets implemented various strategies to maintain the sale of their products in the face of the scenario resulting from the pandemic. These adjustments not only allowed them to continue their activities but also increased their capacity for growth and the consolidation of their objectives. This suggests that the incorporation of web-based systems could become a strategic component for open-air markets and traditional markets, promoting their survival and strengthening them in crisis situations.

Finally, in accordance with Arrellanes-Cancino and Helen (2022), these results reaffirm that agroecological markets and tianguis not only constitute venues for economic exchange, but also for building community networks and solidarity. The incorporation of digital tools, far from replacing this social dimension seems to have enhanced it, as it facilitates communication, the organization of activities, and the dissemination of agroecology, to a wider audience.

## CONCLUSIONS

Some producers at the El Cooperativo Market have a access to the digital world through social media; however, this isn't always sufficient to showcase all their products. Although most have basic knowledge of how to use these platforms, their technological skills are limited, highlighting a digital divide in this sector. This gap can be bridged through training workshops that inform and motivate producers to implement new digital tools. These actions would represent a first step toward the later implementation of web-based information systems, such as the one proposed for the market. While direct contact with attendees remains essential, the proposal doesn't seek to fragment this connection, but rather to complement it.

The use of digital tools can serve as an additional channel for communication, sales, awareness-raising, and promotion of these venues. Similarly, strengthening open-air markets and alternative markets using digital media

can contribute to consolidating local networks, promoting agroecological practices, and opening new lines of research.

These lines of inquiry could include an analysis of the use of digital media as a robust channel for offering and selling products, measuring the benefits for the various stakeholders involved, and determining whether the strategies employed could be replicated in other open-air and street markets. This would allow, not only for documenting the impact of these venues, but also for identifying and developing innovative strategies that ensure their continuity and growth.

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