Aplicación web para promover el trueque en el comercio justo y la soberanía alimentaria

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Revolutionizing fair trade and food sovereignty: The powerful synergy between computing and engineering in a web-based bartering application

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Abstract. Technology over time has been a fundamental means in the development and evolution of fair trade and food sovereignty. In many regions, small-scale farmers face significant challenges due to deficiencies in the economic system. Lack of access to markets, overproduction of cash crops, limited price information and dependence on expensive imports are just some of the problems they face. In this context, the web-based barter application harnesses the synergy between computer science and engineering to address these challenges. This web-based application facilitates the direct exchange of goods between producers and consumers, eliminating unnecessary intermediaries and fostering closer and more transparent relationships. Local producers can make their products known in a global market, overcoming geographical barriers and traditional distribution costs. On the other hand, consumers have access to a wide variety of fresh and authentic products, directly from the producers. The application also integrates intelligent functionalities, such as personalized recommendation algorithms and reputation systems, which enhance user experience and build trust in transactions. Artificial intelligence and machine learning adapt the platform to the preferences and needs of each user, facilitating the search for specific products and fostering virtual communities based on common interests.

Keywords: Technology, fair trade, food sovereignty, implementation, barter, synergy, IT, engineering, producers, consumers, artificial intelligence.

1 Introduction

Agriculture plays a key role in the society and economy of many low-income countries. In sub-Saharan Africa, approximately 65% of the population works in the agricultural sector, generating 32% of GDP growth [1]. Specifically, most people rely on small-scale agriculture as a source of livelihood and well-being [2]. This form of agriculture involves both the production of staple foods for family survival and the cultivation of cash crops. Moreover, small-scale farming plays a key role in improving food security, especially in rural areas.

Despite the essential role that small-scale farmers play; they face significant challenges due to various deficiencies in the economic system. For example, markets selling agricultural products are often inaccessible due to lack of transport or knowledge of buyers [3]. Anecdotal evidence suggests that overproduction of key cash crops frequently occurs, which lowers profit margins. In addition, smallholder farmers often have limited or unreliable information on the current selling price of goods. This can result in farmers having little bargaining power and therefore receiving sub-optimal prices for their produce from buyers in large central markets who have advantages in both resources and information. Finally, pressure to sell into larger regional and national markets can lead to unmet local needs and increased reliance on more expensive imports.

At the same time, the health emergency caused by Covid 19 led to a decrease in the cash flow of society in Ecuador and, in turn, caused an increase in the difficulty of obtaining food, which presented a harsh reality in households in the region and the current situation, generating fear among communities when using cash, which is why the vast majority prefer to pay using digital platforms with electronic money.

For this reason, new information technologies have radically transformed the way we interact, work and consume. From social networks to e-commerce, these innovations have revolutionized various sectors of society, and fair trade and food sovereignty are no exception. In this context, a powerful synergy is emerging between computer science and engineering, which has given rise to a web-based barter application, opening up new possibilities and transforming the way we interact with food and the exchange of goods.

Fair trade and food sovereignty are fundamental concepts in building a more equitable and sustainable world. Fair trade seeks to ensure fair and equitable conditions for producers, especially those in developing countries, while food sovereignty seeks to empower communities to have control over their food systems, encouraging local and sustainable production. Both approaches share the vision of promoting fair, environmentally friendly and socially responsible trade relations. In this context, the web-based barter application emerges as an innovative and efficient solution to promote fair trade and food sovereignty. This application uses advances in computer science and engineering to create an online platform that facilitates the direct exchange of goods between producers and consumers, eliminating unnecessary intermediaries and promoting closer and more transparent relations.

The web-based barter application allows local producers to make their products more widely known and access a global market, overcoming the geographical barriers and costs associated with traditional distribution. At the same time, consumers can discover a variety of fresh and authentic products directly from the hands of producers, promoting diversity and food culture. In addition, the application integrates intelligent functionalities, such as personalised recommendation algorithms and reputation systems, which enhance the user experience and build trust in transactions. Artificial intelligence and machine learning allow the platform to adapt to the preferences and needs of each user, facilitating the search for specific products and fostering the creation of virtual communities based on common interests.

2 Background

2.1 Fair trade and food sovereignty

Fair trade and food sovereignty are two interrelated concepts that advocate fair and sustainable trade and agricultural practices. Both approaches aim to promote social justice, protect the environment and guarantee the right of communities to decide on their food production and consumption [4].
Fair trade and food sovereignty share a common vision of promoting sustainable, environmentally friendly and socially just agricultural practices. They also seek to reduce the dependence of developing countries on food production and distribution systems dominated by multinational corporations, encouraging instead local development and self-sufficiency.
The promotion of fair trade and food sovereignty has become increasingly relevant in the current context of globalization and the industrialization of agriculture. These approaches offer alternatives to conventional models of food production and trade, with an emphasis on social justice, environmental sustainability and respect for local traditions and cultures.

2.2 Computer science and engineering in international trade

Information technology and engineering have driven the expansion of international food trade, facilitating secure and efficient transactions through digital platforms. Advances in e-commerce, data management and payment systems have enabled farmers and producers to access new markets and establish direct trading relationships with consumers [5][6][7].

2.3 Informatics and engineering in food sovereignty

Food sovereignty is a concept that promotes the ability of countries to ensure food security and autonomy in food production. Information technology and engineering can play a key role in strengthening food sovereignty by improving agricultural productivity, encouraging crop diversification and facilitating access to information and technical knowledge [8].

2.4 Agriculture in the Belisario Quevedo sector, Ecuador

Belisario Quevedo is a sector located in the city of Latacunga, in the province of Cotopaxi, Ecuador. This region is characterized by a strong agricultural focus, where food production plays an essential role in the local economy and in the life of the communities.
The main crops grown in the area include potatoes, maize, wheat, barley, legumes, vegetables and fruits. These foods are grown by small-scale farmers.

3 System Architecture

The deployment of the barter application focuses on allowing interconnection between the different areas of the town of Belisario Quevedo, since, being a rural area, the availability of internet is limited and connecting from point to point would take months due to its mountainous ecosystem. For this reason, it was decided to create a local network that, together with signal repeaters, would communicate each barter station.

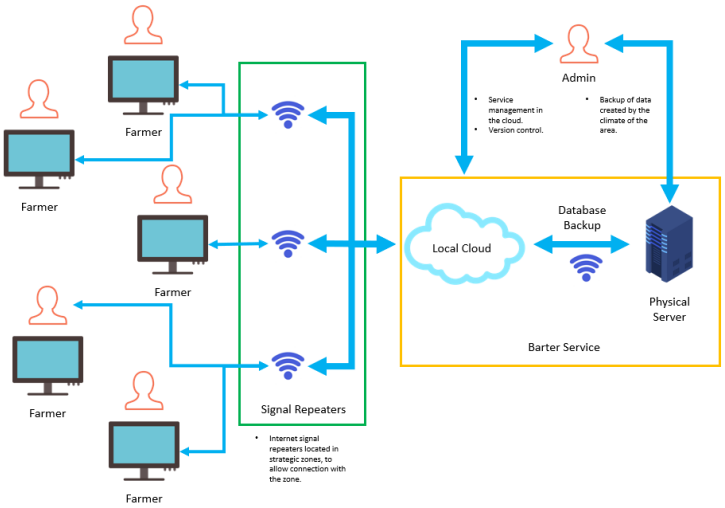

Fig. 1. Web system deployment architecture for barter application.

As shown in figure 1, the barter system has a client-server architecture, with a backup hosted on its physical server and the main hosting in the cloud, for communication between the different areas of shops were established antennas that receive the network signal, each one allowing the connection with the site and the corresponding services, in addition the system has a backup in case of disconnection, allowing to maintain the local connection with it in case of network problems, being a source of stable marketing in the area.

4 System Development

4.1 Creation phase

Fair trade and food sovereignty are two interrelated concepts that advocate fair and sustainable trade and agricultural practices. Both approaches aim to promote social justice, protect the environment and guarantee the right of communities to decide on their food production and consumption [4].

The web application for the implementation of barter is developed with the following technologies:

- **React:** open source Javascript library designed to create user interfaces with the aim of facilitating the development of applications on a single page.
- **Laravel:** open source framework for developing web applications and services with PHP 5, PHP 7 and PHP 8.
- **Heroku:** platform as a service that supports several programming languages, being one of the first cloud platforms.
- **Vercel:** US cloud platform as a service company. The company maintains the Next.js web development framework. Vercel's architecture is based on Jamstack and deployments are managed through Git repositories.
- **Terraform:** infrastructure-as-code software developed by HashiCorp. It allows users to define and configure a data center infrastructure in a high-level language.

The technological stack is composed in such a way that it allows a quick implementation and agile management of the development, for this we made use of the SCRUM methodology, being an agile framework that will allow a quick deployment, where the back-end was coded using react with JS and a solid front-end using Laravel as can be seen in Figure 2, The same were deployed in Heroku for the back-end and Vercel for the from-end deployment, in addition we proceeded to use Terraform, due to the conditions of the area, where there is no large number of specialized technicians, so the deployment of the same is documented and coded, allowing to restore the system in an agile and fast way.

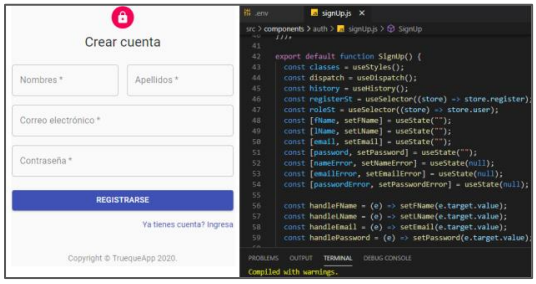

Fig. 2. Development of the web application for barter.

4.2 Deployment phase

The deployment phase begins with the creation of 2-metre high poles, which have polymer cases where the receivers and signal repeaters will be housed, thus creating a local network connected to each of the community's collection centers.
In order to carry out the exchange, the web application has the implementation of mailtrap (see fig. 3), a server for sending and delivering e-mails, where each of the

users will be able to carry out the respective exchange of words until an agreement is reached that benefits both parties.

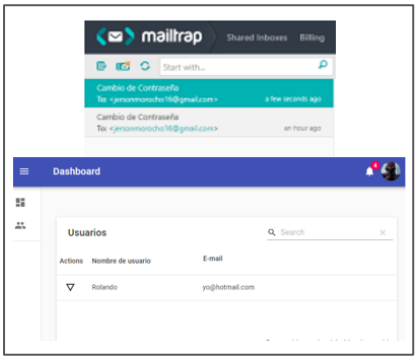

Fig. 3. Mailtrap implementation.

5 Results and Discussion

This section presents the results obtained in the development and implementation of the website to revolutionize fair trade and food sovereignty in the sector of Belisario Quevedo, Latacunga, Ecuador. These results are divided into two stages, A) Interaction with the web system, which details the functionality of the site developed through the different products offered by farmers in the area and B) Validation of the application, which analyses the results obtained from the manipulation of the system by a group of community users.

A. Interaction with the system

Once the user accesses the website, he/she must register in the system, with his/her registration he/she will be able to publish each of the products he/she wishes to exchange, within these fields a name, price and description must be added, finally the system will notify you when another user wishes to exchange with you, as can be seen in figure 4.

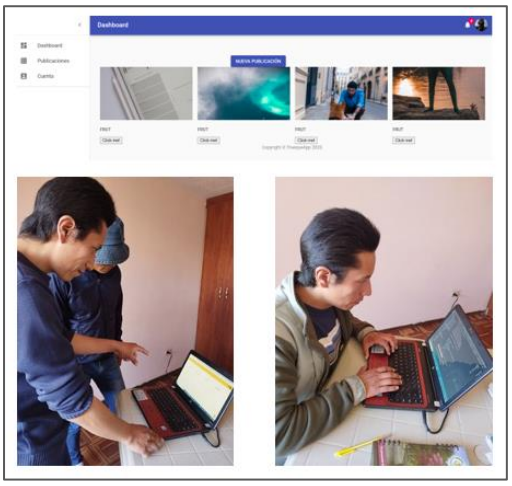

Fig. 4. Implementation and validation testing.

B. Validation

Using the convenience sampling technique, 20 users/producers/consumers from the community who had not used any barter-like system were selected as respondents. After a brief explanation of the functionality of the web application, each of the users entered the system and interacted with the various options, i.e.: entry of new products, search for available products with intelligent detection, where the item close to the consumer's location was displayed. Additionally, it was possible to negotiate with the owners of the desired product, to offer another product in exchange, until a mutual agreement was reached.

A reliability analysis using Cronbach's alpha was conducted to give consistency to the aptitude test (Fig. 1), which resulted in a value of 0.8251, indicating that the measurement items (questions) were positively correlated, so all constructs were considered reliable [9].

Fig 1. Cronbach Alpha Scale.

The formula applied was, using the variance of the items:

$$\alpha = \frac{k}{k-1}\left[1 - \frac{\sum V_i}{V_t}\right] \quad (1)$$

$\boldsymbol{\alpha}$: Cronbach's alpha

$\boldsymbol{k}$: Number of item

$\boldsymbol{V_i}$: Variance of each item

$\boldsymbol{V_t}$: Total Variance

Next, the aptitude test [10] was applied, which is designed to assess the users' ability to navigate and use the basic functions of the web application related to fair trade and food sovereignty, such as searching for products, viewing information about producers and suppliers, making purchases and transactions, based on the integration of the website with agriculture in the Belisario Quevedo sector. The results show that the general opinions of the products/consumers were as follows:

- Learning the basic functions of the application, such as searching for products, viewing and making purchases and transactions showed moderate improvement ($\bar{X}$=3.7, SD=1.00).
- The measure of users' level of understanding of the key principles and concepts of fair trade and food sovereignty, such as fairness in trade relations, environmental sustainability, support for local producers was satisfactory ($\bar{X}$=4.1, SD=0.92).
- The usefulness of the website was considered quite good ($\bar{X}$=4.7, SD=0.53).
- The collection of user comments and suggestions on the web application was of great value for future updates and improvements of the system ($\bar{X}$=4.3, SD=0.83).
- The content displayed was helpful in raising awareness of the products on offer ($\bar{X}$=4, SD=0.69).
- The web application helped to better market the products from the Belisario Quevedo sector ($\bar{X}$=4.33, SD=0.66).
- The site was in line with their expectations ($\bar{X}$=4.03, SD=0.66).

In addition, the System Usability Scale (SUS) is used to assess the usability of the website. The SUS consists of a 10-question questionnaire with 5 options for each question. Tabulate the results and calculate the availability point, where 100 is the maximum value and 0 is the minimum value. A value above 80 is considered too accessible for users/producers/consumers, while a value below 68 is considered low average. The results shown in Table 1 describe the calculations performed and the web application can be considered easy to use as the average availability of the system is 84.67.

Table 1. Application Usability Evaluation

Evaluated parameters	Average	Weight	SUS Final Score
1. I think that I would like to use the website.	4,13	x-1	3,13
2. I found the website unnecessarily complex.	1,23	5-x	3,77
3. I found the web application easy to use.	3,63	x-1	2,63
4. I think that I would need the support of a technical person to be able to use the website.	1,06	5-x	3,93
5. I found the various functions on the website were well integrated.	4,70	x-1	3,70
6. I thought there was too much inconsistency in the web application.	1,03	5-x	3,97
7. I would imagine that most people would easily learn to use the website.	4,23	x-1	3,23
8. I found the website very cumbersome (awk-ward) to use.	2,97	5-x	2,03
9. I felt very confident using the web application.	4,60	x-1	3,60
10. I needed to learn a lot of things before I could get going with the website.	1,13	5-x	3,87
Total Amount			**33,87**
SUS Score			**84,67**

6 Conclusions

- The web-based barter application was able to strengthen food sovereignty by allowing local communities to exchange their products directly. This helped reduce dependence on large supply chains and promoted local production and consumption, benefiting farmers and producers.
- By connecting producers and consumers directly through the website, it was possible to encourage the exchange of fresh and healthy food. This was especially important in areas where access to nutritious products is limited, in this case the Belisario Quevedo study area.
- The web-based barter application was able to help reduce food waste by allowing surplus or unused produce to be exchanged rather than discarded. This not only benefited producers by avoiding economic losses, but also contributed to environmental sustainability by minimizing the amount of food wasted.
- The website was able to empower local communities by allowing them to have greater control over their own food trade and production.

- The website was well received in the Belisario Quevedo sector, as they were able to offer their products and were part of a big change thanks to the implementation of new technologies.

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