



**Education development and
its link to community engagement
SECOND EDITION**

**Education development and
its link to community engagement
SECOND EDITION**

Book title

Education development and its link to community engagement second edition

ISBN: 978-9942-33-668-2

Published 2023 by arrangement with the authors.

© 2022, Editorial Grupo Compás

Guayaquil-Ecuador

Universidad de Guayaquil supports copyright protection, each of its texts has been submitted to a process of evaluation by external peers based on the publisher's regulations.

Copyright stimulates creativity, defends diversity in the field of ideas and knowledge, promotes free expression and favors a living culture. The production or storage of all or part of this publication, including the cover design, as well as its transmission by any means, whether electronic, chemical, mechanical, optical, recording or photocopying, without the authorization of the copyright holders, is strictly prohibited under the penalties of the law.

   @grupocompas.ec
compasacademico@icloud.com

INDEX

INDEX.....	1
The enterprise operating system of the new era.	6
<i>Introduction.....</i>	6
<i>Literature review</i>	13
<i>Conclusions.....</i>	27
<i>References</i>	31
Digital competencies and the impact on academic teleworking activities in the pandemic by Covid-19	35
<i>Introduction and state of the art.....</i>	35
<i>Inclusion Criteria</i>	44
<i>Data collection instrument used.....</i>	45
The challenge of the post pandemic in higher education from face-to-face and virtual classrooms.	54
<i>Introduction.....</i>	54
<i>Conclusions.....</i>	64
<i>Reference.....</i>	64
Curricular organization in higher education for the online modality in the 21st century.	67
<i>Introduction.....</i>	67
<i>The competency-based curriculum model for higher education in the online modality.</i>	69
<i>Competency-based curriculum design for higher education in the online modality.</i>	71
<i>Conclusions.....</i>	93
<i>References</i>	94
State of the art on problems of financial tools in the development of microenterprises in the province of El Oro.....	95
<i>Introduction.....</i>	95
<i>State of the Art Financial Tools.....</i>	99
<i>Evolution of Financial Theory</i>	99
<i>Financial Tools</i>	102
<i>Results of the information in databases</i>	107
<i>Conclusions.....</i>	114
<i>References</i>	115
Effects of electronic invoicing, micro-enterprise sector in	

the province of El Oro	123
<i>Introduction</i>	124
<i>Microenterprise</i>	129
<i>Natural Person</i>	130
<i>Electronic Invoicing</i>	131
<i>Social Effects</i>	133
<i>Economic Effects</i>	134
<i>Environmental Effects</i>	134
<i>Results of Surveys Applied to Microentrepreneurs and Accountants in El Oro</i>	149
<i>Microentrepreneurs</i>	149
<i>Counters</i>	152
<i>Conclusions</i>	154
Quality management and educational innovation from postpandemica covid19: Synchronous and asynchronous classes, Ecuador.....	165
<i>Introduction</i>	165
<i>Conclusion</i>	183
<i>References</i>	184
Financial study of Ecuador's public banks using Camel and Dupont analysis.....	189
<i>Introduction</i>	189
<i>Regulation of Ecuador's financial system</i>	189
<i>1.2 Public Banking in Ecuador</i>	190
<i>State of the art</i>	191
<i>The Dupont identity</i>	195
<i>Extended Dupont analysis</i>	196
<i>Camel risk analysis</i>	197
<i>Financial analysis of Ecuador's public banks</i>	197
<i>Conclusions</i>	218
<i>References</i>	220
Evaluation of learning in the Diploma Course: Methodology in teacher training for the online modality. University of Otavalo	227
<i>Introduction</i>	227
<i>Conclusions</i>	248
<i>References</i>	248
CO2 emissions: Effects and mitigation technologies ..	253

<i>Conceptual Framework: CO₂ emissions and global warming</i>	256
<i>Study design</i>	257
<i>Data collection and analysis of results</i>	259
<i>CO₂ emissions: Climate impact and mitigation technologies</i>	260
<i>Summary of subcategories found in the review</i>	264
<i>Conclusions</i>	269
<i>References</i>	269
Strategic Planning for the Hotel School at the Chirije-ULEAM Research Center towards Sustainable Tourism:	
Logical Framework Matrix MML	282
<i>Introduction</i>	282
<i>World Tourism Situation</i>	284
<i>Tourism Growth in Ecuador</i>	287
<i>Research project</i>	289
<i>Logical Framework Matrix MML</i>	290
<i>Conclusions</i>	303
<i>References</i>	303
Agro-ecotourism management through circular economy in Sucre canton -Manabí- Ecuador	307
<i>Introduction</i>	308
The "Taking of Venezuela": analysis of the conflict in the political contest	317
<i>Introduction</i>	317
<i>The Application of Game Theory</i>	319
<i>Context of the Mobilization "Toma de Venezuela"</i>	322
<i>Analysis of the Venezuelan Political Conflict under Pigeon Hawk Game Theory</i>	325
<i>Conclusions</i>	331
<i>References</i>	333
Impact of the Covid 19 pandemic on the values of university students in the Amazon region	335
<i>Introduction</i>	335
<i>Conclusions</i>	346
<i>References</i>	348
The challenges of informatics in nursing practice: Integrative review	352

<i>Introduction</i>	352
<i>Conclusions</i>	355
<i>References</i>	356
Stock Market Prediction using LSTM-MACD	358
<i>Introduction</i>	358
<i>State of the Art</i>	359
<i>LSTM</i>	360
<i>MACD (Moving average convergence / divergence)</i> ... 361	
<i>CRISP-DM</i>	362
<i>Application of the methodology</i>	364
<i>Understanding the data</i>	365
<i>Modeling</i>	367
<i>Conclusions</i>	374
<i>References</i>	376
<i>Introduction</i>	381
<i>Importance of the technological scenario in education</i>	383
<i>Conclusions</i>	390
<i>References</i>	391
RGB free colorimeter for sensing and sorting of pigmented spheres	393
<i>Development</i>	394
<i>Mathematical model</i>	399
<i>Development of the system</i>	401
<i>Physical architecture</i>	404
<i>Conclusions</i>	421
<i>References</i>	422
Machine Vision for Pattern Detection and Recognition in Surveillance Environments	425
<i>Introduction</i>	425
<i>Presentation of the problem or objective</i>	426
<i>Intelligent System Architecture</i>	427
<i>Light source</i>	428
<i>Image Sensor (Camera)</i>	428
<i>Acquisition System (Graphic Card)</i>	430
<i>Digital Image Processing (DIP)</i>	431
<i>Interface</i>	431

<i>External Actuators</i>	431
<i>A. Pattern recognition</i>	432
<i>II. Pattern Recognition Process</i>	434
<i>Machine Vision Phase</i>	435
<i>Image preprocessing</i>	435
<i>Image processing</i>	435
<i>Algorithms Used</i>	436
<i>Intelligent System Environment</i>	447
<i>Conclusions</i>	453
<i>References</i>	454
The teaching of food biotechnology in an engineering career through a face-to-face and hybrid system in Ecuador	456
<i>Introduction</i>	456
<i>Biotechnology in the field of higher education</i>	458
<i>References</i>	485

The enterprise operating system of the new era

Diego Ignacio Montenegro

PhD, Universidad de Los Hemisferios, IDE Business School

diegom@uhemisferios.edu.ec

<https://orcid.org/0000-0002-9760-1181>

Introduction

Innovation should be seen as a strategic process, part of the DNA of an organizational culture that is centered on people, starting with the leaders. "Creation is not an isolated voice in the dark, but a conversation, a process of dialogue and discovery (...) organizations must focus their efforts on gathering enough talented individuals to ensure renewal. It is the leaders who have to create the kind of fertile ground in which each individual can develop his or her individual strengths." (Ridderstrale & Norström, 2003). As Walsh mentions (2019) "the importance of designing work is not limited to finding innovative ways of thinking; it includes identifying, preserving, and replicating patterns of talent, or the implicit knowledge and experience of your best employees before they leave or retire."

Consequently, the study of innovation, creativity and technology adoption is ever increasing due to the speed of change in the world; and companies (along with individuals) have no choice but to learn to adapt, and this will be difficult and will require more self-motivation. The accelerations have opened a huge gap between the speed of technological change, globalization and environmental havoc, and the ability of people and governance systems to adjust to it all and be able to manage it (Friedman, 2018).

Therefore, countries need to be competitive and two of the

main pillars, as the World Economic Forum states. (2018) are: (1) **Business dynamism**, defined as the ability of private sector companies to adopt new technologies and ways of managing work through an organizational culture that considers change, risk, new strategic models and business rules that allow companies to enter and exit the market with ease; and, (2) **Innovation capacity**, which measures the quantity and quality of innovation, and is related to the promotion of a business environment that fosters collaboration, connectivity, creativity, diversity, and the confrontation of diverse perspectives and the ability to convert ideas into products or services. Ecuador, the South American country that is the subject of this study, in the 2018 report ranks 129th out of 140 countries in business dynamism (45.2 points out of 100) and 88th in innovation capacity with a score of 32 out of 100 points; Chile, the most competitive country in the region, ranks 66th in business dynamism and 53rd in innovation capacity. For 2019, Ecuador falls to 130th place out of 141 countries in business dynamism, while remaining in the 88th *ranking* in innovation (Schwab, 2019)..

In fact, "the environment is transforming at the speed of light, like a moving atom that changes its position in microseconds; many have decided that the best way to face this new order is to wait for events to come and then try to solve them (...) others take the initiative" (Montenegro & Calvache, EmotionShare). (Montenegro & Calvache, EmotionShare. Strategy and Disruptive Marketing, 2016). So, how does the type of leadership influence the relationship with the components of creativity and innovation in Ecuadorian companies? What level of technological adoption do the organizations investigated present? How would the assumptions related to creativity, innovation and new-age technologies be integrated into the

design of the future value proposition of the companies? This study aims to provide answers through data for the construction of a scheme of action regarding the design of business culture and the planning of strategic choices for Ecuadorian companies (and those from other latitudes) that want to incorporate elements of innovation to their models in order to achieve differentiation.

The research is framed within the descriptive type, which serves to analyze what a phenomenon and its components are and how they are manifested. It allows detailing the phenomenon studied through the measurement of one or several attributes, and the description of the characteristics that identify the different elements and components; in addition, concrete behaviors are established and the association between research variables is discovered. At the same time, it is an explanatory study because it seeks to find the reasons or causes (independent variables) that cause certain phenomena and results, which are expressed in verifiable facts (dependent variables); studies of this type involve effort and the capacity for analysis, synthesis and interpretation. (Behar, 2008).

The basis of the study is a questionnaire conducted by Montenegro (2020) to companies in Ecuador with annual revenues between \$5 and \$50 million USD, and answered by managers and high-level officials from various private industries. Simple random probability sampling was used to determine the sample size:

$$n = \frac{Z_{\alpha/2}^2 * P * Q * N}{\varepsilon^2(N - 1) + Z^2 * P * Q}$$

Where:

n = sample size required.

Z = confidence margin or number of standard deviation units in the normal distribution that will produce the desired level of confidence (for 95% confidence or a $\alpha = 0.05$, $Z = 1.96$; for a confidence of 99% or a $\alpha = 0.01$, $Z = 2.58$).

P = probability that the event will occur.

Q = probability that the event does not occur.

ε = maximum error or difference between the sample mean and the population mean that one is willing to accept at the confidence level that has been defined.

N = population size.

$$\begin{aligned} n &= \frac{(1,96)^2 * 0,5 * 0,5 * 2.382}{(0,065)^2(2.382 - 1) + (1,96)^2 * 0,5 * 0,5} \\ &= 207,59 \approx 208 \end{aligned}$$

Where:

n = sample size required (result = 208 companies to apply the questionnaire).

Z = confidence margin or number of standard deviation units in the normal distribution that will produce the desired level of confidence (95% or a $\alpha = 0.05$, $Z = 1.96$).

P = probability that the event will occur (50% is used).

Q = probability that the event does not occur (50% is used).

ε = maximum error or difference between the sample mean and the population mean that one is willing to accept at the confidence level that has been defined (6.5% is used).

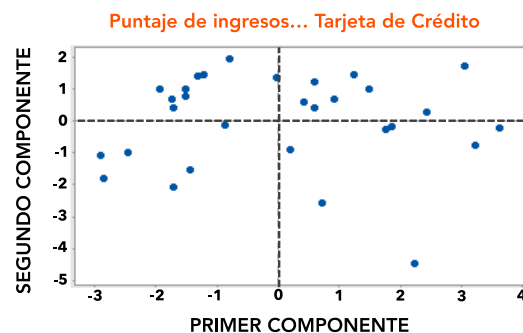
N = population size (using 2,382 companies between \$5 and \$50 million USD, which was the last data reported in 2018 by the Superintendence of Companies of Ecuador).

Although 208 companies were required to have a correct sampling error (6.5%), 276 surveys were obtained, corresponding to a sampling error of 5.5%. For the analysis of scores and influences using the *Biplot* graph, 239 companies and 168 variables were used (after eliminating outliers). For the comparison between research questions, multiple-response analysis with crosstabs was used "because the subject can choose more than one or all of the options offered. This causes these questions to be broken down for tabulation into as many dichotomous variables as options are posed; in many cases there are also unchosen responses" (Serrano, 2013). "The multiple-response cross-tabulation procedure presents in cross-tabular form a set of multiple responses, elementary variables, or a combination" (IBM, 2020).

Finally, the plot of scores and influences should be considered. For Greenacre (1984) "scores are linear combinations of data that are determined by the coefficients of each principal component. To obtain the score for an observation, the values are substituted into the linear equation of the principal component. If the correlation matrix is used, the variables must be standardized to obtain the correct component score when

using the linear equation." The scores plot visually represents the scores of the second principal component versus the scores of the first principal component. Greenacre (1984) further mentions that "the plot interprets whether the first two components explain most of the variance in the data, so the score plot can be used to assess the structure of the data and to detect clusters, outliers, and trends." Clusters of data in the plot may indicate two or more separate distributions in the data. If the data follow a normal distribution and no outliers are present, the points are randomly distributed around zero, as shown in the following example:

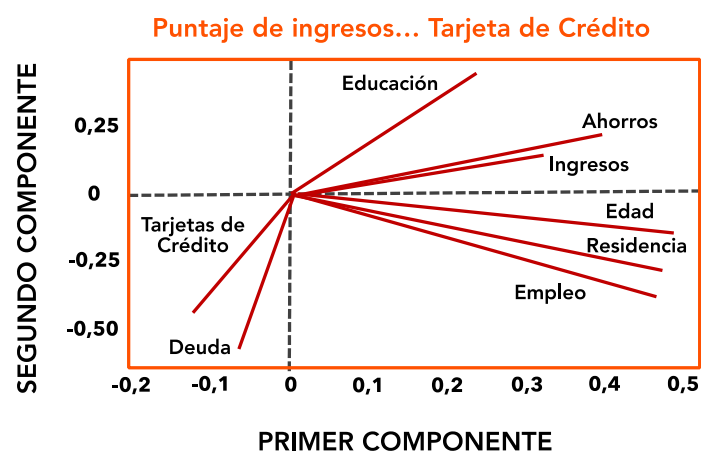
Figure 1. Graph of scores.



Note: the point in the lower right corner could be an outlier, so special research should be done on this particular point. Greenacre (1984) also cites that "the influence plot indicates the coefficients of each variable for the first component versus the coefficients for the second component". The influence plot is used to identify which variables have the greatest effect on each component. Influences can range from -1 to 1. Influences approaching -1 or 1 indicate that the variable significantly affects the component. Influences close to 0 indicate that the variable

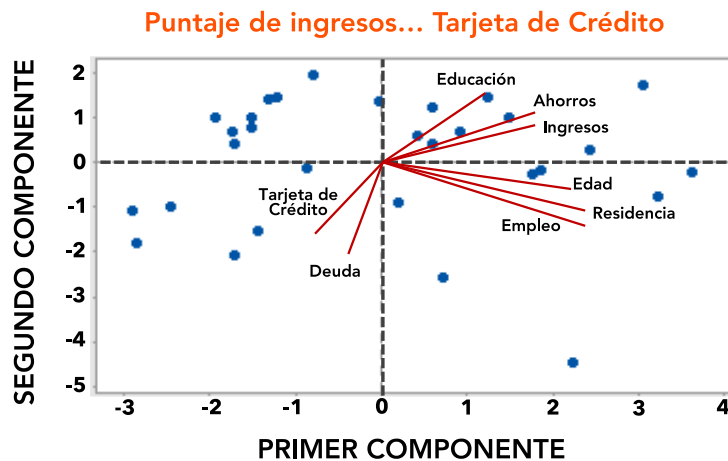
has little influence on the component. Evaluating the influences can also help characterize each component in terms of the variables. An example is shown in the graph below:

Figure 2. Influence graph.



Pinzón (2011) describes the double projection plot or *Biplot*. This projection figure superimposes the scores plot and the influences plot. The double projection plot is used to evaluate the structure of the data and the influences of the first two components in a plot as shown in the example:

Figure 3. Double projection or *biplot* graph.



Note: This example double projection plot shows that: age, residence, employment and savings have a large positive influence on component 1; thus, this component focuses on an applicant's long-term financial stability. "Debt" and "credit card" have large negative influence on component 2; i.e., this component focuses on an applicant's credit history. The dot in the lower right corner could be an outlier and the causes of this result should be investigated.

Literature review

Algorithms "are particular ways of solving problems in simple steps." (Louridas, 2020). By understanding these algorithms and how interactions and experiences are shaped as humans, one can better understand the types of platforms and products that will be successful in the future; it is an era of "winner takes all": leaders who think big and invest for growth will be in a better position to achieve success (Walsh, 2019). Now, "one of the primary functions of the leader is to introduce chaos into order; leaders must push people off the beaten path and destroy current centers of production to create new ones. Meaning-laden

leadership is about stirring up rather than putting things in place." (Norsdstöm & Ridderstrale, 2000).

Kofman (2008) states that "leadership is the process by which a person determines a goal that others should achieve and motivates them to achieve that goal with effectiveness and full commitment. Leadership transforms individual potential into collective performance. Formal authority is never enough to win the enthusiasm of the led". This leadership is defined as "conscious or transcendent" and has: (1) attitudes such as essential integrity; (2) behaviors such as constructive negotiation; and (3) emotional competence. For Peus (2012) "managers are under so much pressure that they place money above people; many are faced with ambitious goals that can only be achieved, or so it seems, by ignoring humanistic values". To complement the types of leadership, MacGregor Burns (1978) introduces the concept of transformational leader and understands as such "the one who mobilizes his followers towards the achievement of noble goals and brings out the best in them: the spirit of service, solidarity and the search for excellence"; he identifies three traits in the transformational leader: charisma, individualized consideration and intellectual stimulation. (Bass, 1998). Lussier and Achua (2010) complement these characteristics of the transformational leader by saying that they are agents of change, visionaries, who enjoy a high level of trust from their followers, take risks with caution, their results are guided by core values, possess cognitive skills, believe in people and are sensitive to their needs, are flexible and open to learning. Finally, leadership with a transactional approach usually occurs when leaders reward or, on the contrary, sanction (intervene negatively) by virtue of verifying whether the followers' performance is in accordance or not with what is expected; the leader

intervenes when corrections or changes in the followers' behaviors must be made. (Avolio & Bass, 2004).

Consequently, innovation is chaos in order, but with conscious leadership. For Rao (2012) "innovation should be seen as a *management* discipline worthy of systematic understanding, strategic implementation and resourceful management"; De Mayer (2011) mentions that the innovation process starts with "good leadership" and continues with project management skills under uncertainty, intelligent knowledge management, ability to take calculated risks, integrated organizational model, determined protection of intellectual property, willingness to listen to end users and create conditions that stimulate creativity. Amabile (1996) states that "innovation is the successful application of creative ideas in an organization" and contains three components: (1) **The organizational environment** for innovation, which is the degree of the organization's basic orientation towards innovation; (2) **Resources** related to the organization's readiness to facilitate work related to the object of innovation; and, (3) **Management practices**, which includes management both at the level of the organization as a whole and at the level of individual departments and projects.

In turn, "creativity is not a state of mind or a form of personal connection. Instead, creativity is a process of developing and expressing novel ideas to solve problems or satisfy needs. Therefore, creativity is not just talent, but a goal-oriented development to produce innovation." (Harvard Business School, 2003). Teresa Amabile herself (1996) confirms the meaning of creativity when she says that "creativity is generating new and useful ideas in any field", and for this it is necessary: (1) **Mastery of knowledge**, also known as "*expertise*", is the basis of any creative work; (2) **Creative thinking**, which provides that

"something more" of creative behavior, being able to apply the ability of creative thinking to any topic; and, (3) **Intrinsic motivation to the task**, which is the component of motivation to the task that determines what that person will actually do.

Along with innovation and creativity, a third essential element for achieving competitiveness and generating value in this new business operating system is the adoption of Industry 4.0 technologies. "Industry 4.0 is a natural evolution of previous industrial revolutions, from the mechanization of manual labor in the 18th century to today's automation, with intelligent and interconnected machines that act autonomously to manufacture products in highly flexible and reconfigurable systems" To achieve this, companies must follow a series of steps that are: (1) Data generation and capture; (2) Data analysis; (3) Human-machine interaction; (4) Flexible production; and, (5) Intellectual property (Sachon, 2017). When talking about Industry 4.0, the most important reference is towards Artificial Intelligence (AI); there are many variations of AI, but the concept can be broadly defined as intelligence systems with the ability to think and learn (Russel et al., 1995). Furthermore, when referring to intelligent machines, "the idea is related to the technological singularity and the possibility of an intelligence explosion, especially the prospect of artificial superintelligence. Perhaps there are people convinced, that another drastic change in the mode of growth, comparable to the Agricultural Revolution or the Industrial Revolution, is just around the corner." (Bostrom, 2014). All of this produces a profound change in organizations, which as Kurzweil says (2016) "goes according to the law of accelerating returns, the pace of technological progress, especially information

technology, and accelerates exponentially over time because there is a common force driving it forward."

Walsh (2014) presents 100 concepts about exponential technologies that will change the world: (1) **Artificial Intelligence (Artificial Intelligence)**, the ability of a machine to emulate human qualities such as perception, pattern recognition and judgment; (2) **Automation (Automation)**, use of technologies to make a process or activity execution without the need for human intervention; (3) **Big Data**, data set large enough, which challenges conventional approaches to management and analysis; (4) **Blockchain**, public record of all encrypted transactions that have ever been executed; (5) **Internet of Things**, emerging network of connected objects and devices capable of sensing the environment and sharing information; (5) **Virtual Reality**, set of immersive technologies capable of creating the impression of being inside a digitally constructed environment.

Walsh's exponential technologies can be complemented by those mentioned by Singularity University (2019)(1) **Robots**, are computerized machines with sensors or artificial intelligence of different materials and sizes; (2) **3D Printing**, this technology can create objects "drop by drop" accurately, efficiently and without waste that includes the possibility of working on living cells to, for example, print human organs; (3) **Augmented Reality**, are images and sounds from computers to enhance the experience around the world of people, and are added to the reality or additional effects through computers.

Schneier (2018) makes special emphasis that "everything is becoming vulnerable and it is because everything is computational; more specifically it is computational on the internet. Objects are getting smarter and this technological

change happened over the last decade or so. Things have computers in them and they are now connected; and as computers continue to get smaller and cheaper, they are becoming embedded in more things, and more things are becoming computers. The name given to this ubiquitous connectivity is the Internet of Things (IoT)." This is the next "big wave" of technology. While mature sectors stagnate, information technology has grown so fast that today it has become synonymous with the word "technology" itself; computers now have enough power to outperform people in the traditional activities of the past that were attributed to humans alone. However, technology means complementarity; "men and machines are good at radically different things. People have intentionality, make plans and make decisions in complicated situations. Computers are the exact opposite: they excel at efficient data processing, but struggle to make basic judgments that any human would find straightforward" (Thiel & Masters, 2015).

In the current development of business culture and strategy, innovation, creativity and technological adoption are deeply related to the value proposition, which "is the factor that makes a customer choose one company or another; its purpose is to solve a problem or satisfy a customer need (...) some value propositions may be innovative and present a new or breakthrough promise, while others may be similar to existing offerings and include some additional feature or attribute" (Osterwalder & Pigneur, 2011). (Osterwalder & Pigneur, 2011).

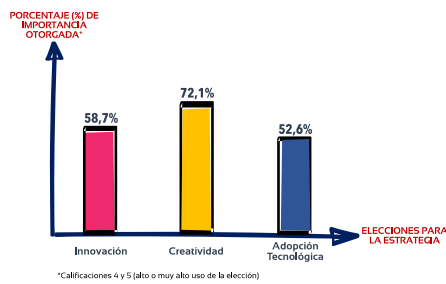
Ken Segall (2012) alludes to what is possibly the most significant value proposition: "**simplicity**". He defines it as "the ability to keep things simple and avoid complications". We live in an increasingly complex world in which simplicity is in short supply. As Trout and Rivkin (1996) "to solve problems we resort to the great word:

"more". When roads become clogged, we build more roads; when cities become more unsafe, we hire more police. "More" is not the solution to problems. People reject what is confusing and prefer what is simple. What people want are things that work at the push of a button. Simplicity is "making life simpler for consumers; through a product or service, users can be certain that it is a simple way to improve their quality of life". In addition, an **experience value proposition** is understood as the process of making innovation deliver results that meet or exceed market expectations; this is defined as customer-centric innovation, and requires a rigorous customer research and development process that helps companies to continuously improve their understanding, or who their customers are and what exceeds their expectations. (Selden & MacMillan, 2006)..

In addition, Jeremy Gutsche (2015) identifies the value propositions for the new era: (1) **Acceleration or exponentialism**, which is identifying a critical business or product feature and growing it dramatically; (2) **Convergence**, is creating a winning product or business by combining multiple products, services, trends or technologies; (3) **Divergence or countercurrent**, refers to products and services designed to oppose, do the opposite of, or break free from the mainstream.

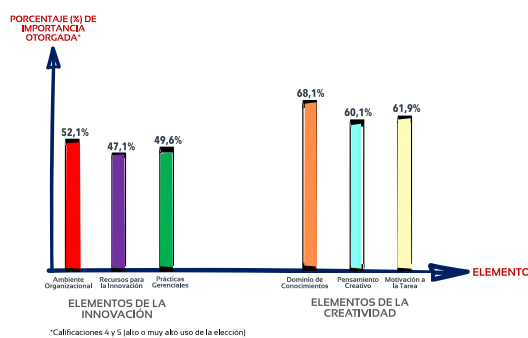
Based on the descriptive data from the study of Ecuadorian companies in the 4.0 era conducted by Montenegro (2020)The results on innovation, creativity and technological adoption as fundamental elements for the construction of future strategy in companies are shown first. Responses with ratings 4 and 5 (high or very high importance of the element) are included:

Importance of innovation, creativity and technological adoption as choices for strategy in organizations in Ecuador.



The companies surveyed give greater importance to the creation of ideas in various fields through people (creativity = 72.1%). However, innovation understood as the successful application of creative ideas in an organization and Industry 4.0 technologies are at regular levels of importance for the design of future strategy (58.7% and 52.6% respectively).

Figure 5. Importance of the elements of innovation and creativity for organizations in Ecuador.



Companies in Ecuador give medium importance to the elements of innovation for the creation of a sustainable strategy in the long term; the creation of an adequate organizational environment stands out with 52.1%, which

refers to the value given to innovation, the acceptance of risk, optimism about what people are capable of doing and an adequate strategy to achieve leadership. On the side of the elements of creativity, the mastery of knowledge with 68.1% is the most valued, and is related to the technical competence and talent of the people who collaborate in the organization.

Next, the analysis of the study questions is made through multiple answers with cross tables. In the first instance, the value propositions of the new era are contrasted with innovation, creativity and technology adoption; and, subsequently, a comparison is made of the same value propositions versus Industry 4.0 technologies. Responses rated 4 and 5 (high or very high importance of the element) are included:

Table 1. Cross-tabulated multiple response analysis. New age value propositions versus innovation, creativity and technology adoption.

	Propuesta de valor de la nueva era*									
	Simplicidad		Aceleración o Exponencialidad		Contra-corriente		Convergencia		Experiencia	
	Emp.	(%)*	Emp.	(%)*	Emp.	(%)*	Emp.	(%)*	Emp.	(%)*
Innovación	54	22,6%	18	7,5%	10	4,2%	28	11,7%	54	22,6%
Creatividad	70	29,3%	18	7,5%	11	4,6%	33	13,8%	58	24,3%
Adopción Tecnológica	58	24,3%	16	6,7%	8	3,3%	28	11,7%	41	17,2%

*Calificaciones 4 y 5 (alto o muy alto uso de la elección)
Emp.: Número de Empresas que contestan de las 239 analizadas

Of the companies in Ecuador that chose "simplicity", 22.6% consider innovation to be important for the design of this value proposition; 29.3% do the same with creativity and 24.3% with the adoption of technologies. With respect to the "acceleration or exponentiality" proposal, only 7.5% consider innovation and creativity to be critical, and 6.7%

consider technological adoption to be critical for the design of this value proposition. The "countercurrent" and "convergence" proposals have lower results; and in the case of the generation of "experience", 22.6% consider innovation as the most important element for the design of the proposal, above the results of creativity and technology (24.3% and 17.2% respectively).

Table 2. Multiple response analysis with cross-tabulations. New age value propositions versus Industry 4.0 technologies.

	Propuesta de valor de la nueva era*									
	Simplicidad		Aceleración o Exponencialidad		Contra-corriente		Convergencia		Experiencia	
	Emp.	(%)*	Emp.	(%)*	Emp.	(%)*	Emp.	(%)*	Emp.	(%)*
Big Data	16	6,7%	7	2,9%	3	1,3%	12	5,0%	12	5,0%
Robots y Automatización	7	2,9%	2	0,8%	2	0,8%	5	2,1%	10	4,2%
Inteligencia Artificial (AI)	7	2,9%	3	1,3%	3	1,3%	7	2,9%	9	3,8%
Internet de las Cosas (IoT)	11	4,6%	6	2,5%	2	0,8%	6	2,5%	7	2,9%
Impresión 3D	2	0,8%	1	0,4%	1	0,4%	1	0,4%	3	1,3%
Realidad Aumentada y Virtual (AR / VR)	2	0,8%	1	0,4%	1	0,4%	0	0,0%	3	1,3%
Blockchain	4	1,7%	2	0,8%	1	0,4%	1	0,4%	2	0,8%

*Calificaciones 4 y 5 (alto o muy alto uso de la elección)
Emp.: Número de Empresas que contestan de las 239 analizadas

6.7% of the companies that chose "simplicity" as a value proposition, consider *Big Data* as fundamental to carry out that proposition; 2.9% for the "acceleration and exponential" proposition, 1.3% for "countercurrent" and 5% for "convergence" and "experience". 4.6% of companies say

that the Internet of Things (*IoT*) is relevant to the design of the "simplicity" value proposition, and 4.2% that *Robots* and *Automation* serve to generate "experience" for the customer. As can be seen in Table 2, all other 4.0 technologies have low or irrelevant ratings for any new age value proposition.

To conclude the results section, the double projection graph or *Biplot* is presented, which superimposes the scores graph and the influences graph for the elements of innovation and creativity with respect to the type of leadership, as shown below:

Table 3. Rotated component matrix for innovation and creativity elements.

Rotated component matrix

	Component	
	1	2
Organizational environment for innovation	,811	,307
Resources for innovation	,861	,185
Management practices	,844	,244
Knowledge mastery	,155	,815

Creative thinking	,231	,866
Motivation towards the task	,434	,705

Component 1 is labeled "innovation", and the 3 variables (organizational environment, resources for innovation and management practices) have a high influence. Component 2 is labeled "creativity", and the variables "knowledge domain", "creative thinking" and "task motivation" have values above 0.5, therefore, they also exert a strong influence.

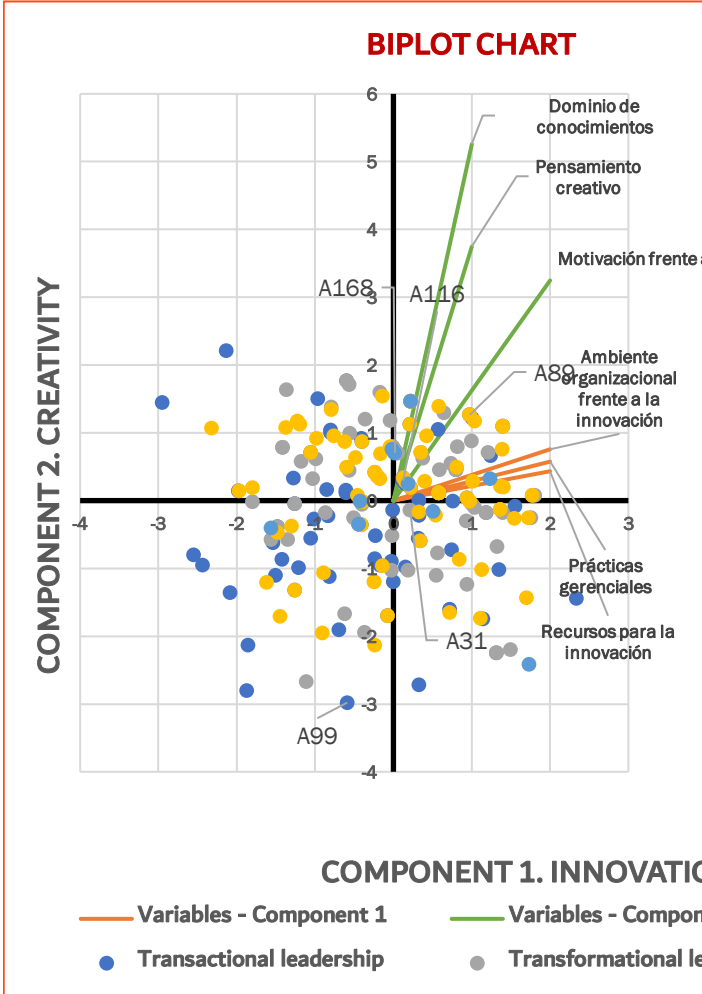
When the factors or components are not correlated, the total variance explained by the factorial model of the sum of the different factors can be known. The analysis of the elements of innovation and creativity are shown in the following table:

Table 4. Total variance explained for each component. Innovation and creativity elements.

<i>Component</i>	<i>Extraction sum of squared loads</i>			<i>Rotation sum of squared loads</i>		
	Total	% variance	Accumulated	Total	% variance	Accumulated
1	3,491	58,181	58,181	2,376	39,600	39,600
2	0,984	16,395	74,576	2,099	34,976	74,576

Table 4 shows that the factorial model composed of two common values manages to explain 74.6% of the total variance of the six empirical variables. As is common, the first factor explains the highest percentage of variance (39.6%).

Biplot graph for the elements of innovation and creativity grouped according to type of leadership.



Component 1 (innovation) has a greater positive influence of the variables: organizational environment for innovation, resources for innovation and management practices.

Component 2 (creativity) has a greater positive influence of the variables: knowledge mastery, creative thinking and task motivation.

As an example, certain companies are used to place them on the graph and make the respective analysis:

- Company **A31 (0.2125, -0.14091)**, which has transformational leadership, is closer to the positive part of component 1 and is related to the variables: organizational environment for innovation, resources for innovation and management practices.
- Company **A89 (0.9751, 1.26548)** which has transcendent leadership, is next to the positive part of component 2, therefore, it is related to the variables: knowledge mastery, creative thinking and motivation towards the task.
- Company **A99 (-0.59018, -2.97942)**, which has transactional leadership, is closer to component 2 in its negative part and is poorly related to the variables: knowledge mastery, creative thinking and task motivation.
- Company **A116 (0.12381, 0.29812)**, which has transcendent leadership, is close to component 2 in its positive part, thus it is related to the variables: knowledge mastery, creative thinking and motivation in front of the task.

- Company **A168 (0.02023, 0.70629)**, which has no leadership, is close to component 2 in its positive part, therefore, it is related to the variables: knowledge mastery, creative thinking and task motivation.

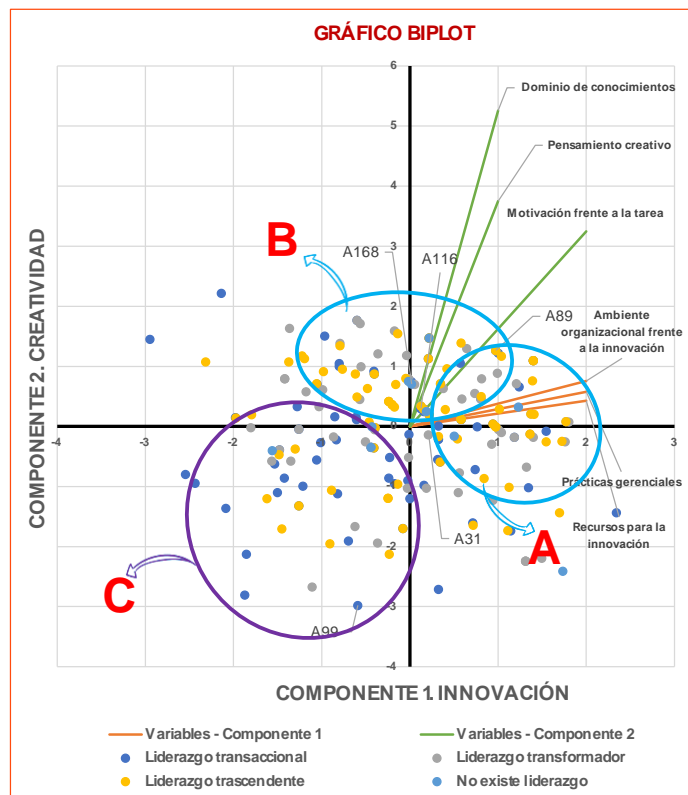
The table of the analysis of scores by type of leadership for each of the 239 companies investigated is shown in Appendix 1.

Conclusions

Innovation, creativity and technologies of the 4.0 era are critical for the design of the strategy in the long term. If the purpose of organizations is infinite, companies must accelerate in order to adapt to all the changes that the new paradigm requires. In Ecuador, the adoption of information and communication technologies, business dynamism to achieve differentiating strategic models, and the quantity and quality of innovation are pending tasks. In this "era of abundance and over-information, those who decipher what to leave out in order to concentrate on what is really important will stand out. Nothing paralyzes more than the idea of limited possibilities. The idea of doing anything is absolutely terrifying." (Kleon, 2012). But when the context is so limited, as in the context in which Ecuadorian or regional companies develop, setting limits to what should not be done means freedom; it is necessary to focus on what really generates value in the future to achieve competitiveness.

Regarding specific objective 1, on the *Biplot* graph shown in Figure 6, the elements of innovation and creativity rated by the organizations are grouped according to the type of leadership:

Figure 7. *Biplot* graph: grouping of Ecuadorian companies in innovation and creativity based on type of leadership.



It is concluded that:

- **Group A:** the majority of organizations that value the elements of innovation such as organizational environment, resources for innovation and management practices, are those that have transcendent (conscious) or transformational leadership. In this group there are few companies with transactional leadership or no leadership that value the components of innovation. These

companies are also influenced by the elements of creativity (knowledge mastery, creative thinking and task motivation) due to their proximity to these variables.

- **Group B:** many organizations that value the elements of creativity such as knowledge mastery, creative thinking and task motivation are those that have transcendent (conscious) or transformational leadership. In this group there are few companies that, having transactional leadership or no leadership, value the components of creativity. These companies are also influenced by the elements of innovation due to their proximity to these variables.
- **Group C:** the majority of companies that do not have leadership or that apply transactional leadership, have no relationship with or do not value any of the elements of innovation and creativity. However, in this group there are some organizations that have transcendent or transformational leadership and do not value innovation or creativity as *drivers* of strategy; the latter is inconsistent with the concept of leadership that seeks competitiveness, change and business growth.

Regarding specific objective 2, it can be concluded that the value propositions of the new era are little used in companies in Ecuador and, in addition, there is no awareness of the incorporation of innovation, creativity and technological adoption to strengthen these proposals. It is not possible to conceive, for example, a proposal of acceleration or exponentiality without innovation, as shown by the results obtained (only 18 companies out of 239 consider this important); or that only 41 organizations think that technology is relevant for the creation of

customer experience. Regarding the specific use of 4.0 era technologies, they seem irrelevant (or unknown) to these organizations; barely 1.7% mention that *Blockchain* is significant for simplicity; 0.4% ponder that 3D printing is important for a convergence value proposition; or, 1.3% believe that artificial intelligence has an influence on a counter-current proposition. The following figure presents an outline for the alignment of organizational culture, value proposition and strategic projects to achieve the results. This allows us to conclude on specific objective 3:

From the above it can be indicated that everything starts with the construction of a people-centered corporate culture, and the first pillar is the conscious or transcendent leadership that "allows shaking things up to get them out of their place". Leadership, in turn, projects an infinite purpose to achieve goals. For this new-age operating system to function properly, it must include innovation, creativity and technology in the organizational DNA.

Organizational culture is also the support for the business model based on simplicity, acceleration, countercurrent, convergence and experience to create value for a consumer, customer or user (who is also a person), who has acquired different habits and is living with new trends. But for these proposals to be put into practice, it is necessary to strategically choose 4.0 technologies to adapt to the speed of change.

Consequently, projects are planned to be executed to achieve value and the expected results with superior performance, cost efficiency and at the right speed to take advantage of opportunities. Innovation, creativity and technology have a transversal impact on each of the elements of the value formula.

"Currently, it is necessary to be at the forefront of all technological trends to generate disruptive changes. In our case, artificial intelligence and machine learning will allow the optimization of operations at levels never seen before, and that cannot be achieved with simple changes in processes, implementation of transactional systems or business intelligence as it was traditionally done"..." (Andrade, 2020).

"The current situation and the vertiginous technological development demand that the organizational culture has innovation and creativity as the cornerstones of the strategy. For this, Industry 4.0 technologies become a key ally to be close to customers, to know them better and provide them with a superior service" (Pazmiño, 2020).

References

- Amabile, T. M. (1996). *Creativity and Innovation in Organizations*. Boston, MA, USA: Harvard Business School Publishing.
- Andrade, M. (June 1, 2020). *Innovation, Creativity and Technological Adoption at Azurian Consulting* (Montenegro, D. I., Interviewer).
- Avolio, B., & Bass, B. (2004). *Multifactor Leadership Questionnaire. 3 ed.* New York: Manual and Sampler Set. Mind Garden.
- Bass, B. M. (1998). *Transformational Leadership*. Mahwah: Lawrence Erlbaum.
- Behar, D. S. (2008). *Research Methodology*. Bogotá: Shalom.
- Berman, A. E., & Dorrier, J. (2016). *SingularityHub*. <https://singularityhub.com/2016/03/22/technology>

-feels-like-its-accelerating-because-it-actually-is/?_ga=2.163999679.1622414328.1556930293-1949383976.15...

- Bostrom, N. (2014). *SUPERINTELLIGENCE, Paths, Dangers, Strategies*. Oxford University Press.
- De Meyer, A. (2011). *The Age of Innovation Made in Asia*. *IESEInsight* (10), 21-29.
- Friedman, T. L. (2018). *Thanks for Being Late*. Barcelona: Deusto.
- Greenacre, M. (1984). *Multiple Correspondance Analysis and Related Methods*. London: Chapman and Hall.
- Gutsche, J. (2015). *Better and faster*. Currency.
- Harvard Business School (2003). *Creativity and Creative Groups: Two Keys to Innovation*. Boston: Harvard Business School Press.
- IBM (2020). *SPSS Statistics*
<https://www.ibm.com/docs/es/spss-statistics/version-missing?topic=analysis-multiple-response-crosstabs>
- Kleon, A. (2012). *Steal Like an Artist*. Workman Publishing Company.
- Kofman, F. (2008). *La Empresa Consciente*. Aguilar.
- Louridas, P. (2020). *Algorithms*. Cambridge: MIT Press.
- Lussier, R. N., & Achua, C. F. (2010). *Leadership. Theory, Application & Skill Development*. 4e. Boston: Cengage Learning.

- MacGregor Burns, J. (1978). *Leadership*. New York: Harper.
- Montenegro, D. (2020). *Competitiveness Research of the Ecuadorian Enterprise in the 4.0 era*. IDE Business School.
- Montenegro, D. I., & Calvache, M. (2016). *EmotionShare. Strategy and Disruptive Marketing*.
- Norsdstöm, K., & Ridderstrale, J. (2000). *Funky Business. Talent Makes Capital Dance*. Stockholm: BookHouse Publishing.
- Osterwalder, A., & Pigneur, Y. (2011). *Business Model Generation*. Deusto.
- Pazmiño, J. D. (June 3, 2020). *Innovation, Creativity and Technological Adoption in Tecniseguros S.A.* (Montenegro, D. I., Interviewer).
- Peus, C. (2012). *Claves para Conseguir un Liderazgo de Altura*. *IESEInsight* (13), 20-22.
- Pinzón, L. (2011). *Biplot, Consensus for the Analysis of Multiple Tables*. University of Salamanca.
- Rao, J. (2012). *Learn the lingua franca of innovation*. *IESEInsight* (14), 13-19.
- Ridderstrale, J., & Norström, K. (2003). *Karaoke Capitalism. Management for Mankind*. Stockholm: Bookhouse Publishing.
- Russel, S., Norvig, P., & Intelligence, A. (1995). *Artificial Intelligence: A Modern Approach*. Englewood Cliffs, Prentice-Hall.

- Sachon, M. (2017). *The Five Props of the Value Chain in Industry 4.0. IESEInsight (33), 15-21.*
- Schneier, B. (2018). *Click Here to Kill Everybody.* New York: W. W. Norton & Company.
- Schwab, K. (2018). *The Global Competitiveness Report 2018.* WeForum.
- Schwab, K. (2019). *The Global Competitiveness Report 2019.* WeForum.
- Segall, K. (2012). *Incredibly Simple.* Barcelona: Gestión 2000 - Grupo Planeta.
- Selden, L., & MacMillan, I. C. (2006). *Manage Customer-Centric Innovation Systematically. Harvard Business Review, 1-8.*
- Serrano, J. (2013). *Multiple Responses in Educational Research: Coding, Tabulation, and Analysis. Journal of Educational Research, 31(2), 361-374.*
- Singularity University. (2019). *Foundations of Exponential Thinking.*
[https://learn.su.org/learner_module/show/161219?lesson_id=711643§ion_id=2647396.](https://learn.su.org/learner_module/show/161219?lesson_id=711643§ion_id=2647396)
- Thiel, P., & Masters, B. (2015). *Zero to One.* Management 2000.
- Trout, J., & Rivkin, S. (1996). *The New Positioning.* McGraw-Hill.
- Walsh, M. (2014). *The Dictionary of Dangerous Ideas.* HK: Blurb.
- Walsh, M. (2019). *The Algorithmic Leader.* Amanda Lewis.

Digital competencies and the impact on academic teleworking activities in the pandemic by Covid-19

Elizabeth del Carmen Ormaza Esmeraldas

elizabeth.ormaza@uleam.edu.ec

edcoe@hotmail.com

<https://orcid.org/0000-0003-3768-3194>

Universidad Laica Eloy Alfaro de Manabí, School of Administrative Sciences, Accounting and Commerce.

Introduction and state of the art

Within the different educational institutions, both at the basic education level and at the university level, it is proposed as part of the training and learning adaptation processes, that teachers should be able to alternatively handle the most current teaching media, which sometimes contrast with the conventional means of instruction, giving the possibility of adapting to other teaching schemes.

According to Fernández, Ordoñez, Morales and López (2019) "The different educational institutions at all levels, from Early Childhood Education to Higher Education, integrate digital competencies in their educational plans, an aspect on which this text is going to focus." (p.10).

Thus, in the context of the use of Communication and Information Technologies, academic plans must be flexible so that, in adverse circumstances, in which it is estimated that there is no possibility of fulfilling all the tasks and assignments, digital interaction channels are created, making use of telework (distance activities) as a way for assignments and deliveries of educational projects, which so merit it. This is the case of higher education, which has

had to adapt to the current reality of the COVID-19 virus pandemic, in which many universities have had to adjust their teaching plans to the demands of educational directors and managers in order to be able to give continuity to the training objectives of each subject.

As it is a public fact, the pandemic caused by the so-called COVID-19 virus has been an element that has transformed normality in all social scenarios, which also includes the space of academic training at all educational sub-levels. Thus, according to official sources, one of the measures to reduce the risk of suffering from the disease produced by this agent is social distancing, which according to the World Health Organization (WHO) (2020) counteracts this disease is prevention.

Therefore, in all regions of the world and especially in the context of Latin America, according to Hodges et al. (2020), emergency remote teaching initiatives have been launched in order to provide short-term solutions and maintain some continuity in the teaching and learning processes. Thus, the COVID-19 pandemic has directly impacted the educational systems of all countries in the region, affecting students, households, ministries, secretariats, educational centers, teachers and managers.

Thus, the need arises for instructional models to be adjusted to the requirements of non-attendance, as part of the due prevention for compliance with health protocols, which is why the clarification of teachers' criteria for the implementation of alternative schedules to daily class attendance, no longer becomes a matter of occupation for students, who must be guarantors of an online study schedule, attendance to video calls, fulfillment of homework and other assignments through virtual classrooms, among other aspects, but it is also the teachers

themselves who must provide spaces for the evaluation of their own competencies for the adequate fulfillment of distance activities. In this order, Aguilar (2016) students and teachers, especially the latter, deserve the detachment of their old teaching models, so that all the changes that are required for the fulfillment of the activities found in the vitalization of educational processes are feasible.

In this sense, many are the aspects that deserve evaluation when questioning or not the teaching processes under the approaches of educational planning in the order of telework and virtuality, according to Bohorquez et al. (2018) The criteria that present greater satisfaction are in the orientations for the use of the platform, the clarity in the delivery dates and those of evaluation, where the teacher evaluated the activities from the evaluation methods and promotes processes that seek interaction with other colleagues, the academic commitments in the learning classroom promoted the use of ICT outside the platform, there was a cordial and equitable treatment by the teacher and doubts were resolved in a timely manner.

As can be seen in the research where the author Bohorquez et al. (ob. cit.) proposed his conclusion regarding the interactions and opinions of students on virtual academic activities, it is important to mention that students always highlight as an important element the way in which the teacher or academic director exposes ideas in conversations through video calls, interactions via various platforms and applications, among others, which is why teachers deserve to have the capabilities that induce the proper monitoring of tasks and assignments in an appropriate manner.

In the words of Sangra (2001) The most important difference between face-to-face and virtual education lies in the change of medium and in the educational potential that

derives from optimizing the use of each medium. We cannot do the same thing in different media, even if our educational purposes and, therefore, the results we are pursuing are the same, but we must know beforehand that the path we must follow is different. In the acceptance of this difference in the means of communication lies the success or failure of the educational activity. (p.2)

So that, being a model with a means of alternative training that due to various circumstances may or may not be a purely virtual or semi-presential model, is when the figure and the role of the administrators of the telework space or distance tasks, where students and teachers converge through virtual classrooms or through applications designed for the same purpose, emerges significantly. Thus, Sangra (ob. cit.) notes that virtual learning environments are the place where the subjects of study are found, as well as the learning materials. Students, teachers, etc., are all part of the community. This is why,

Each student has specific needs, own interests, individual beliefs this is related to the term diversity, it is necessary to create individualized learning experiences based on pedagogy, didactics and strategies that achieve attention to diversity (Balongo & Mérida, 2016).

According to Guerrero and Dote (2011), ICTs have had a great impact on different areas of society, transforming communications, information processing and interpersonal relationships within society. Thus, teaching under new pedagogical methods with the use of computer devices should be oriented to the implementation of communication and information technologies through the use of tools such as the Internet and computer software for the various subjects, as well as the incorporation of virtual

classrooms in education plans, has been a very distorted and forgotten task in most cases.

In this regard, in the universities of the 21st century, the teacher must cease to be the controller of the student's access to information and become the student who is ultimately responsible for it" (Espinosa et al., 2018, p. 9).

In this order, one of the aspects that has had the greatest impact on the process of compliance and continuation of academic activities on a regular basis is precisely the lack of knowledge that many teachers or university professors have in accessing technical and technological resources to complete the tasks and assignments of the different academic programs. For many teachers the use of digital tools has represented an obstacle, due to the fact that face-to-face teaching was almost entirely replaced by virtual learning environments, in this sense it is worth mentioning that in Ecuador "At the national level people who use computers represent 52.4% and 36.7% of households have at least one laptop" (Cedeño Alcívar, Hernández and Morales Intriago, 2017).

Thus, according to the European Communities (2009) a competence is the "demonstrated ability to use knowledge, skills, personal, social and methodological abilities, in work or study situations or in professional and personal development; in the European Qualifications Framework, competence is described in terms of responsibility and autonomy." (p.2)

Thus, in the context of communication and information technologies (ICT) and academic planning, criteria are established that guide the precision of the capabilities possessed by a person who stands out for the possibility that he/she has to fulfill a given task. In this sense, according to

Garcia-Valcarcel (2013), the theory related to competency-based training provides training with an integrative character, bringing together three forms of knowledge: theoretical knowledge (knowledge), practical knowledge (skills and abilities) and knowing how to be (attitudes) (p.2). There are several benefits in the use of ICTs in the teaching-learning process: access to materials, increases in motivation and productivity, as well as improvements in students' understanding and performance, among others (EFE, 2016).

According to Garcia Valcarcel (2015) it can be stated that a competence is then an effective action in response to situations and problems of different types, which require the use of available resources. In order to respond to the problems posed by such situations, it is necessary to be willing to solve them with a definite intention, that is, with certain attitudes (p.2).

The specific competencies are specific to each of the disciplines, depending on the field and branch of study established for each master's degree. They are directly related to a profession, so they are intended to delimit the profile of the graduate (Ramírez and Rey, 2015).

According to specialists in the academic field, one of the main challenges of current educational systems is the development of skills and abilities that make the subject skilled for the fulfillment of academic activities that are appreciable and that are consolidated as skills and competencies for the execution of various tasks and activities in the course of time. In this order, when reference is made to the importance of the actions that people are capable of fulfilling to carry out a task, this is what is known as an aptitude for work. This aspect cannot be measured or

qualified in all subjects in the same way, but through various analyses of the criteria and conditions of the context and the person him/herself.

Lopez (2018) argues that.

Teachers are obliged to keep themselves constantly updated, using all their creativity, skills and abilities to successfully bring ICT to the classroom. The teacher's goal is to prepare the new generations for their incorporation into the world of work and relationships, and digital tools are an ally.(p.3).

For García-Valcarcel (ob. cit.)

Students of the 21st century require teachers to be updated and prepared to face the changes required by education. A much more active, constructivist and collaborative teaching methodology is required, where the sources of information and their formats are varied, stimulating thinking, incorporating the image in a meaningful way, encouraging reasoning from collaborative work and discussion of various types of information, critical analysis, etc. (p.8).

Therefore, teachers and students must acquire the competencies (personal, social and professional) that will allow them to successfully incorporate ICT in the classroom (Gozálvez et al., 2014; Sevillano and Quicios, 2012). It is important to mention what is the conceptualization of "Digital Competencies", according to ISTE (2008), are those that make them use digital media and environments to communicate and work collaboratively to support individual learning and contribute to the learning of others. Digital competencies are those that make them understand

the human, cultural and social issues related to technology (p.9).

In this regard, Law & Chow (2008) refer to the factors associated with the development of digital competencies, among which the effects of gender and age must be studied together with other contextual factors due to their incidence. All this implies the need to conduct studies that show how various contextual and personal factors affect teachers' competencies, approached from different situations and varied perspectives. Likewise, the factor of teachers' perception towards ICT integration represents one of the most significant elements in the appropriation process, since it is important to know their thinking and willingness to adhere to new educational models.

According to Ala-Mutka (2011) there are skills that can be studied in the context of the use of Information and Communication Technologies:

- Instrumental skills and knowledge, necessary for the management of digital tools, considering their interconnected, visual, dynamic nature.
- Advanced skills and knowledge, necessary to apply the instrumental abilities in digital environments, organized in progressive order, from the resolution of tasks, to the strategic application to achieve integration in the personal life of each citizen.
- Attitudinal skills and knowledge, which represent ways of thinking and motivations that move citizens to act in certain ways in digital environments.

In this regard, Ferrari (2013) summarizes digital competencies as follows:

1. Information: identify, locate, retrieve, store, organize and analyze digital information, evaluating its purpose and relevance.

2. Communication: communicate in digital environments, share resources through online tools, connect and collaborate with others through digital tools, interact and participate in communities and networks; intercultural awareness.

3. Content creation: Create and edit new content (texts, images, videos...), integrate and rework previous knowledge and content, create artistic productions, multimedia content and computer programming, know how to apply intellectual property rights and licenses.

4. Security: personal protection, data protection, digital identity protection, security use, safe and sustainable use.

5. Problem solving: identify needs and digital resources, make decisions when choosing the appropriate digital tool, according to the purpose or need, solve conceptual problems through digital media, solve technical problems, creative use of technology, update own and others' competence.

In such a way that, the competences are a fundamental aspect inside the new normality that has become to the emergence of the pandemic of the COVID-19, reason for which it has been imperative to motivate the professionals of the teaching to the incorporation of activities at a distance for the fulfillment with the tasks and academic assignments, in such a way that the present study has been raised with the general objective of determining digital skills of teachers and the impact on the use of teleworking tools for the fulfillment of academic activities in the Faculty

of Administration of the Eloy Alfaro University of Manabi, Ecuador. This due to the relevance that by the same health condition exists in the present in the academic community, so that an emerging issue is precisely the adequacy of technological knowledge of teachers to the demands of the context and social reality where the distance has been adopted as a mandatory measure of protection; without this representing the absenteeism of the training objective of each subject.

The present article was based within the quantitative paradigm, reason for which was developed a research based on the management of the tools of telework by the teachers of the Faculty of Administration of the University Eloy Alfaro. Being these the selected population to carry out the diagnosis by means of digitalized forms as part of the survey applied, in the phase of information gathering.

Inclusion Criteria

1. Teachers of both genders: Female and Male.
2. Active in the fulfillment of their duties as professors of: the School of Administration of the Eloy Alfaro University of Manabí, Ecuador.
3. Participants of virtual planning and use of Telework tools from 2020 to present.

Within the population universe were considered the seventy teachers attached to the Faculty referred to above, however, the data of the items answered by the sample have been specified, a subset of forty-one (41) teachers of the same center and the same school within the Eloy Alfaro University, which were those who voluntarily and with their own decision expressed their willingness to participate in the survey referred to, as part of the diagnosis.

Procedure: in principle, the location of the information concerning the subject was executed as well as the organization according to the date of issue of previous works and other studies consulted, so that the selection of the most important productions was made and the designation of the elements concerning the predefined criteria, which are described within a first scheme derived from the management or not that the teachers of the Faculty of Administration of the Eloy Alfaro University of Manabi, Ecuador have on the digitized didactic resources, within which are encompassed: computer software, hardware with advanced technology to generate links with students in real time, such as tablets, desktop computers, laptops, as well as the different versions of operating systems and applications that run on them.

So that in the process of determining the investigated aspects, a form was developed at first within the Microsoft Word application, which was described with a series of items, according to the general objective of this study, then within the design of Google forms, to reach the teachers of the Faculty of Management online consultation on digital skills and the impact on the activities that due to the pandemic have had to perform.

Data collection instrument used

In this sense, a data collection instrument was developed to verify the aspects related to the proposed research. Thus, the questionnaire was structured in Google Forms with a total of twelve (12) questions with closed answers (Yes/No).

A significant number of the criteria initially studied could be clarified, since a significant number of respondents indicated that they knew almost all the basic resources for the development of distance learning academic activities, because due to the current health situation, face-to-face

classes are limited in much of the academic planning within the higher education institution Eloy Alfaro University of Manabi, Ecuador.

Therefore, the results presented below correspond to the needs of the teaching population consulted, and for this reason the conclusions drawn from these results are only linked to the initial approach that there is an impact on the modification of the normal course of training activities under the face-to-face approach, because not all teachers who teach classes are in agreement with the technological adaptation, due to the fact that most of the tasks are carried out through digitalized and online activities under the real time and timeless scheme that the situation warrants.

The data resulting from the research are presented below:

As can be seen in the results obtained and shown in Table 1, the teachers have basic knowledge about turning on and off the computer equipment, with which they develop their teleworking activities on a frequent basis. Aspect that is one of the indicators for the measurement of the level of difficulty that has for the participants the use of the computer tools, in this order. None of the respondents expressed any kind of difficulty in this regard, "digital" is called the intangible context of applications, computer objects and records that are derived from the process of data that can not be touched or created physically, even when they exist, within which are included: programs, files, data, among others. When the population was consulted about this concept, 90% of them indicated that they are aware of the elements of this nature and that they are therefore used within the context of academic planning derived from the virtuality adopted in the process of confinement by the COVID-19 Virus. In this regard, only 10% of the teachers surveyed indicated that they do not

know the term or the aspects derived from it. In this context of the research, a significant number of the surveyed teachers, 95% of them, state that they have knowledge about the use of digital tools in the contextualization of the new teaching approach under the principle of virtuality, due to the measures to prevent the spread of the COVID-19 virus, in its totality, the respondents claimed to have in their work and housing means the digital tools for compliance with the academic assignments under the context of virtuality. Thus, the scenario is favorable for communications through alternative means to be carried out in a timely and efficient manner in this area.

The result of the research regarding the form of communication and the technological means used, represents another indicator in the context of digital competencies, in this order, all respondents expressed to have the level of knowledge of communications that are established through tools for video calls and online forums, using for this purpose the smartphone and the computer.

The research conducted showed that most of the respondents make use of computer applications for the design and construction of didactic and learning evaluation strategies with the students in their charge; in this sense, only 7% of the respondents stated that they do not. This aspect is important to highlight because this number of teachers expressed in the percentage that indicated that they do not make use of computer software for the planning of their activities as teachers of the subjects they are in charge of, merit adapting their functions to the virtual environment in which, at present, the assignments are being carried out, this indicator is also of utmost importance, When the teachers of the School of Administration were asked if they comply with the hours of attention through video calls to the students they are in

charge of, all of them indicated that they do, which can be interpreted as the follow-up and attention given to the students, as well as the advice on the contents they understand and the doubts or concerns they have. It is important to highlight that 98% of the respondents affirmed that they can evaluate the consolidated learning of the academic population through digital instruments, which represent tools that favor the concept of distance education, since the measurement of knowledge is a fundamental aspect for progress in the levels of instruction that are fulfilled as part of the teaching plans.

Interpretation: web-based tools are other alternatives that due to the healthy distance that has represented absenteeism from classrooms due to the COVID-19 pandemic, it is important to consult, therefore the research was conducted on the use of the advantages of social networks as channels of communication and interaction of teachers with their students resulting that in effect most teachers know how to make use for academic purposes of these tools, representing 80% while the remaining 20% represents the subset that does not know the forms of communication through this type of interaction channels with students.

At the end of the research, after processing the results, the indicators studied were: recognition and use of electronic devices, use of social networks for academic purposes, knowledge of computer tools with application to teaching, design and construction of reusable objects: recognition and use of electronic devices, use of social networks for academic purposes, knowledge of computer tools with application to teaching, design and construction of reusable objects were criteria answered, for the most part, in the affirmative by the teachers of the Faculty of Administration of the Eloy Alfaro University of Manabí - Ecuador, which is

interpreted as a positive element for the modification of the face-to-face scheme that has been adopted for decades in the higher educational institution, representing then an advantage the conditions of social distancing and confinement as a way to prevent the spread of infections with the COVID-19 virus, because as Mykhnenko (2016) refers, the importance of the application of learning technologies is now considered not only a crucial part of teaching-learning in higher education, but also a vital evidence of innovative teaching practices used as a criterion for promotion.

Thus, due to the importance for the pursuit of studies, especially at the university level, of the proper management of communication and information technologies as well as the use of digital tools, it is extremely important to specify that teachers have the skills to work in this context because "currently the absence of technological tools limits didactic innovation, with the consequence of an expository teaching and transmission of content; resorting to the use of the printed text as the only source of knowledge, in most cases with photocopies, a projection with slides that reproduces the theory, the use of blackboard and dictation (Spain & Canales, 2013). Therefore, it is concluded that, despite the resistance to change of a small group of the teachers surveyed and the lack of knowledge of some specific digital tools, in general the teachers possess the skills and competencies for the normal course of activities under the virtual approach to continue to be carried out.

REFERENCES

Ala-Mutka, K. (2011). Mapping Digital Competence: Towards a Conceptual Understanding. Luxembourg: JRC-IPTS European Commission. retrieved from <http://ipts.jrc.ec.europa.eu/>

publications/pub.cfm?id=4699

Balongo, E., & Mérida, R. (2016). Classroom climate in project work. *Perfiles Educativos*, 152 (XXXVIII), 146 - 162. Retrieved from <http://www.scielo.org.mx/pdf/peredu/v38n152/0185-2698-peredu-38-152-00146.pdf>

Bohórquez, María Cristina; Rodríguez Mendoza, Brigitte; Barrera Buitrago, Dayana; Pachón Pedraza, Hugo. Virtuality immersion in the face-to-face modality: measurement of student satisfaction under criteria of classification of models of an imaginary ideal REXE. *Journal of Studies and Experiences in Education*, vol. 2, no. Esp.2, 2018 Universidad Católica de la Santísima Concepción, Chile. Available at: DOI: <https://doi.org/10.21703/rexe.Especial32018911018>.

Cedeño Alcívar, S.F., Hernández, F. and Morales Intriago J.C. (2017). Digital divide between urban and rural students based on the minimum digital knowledge standard proposed by UNESCO. In: *Revista de Ciencias Humanísticas y Sociales*. Available at: <http://revistas.utm.edu.ec/index.php/Rehuso/article/view/852>.

European Communities (2009). The European Qualifications Framework for lifelong learning (EQF-EQF). Retrieved from https://ec.europa.eu/ploteus/sites/eac-eqf/files/broch_es.pdf

EFE (2016). The digital divide between teachers and students widens. 20 minutos/ Formación y Empleo. Available at: <http://www.20minutos.es/noticia/2730340/0/digital-gap-education/teachers-students/se->

agrandar/

- España, & Canales, (2013). Teaching resources for learning business education: Systematization of an experience in higher education. *Revista electronica@ Educare*.
- Espinosa, M., Porlán, I., & Sánchez, F. (2018). Digital competence: a need for university faculty in the 21st century. *Revista de Educación a Distancia*, 56 (7), 1-22. Retrieved from http://www.um.es/ead/red/56/prendes_et_al.pdf
- Fernández E., Ordóñez, B, Morales, F. & López, J. (2019). Digital competence in university teaching. ISBN: 978-84-17667-44-3 Ediciones Octaedro. First Ed. 2019.
- Ferrari, A. (2013). DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe. Seville: JRC-IPTS. Retrieved from <http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=6359>
- García-Valcárcel, A. and Hernández, A. (2013). Technological resources for teaching and educational innovation. Madrid: Síntesis.
- García-Valcárcel, A. and Martín Del Pozo, M. (2015). Analysis of the digital competencies of graduates in Teacher degrees. XXIII Jornadas Universitarias de Tecnología Educativa "La Formación universitaria en Tecnología Educativa: enfoques, perspectivas e innovación", Badajoz, 11-12 June 2015.
- Gozálvez, V., García Ruiz, M. R., & Aguaded, J. I. (2014). Media competency training: A question of ethical responsibility in higher education. *Revista Interuniversitaria De Formación Del Profesorado*, 28

(1), 17-28.

Guerrero, M, Dote, F. (2012). Integración Curricular De Tic'S En La Enseñanza deLenguas Indígenas En Latinoamérica. Revista Electrónica Diálogos EducativosISSN 0718-1310http://www.umce.cl/dialogoseducativos/n22/dote_guerrero.

Hodges, C., Moore, S., Lockee, B., Trust, T. and Bond, A. (2020). The Difference Between Emergency Remote Teaching and Online Learning. *Educause Review*.

ISTE (2008) ICT Competency Standards for Students [Online] Retrieved from: https://www.iste.org/docs/pdfs/nets_2007_spanish.pdf?sfvrsn=2

Lopez, R. (2018). Ecuador: The Digital Divide between Teachers and Students. Rita López Gaibor. *Cambio Universitario Magazine*. Vol. 3, No. 3, March 2018.

Mykhnenko, V. (2016). Cui bono? On the relative merits of technology-enhanced learning and teaching in higher education. *Journal of Geography in Higher Education*, 40 (4), 585-607. doi: <https://doi.org/10.1080/03098265.2016.1217832>

World Health Organization (2020). Rational use of personal protective equipment for coronavirus disease (COVID-19) and considerations during severe shortages: interim guidance, 6 April 2020. World Health Organization. <https://apps.who.int/iris/handle/10665/331695>. License: CC BY-NC-SA 3.0 IGO.

Ramírez-Fernández, M. B. (2015). "Proposal for quality

certification of the Spanish educational offer of MOOC courses". *International Journal of Educational Research and Innovation (IJERI)*, 3: 121-133.

Sangra, Albert (2001). Teaching and learning in virtuality. *Educar* 28, 2001 117-131

Sevillano, M. L. and Quicios, M.P. (2012). Indicators of Computer Skill use among University Students: Formative and Social Implications. Indicators of Computer Skill use among University Students. Educational and Social Implications. *Teoría De La Educación. Revista Interuniversitaria*, 24 (1), 151-182.

The challenge of the post pandemic in higher education from face-to-face and virtual classrooms.

Lilia Monserrate Villacis Zambrano

lilia.villacis@uleam.edu.ec

<https://orcid.org/0000-0002-2888-6363>

Frank Ángel Lemoine Quintero

<https://orcid.org/0000-0001-8885-8498>

Valeria Cecilia Bravo Gómez

valeria.bravo@uleam.edu.ec

<https://orcid.org/0000-0003-0106-3567>

Eura María Zambrano Vera

aura.zambrano@uleam.edu.ec

<https://orcid.org/0000-0002-4369-0377>

Introduction

The pandemic has meant a huge global crisis in health, education and a great challenge, which the whole of humanity has had to face and adapt to the new changes required to emerge. After the difficulty and bewilderment, in each teacher in the face of training difficulties, is the attitude with which he/she faces the near future. The doses of fear and uncertainty must be overcome with greater doses of hope, enthusiasm, illusion and a positive attitude. The return of mobility without limitations, of classroom activities, some face-to-face and others virtual, shows, courses and face-to-face meetings, brings us closer to a new stage, to meet again. In the working life, the presence of the presence brings us back to the departure from home, from work, to meetings, to friendships and also to resume some jobs that had to be put on hold or postponed for a while. A

new stage, an invitation to be reborn, to bloom and to come out of this long winter in our life, to attract the spring and a new dawn with uncertainty and with great difficulties to manage the presentiality and virtuality, without lowering the quality.

Today, it is evident from praxis that the pandemic has revealed the great difficulties for many students to resume learning:

At a global level, the pandemic condition caused by COVID-19 has generated that most educational systems are facing a great and new challenge: to continue with their activities despite the context. Thus, the response in most countries has been to implement a digital communication system between teachers and students, however, it should be considered the level of reach to more remote areas such as rural areas, where there is also part of the school population, university and non-formal and informal types of education.(Yucra, 2022, p.51).

From the perspective of the document *"Covid-19 and higher education: from immediate effects to the day after. Analysis of impacts, response and recommendations"* argues:

In general, it does not seem that the change of modality has been received very positively. Part of the disaffection stems from the fact that the content offered was never designed in the framework of a distance higher education course, but rather attempts to palliate the absence of face-to-face classes with virtual classes without further prior preparation (UNESCO IESALC, 2020, p. 16).

It is understandable that higher education pays more attention to the production of future productive

professionals for society, researchers and patents, than to the formation of elementary academic skills, since that is its ultimate goal, according to Villaseñor (1997, p. 34):

The research was descriptive, that is the type of study in which the researcher combines research techniques, methods, approaches, concepts or quantitative or qualitative language in a single study. Therefore, this research will present an approach based on the discourse analysis of the categories that were identified in the systematization of the surveys that were applied (qualitative approach); while, once the responses were categorized (Pereira, 2011, p. 18), the Delphi method was also used, taking the instrument to consultations and experts.

A non-probabilistic convenience sample was used, consisting of 73 students from different bachelor's degrees, 15 first level marketing students, 16 eighth level marketing students, 25 business administration students and 17 ninth level tourism students.

Table 1 Reliability analysis

Reliability statistics	
Cronbach's alpha	N of elements
,956	6

According to the verified data, the instrument was found to be reliable because the reliability analysis was 0.95.

Table 2 Face-to-face classes

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Not very important	1	1,6	1,6	1,6
	Neutral	8	12,9	12,9	14,5
	Important	13	21,0	21,0	35,5
	Very important	40	64,5	64,5	100,0
	Total	62	100,0	100,0	

According to the results, it is verified that the students agree with returning to the classroom with 64.5%, which shows that classroom learning is significant and that the students prefer to develop their training in the classroom, considering that the students have become aware that in order to be professionals it is convenient to have a comprehensive training of knowledge to be able to respond to the needs of society.

Table 3 Combination of pedagogical tools in face-to-face classes

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	2,00	4	6,5	6,5	6,5
	3,00	5	8,1	8,1	14,5
	4,00	23	37,1	37,1	51,6
	5,00	30	48,4	48,4	100,0
	Total	62	100,0	100,0	

It is found that 48.4% of the students request that pedagogical tools be combined in the development of class, because they have been able to feel during the synchronous classes, the development of the lecture, many of them have been monotonous, for this reason they determine that face-to-face classes are important. This factor is preponderant for the students because in most of the classes they were connected but avoided the interaction responsibilities of the synchronous class.

Table 4 They find it difficult to integrate face-to-face and virtual classes

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Nothing important	2	3,2	3,2	3,2
	Not very important	6	9,7	9,7	12,9
	Neutral	13	21,0	21,0	33,9
	Important	8	12,9	12,9	46,8
	Very important	33	53,2	53,2	100,0
	Total	62	100,0	100,0	

According to the data, 53.2% of the students state that it is difficult for them to integrate face-to-face and virtual classes, due to the schedule and learning of autonomous work, connectivity problems, lack of technological equipment; in addition, there is evidence of immaturity and co-responsibility in prioritizing their training, and defining learning through the two modalities; on the other hand, there is also a demographic problem due to the adequacy of the distribution of the student workload and the definition of teamwork between teachers and students in having a hybrid modality.

Table 5 Importance of virtual classes

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Nothing important	1	1,6	1,6	1,6
	Not very important	18	29,0	29,0	30,6
	Neutral	12	19,4	19,4	50,0
	Important	12	19,4	19,4	69,4
	Very important	19	30,6	30,6	100,0
	Total	62	100,0	100,0	

For many in times of pandemic, the economic situation became very hard, for this, the most reasonable and logical were virtual classes, because they could work and study within the synchronous class. In this time of transition where both virtual and face-to-face classes are merged, benefits are reflected between both. On the one hand, academic presence strengthens knowledge and there is more interaction between teacher and student. On the other hand, virtual classes are chosen by the student to maintain their continuous education status and in one way or another, there is communication from wherever they are, benefits that are reflected and the fact of continuing to study without economic limitations such as academic bureaucratic procedures that generate a cost for the student, transportation, food and also counteract accidents,

violence and insecurity. Being 30.6% very important for the students, that virtual classes could be maintained because of the benefits experienced from reality.

Table 6 Technology is important in virtual classrooms

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Not very important	7	11,3	11,3	11,3
	Neutral	13	21,0	21,0	32,3
	Important	24	38,7	38,7	71,0
	Very important	18	29,0	29,0	100,0
	Total	62	100,0	100,0	

It is found that students value the use of technology being this important but not so necessary for their academic co-responsibility, this shows the type of professionals that is being provided to society with little expertise in their branch of knowledge to respond to their training and face the work that corresponds to perform in society, it is evident in the student work the automation of their research to handle technological resources critically, does not respond to the argumentative analysis of the research, therefore, there is no scientific production of new knowledge granted.

Table 7 Active learning ceases to be meaningful in virtual classes

		Frequency	Percentage	Valid percentage	Cumulative percentage
Valid	Very Important	17	27,4	27,4	27,4
	unimportant	45	72,6	72,6	100,0
	Total	62	100,0	100,0	

Students value face-to-face training and see virtual learning as less important, because they believe that it is no longer significant in terms of their continuing education in the professionalization process, due to the existence of distractions in their environment or space, be it family, social or cultural, whether internal or external.

By analyzing various works that have occurred since the pandemic and post pandemic, it became evident that many of them have a common element such as the challenges that are evident in the post pandemic to change methodologies and pedagogies in hybrid classes without letting the quality go down and that students assume responsibility for their professional training, as Rodriguez Gomez Guerra, (2020) says. HEIs around the world face problems in trying to guarantee the health of students, professors and workers, as well as enormous challenges to give some continuity to academic activities. In this context, other difficulties for HEIs are becoming more acute, such as the reduction of public funding and the drop in the demand for admission.

It is true that in addition to the methodological, pedagogical and didactic problems, there are also economic problems that are evident in the attendance of students at universities and that they have not been able to integrate, because in times of pandemic they obtained other types of work and today it is difficult for them to stop doing so due to the loss of other employment opportunities.

Another work that evidences the great challenges involved in retaking Higher Education is that of Researcher Imanol Ordorika (2020) with the article Pandemic and Higher Education, where he frames that:

In short - as is to be expected from a process of this magnitude at the global, regional, national and local levels - the COVID-19 pandemic has profoundly affected the institutions, actors and processes that take place in Higher Education. As in other spaces and activities of society, there have been effects and changes whose duration and transcendence are difficult to predict. It seems convenient, however, to overcome a first stage of forced reactions, inevitably hasty and accelerated, to give way to careful reflections on the future of higher education. In Mexico, these reflections must combine demands, projects and initiatives for change that were taking place before the COVID-19 crisis broke out, with analyses of the social, political, economic and cultural transformations that will result from the crisis itself. Referring to the author's research, this is a desirable path and posture to face the challenges that will arise in Higher Education in our country.

UNESCO (1999, p. 2) "The relevance of higher education should be evaluated in terms of the adequacy between what society expects from institutions and what they do", this shows that it is time to retake and evaluate the teaching-

learning processes from the SARS-CoV-2 affectation and the location of the post pandemic to plan new pedagogical models that place both the teacher and the student, responding to the new training demands.

Conclusions

It can be seen that students are convinced from praxis that face-to-face classes are of vital importance because they can learn in a meaningful way and with fewer technical and connectivity problems, and now that is aggravated by the lack of work that is undermining their participation in the classroom and virtually.

It is evident that the students entered a comfort zone in the virtual world, because perhaps they made less effort, today the on-site study involves, in addition to the effort, having to leave the comfort for some and for others, the effort they have to make when they have to move to places with difficult access.

Assume complex approaches, that is, be prepared for the uncertainty that entails risk, preparation without lowering the quality and prepare to meet the demands that the environment requires as part of the teacher to be in continuous training, because students are the most harmed.

It is important to think about quality not as a perception, but as something that should include all the actions and activities of teaching-learning, curriculum design, linkage, research with the community where the infrastructure with its environment to respond to the great difficulties faced in this post pandemic.

Reference

Quicios, M. del P., Herrero Teijón, P., & González Ocejo, P. (2020). The effectiveness of distance learning during

COVID-19 confinement in low coverage areas of emptied Spain. The case of Salamanca. *Enseñanza & Teaching: Interuniversity Journal of Didactics*, 38(2), 67-85.

Yucra-Camposano, J. F. (2022). Rural education and covid-19: a systematic review of studies two during a pandemic. *Revista Universidad y Sociedad*, 14(3), 50-59.

UNESCO IESALC (2020). Covid-19 and higher education: from immediate effects to the day after. Impact analysis, response and recommendations. Paris, France: UNESCO. Retrieved from <http://www.iesalc.unesco.org/wp-content/uploads/2020/04/COVID-19-060420-ES-2.pdf>

UNESCO (1999). Higher education in the twenty-first century, vision and action: final report. Paris, France: UNESCO. Retrieved from: https://unesdoc.unesco.org/ark:/48223/pf0000116345_spa

Villaseñor, G. (1997). *La identidad en la educación superior en México*. Mexico: Centro de Estudios Sobre la Universidad, Universidad Autónoma Metropolitana-Xochimilco, Universidad Autónoma de Querétaro.

Zubieta, J. (2015). The university at the technological forefront: Massive Open Online Courses (MOOCs). In J. Zubieta and C. Rama (coords.), *Distance education in Mexico: A new university reality* (pp. 137-154). Mexico: UNAM and Virtual Educa. Retrieved from

<https://virtualeduca.org/documentos/observatorio/2015/la-educacion-a-distancia-en-mexico.pdf>

ECLAC (2020). *Latin America and the Caribbean facing the Covid-19 pandemic. Efectos económicos y sociales. Informe especial Covid-19*. Santiago de Chile: ECLAC. Retrieved from https://repositorio.cepal.org/bitstream/handle/11362/45337/4/S2000264_es.pdf

Morin, E., Ciurana, E., and Domingo, R. (2002). *Educating in the planetary era. Complex thinking as a method of learning in human error and uncertainty*. University of Valladolid: UNESCO.

Hupkau, Claudia, & Petrongolo, Barbara (2020). *Work, care and gender during the Covid-19 crisis*. Retrieved from London: <https://cieg.unam.mx/covid-genero/pdf/reflexiones/academia/work-care-and-gender.pdf> [Links]

IESALC, UNESCO (2020). *COVID-19 and higher education: From immediate effects to the day after*. Retrieved from <http://www.iesalc.unesco.org/wp-content/uploads/2020/05/COVID-19-ES-130520.pdf> [Links]

Rodríguez Gómez Guerra, Roberto A. (2020, July 2, 2020). *Higher education in the United States. Las horas bajas, Campus Milenio*, 4, [[Links](#)].

Ordorika Imanol(2020) *Pandemic and higher education*. Journal of higher education print version ISSN 0185-2760. Rev. educ. sup vol.49 no.194 Mexico City. http://www.scielo.org.mx/scielo.php?script=sci_artext&pid=S0185-27602020000200001#B13

Curricular organization in higher education for the online modality in the 21st century.

Ledys Hernández Chacón, MSc

University of Otavalo

lhernandez@uotavalo.edu.ec

0000-0002-3706-1873

Jesús Francisco González Alonso, PhD

University of Otavalo jgonzalez@uotavalo.edu.ec

0000-0001-6761-6588

Introduction

The greatest challenge in these two decades of the 21st century lies in the training of competent professionals committed to social development, where every day society demands with greater force the training of professionals capable not only of efficiently solving the problems of professional practice but also, fundamentally, an ethical and socially responsible professional performance. We can assess that Latin American universities have been slow in adopting these realities that lead us to a clear, precise and explanatory definition of learning outcomes represented by measurable performances, sharing the multiplicity of options that we can develop to develop learning.

Universities must take competency-based training by the hand in order to transform their traditional paradigm where the reliance on credits expressed in teaching hours measures the achievement of content retention in undergraduate and graduate students, while learning measures their outcomes. We can affirm that interest in competencies and specifically in the measurement of specific learning is accelerating worldwide.

In the World Conference on Higher Education (UNESCO, 1998), twelve thematic axes were proposed as the agenda for the future development of this educational level, of which three stand out, according to their nature, which oblige us to transform the traditional models on which the training of university professionals has been based, as well as the curricular organization:

- a) The demands of the world of work.
- b) Consolidation of the knowledge society
- c) The impact of new information technologies

The transformation towards a knowledge society constitutes an opportunity for higher education institutions that, by enriching their mission and perspectives, will assume a strategic role in the generation of knowledge and the formation of a critical mass with greater capacity to propose sustainable schemes.

Today we can speak that the change that has been generated with the development of information and communication technologies (ICT) in the educational environment has been vertiginous, which has led to the implementation of educational practices in learning environments that respond to the knowledge and information society, where the roles of the teacher and the university student are transformed into mediators and learners who change in the different environments of modalities from face-to-face to virtuality. In this last environment, it requires a curricular design that attends a pedagogical mediation as a key element for the development of the formative process.

The strategic framework of Higher Education institutions in terms of mission, vision and educational model contemplates a systemic and holistic methodology that allows the integration of educational actors, subjects,

disciplines, modules, managers and society as learners, in order to facilitate access to information and knowledge. In this sense, the methodological development enables academic action for virtual environments that pluralizes didactic strategies and integrates pedagogical, communicational and technological components to support educational processes.

The development of this approach allows considering the educational process as a system, understanding it as the interconnection of all its parts, forming a single structure. The holistic vision is a global perception, where each subject, although it can be treated separately, integrates the whole of knowledge, promoting not only a transdisciplinary but also an interdisciplinary approach (Fingermann, 2021).

This curricular design that we propose establishes the elements for an appropriate virtual learning environment, taking advantage of these spaces mediated by information and communication technologies, make the university teacher develop new competencies to facilitate his performance in the mediation of the teaching-learning process and therefore in the achievement of the proposed objectives.

The competency-based curriculum model for higher education in the online modality.

Competency is defined as the combination of skills, abilities and knowledge necessary to perform a specific task, a competency includes both the means and an end.

Competencies can be approached from different sources, perspectives and epistemology. The most recurrent approaches in the literature are:

- Behavioral,

- Functionalists,
- Constructivist and
- Complex.

The most common elements of the competencies are:

- 1- A competency is a performance, not the capacity for future performance, therefore, it is observable through behavior.
- 2- Competence involves knowing (conceptual), knowing how to do (procedural) and knowing how to be (attitudinal); people mobilize knowledge and the ways in which they do things.
- 3- Competence is always related to a mobilized capacity to respond to changing situations.

The specific purpose of using competencies in curriculum design is to transform learning experiences into performance-based organizational outcomes. The concern of competency-based curriculum design is to ensure that students will be able to demonstrate their learned capabilities after they have acquired a combination of knowledge, skills and abilities.

For all the above reasons, the competency-based curriculum is also known as performance-based training, where its foundations are based on a systemic approach and strategic planning.

It is important to develop some interesting interactions that allow us to approach the curricular model for a virtual environment such as:

- **Pedagogy:** integrates methodological strategies from a constructivist, humanistic and cognitive approach in the development of learning activities.

- **Educational model:** identifies transcendental aspects such as complex thinking, interdisciplinarity and technological inclusion.
- **University academic profile of a virtual environment:** identifies skills, knowledge and abilities, pedagogical, communicative, technological and evaluative for virtual environments.
- **Trend of new information and communication technologies in education:** implements educational programs in line with digital literacy, educational reforms, digital inclusion to support learning processes.
- **Technological infrastructure:** development and use of robust and versatile educational platforms that allow the implementation of participant-friendly virtual environments.
- **Participants:** considers the social, cultural and economic context of the student for the incorporation of ICT in learning environments.

Competency-based curriculum design for higher education in the online modality.

For higher education in this century, as a current trend, online education and its subjects that make up the curriculum for undergraduate and graduate programs, which are relatively designed in modules, can be adapted to different formats depending on the context in which they are developed, but respecting the basic elements that are integrated into the curriculum design:

The following elements can be mentioned as denominators when designing curricula for undergraduate or graduate courses:

Figure 1- Common elements for curriculum design



1- General information: it allows us to locate in time space, for the development of an undergraduate course it will be its description by semester and for the postgraduate program it will be done according to the characteristics that identify it as a bimester, quarter, four-month period, etc. Another aspect to be included in this space are the hours dedicated to the subject or module, highlighting its three components: The calculation of the hours assigned to the subjects and modules does not have criteria based on the theory of curricular design; the proposal for the distribution of these hours is always based on the expertise, experience, information collected, diagnostics applied, etc. of the teachers who design, who will jointly determine as a team the sufficient and necessary time to satisfactorily fulfill the curricular contents according to the competencies foreseen. Determining at the end the calculation of the credits obtained by subjects or

modules, in table 1 example of calculation of credits, it is necessary to point out that for this calculation must be governed by the rules and / or regulations by the institution of higher education in each country.

Learning in contact with the teacher: is the set of individual or group activities developed with the intervention and direct supervision of the teacher (face-to-face or virtual, synchronous or asynchronous) comprising classes, conferences, seminars, workshops, classroom projects (face-to-face or virtual), among others, established by the Higher Education Institution (HEI) in accordance with its institutional educational model. Learning in contact with the teacher may also be developed under the modality of tutoring, except in the field of health, which consists of a mechanism of personalization of teaching-learning, adjusting the process to the characteristics of the student and his/her formative/educational needs; strengthening the development of professional competencies from the institutional and student conditions; as well as the accompaniment to overcome difficulties in the follow-up of the career or program that, eventually, may be encountered. Each HEI will define the mechanisms and conditions for the realization of tutoring, to ensure the fulfillment of its purposes.

Practical-experimental learning: is the set of activities (individual or group) of application of conceptual, procedural, technical contents, among others, to the resolution of practical problems, verification, experimentation, contrasting, replication and others defined by the Higher Education Institutions (HEI); of cases, phenomena, methods and others, which may require the use of infrastructure (physical or virtual), equipment, instruments, and other material, which will be provided by the HEI.

Autonomous learning: is the set of individual or group learning activities developed independently by the student without contact with the academic staff or academic support staff. The activities planned and/or guided by the teacher are developed based on their capacity for initiative and planning; critical handling of information sources and content; problem posing and solving; motivation and curiosity to learn; knowledge transfer and contextualization; critical reflection and self-evaluation of their own work, among the main ones. For their development, specific activities must be planned and evaluated, such as: critical reading of texts; documentary research; academic and/or scientific writing; preparation of reports, portfolios, projects, plans, presentations, among others; as well as other activities established by the IES in accordance with its institutional educational model.

Table 1- Calculation of credits

Credit Calculation					
For undergraduate careers					
Hours of activities with the teacher	Hours of practical-experimental activities	Hours of autonomous activities	Total hours	Number of weeks	Number of hours and credits
2	1	2	5	16	80 hours / 2 credits

3	1,5	3	7,7	16	120 hours / 3 credits
4	2	4	10	16	160 hours / 4 credits

For postgraduate programs

The regulations of the Academic Regime are set forth as follows:

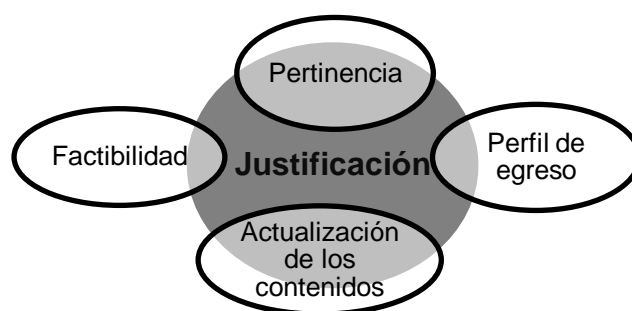
In the case of other study modalities and postgraduate programs, the Higher Education Institutions (HEI) will determine the distribution of learning hours according to the careers and programs.

Each HEI will determine within the framework of its responsible autonomy the hours of learning in contact with the teacher, the hours of autonomous learning and the hours of practical-experimental learning, considering the modality of studies, the degree of complexity of the learning objectives of the subjects or academic activity and other aspects it considers relevant

Preparation: Own

Justification: it is a component of high significance and importance since it is the result of the curricular analysis necessary for the career or program; its integration is detailed in the four essential components:

Figure 2- Elements that make up the justification in curriculum design



Preparation: Own

a) Relevance: the characteristics of the social and educational mission of the undergraduate or postgraduate program are presented, describing the future functions to be performed as part of the professional practice, capable of solving and transforming the current problems of society.

b) Graduation profile: it constitutes the ideal model in the higher education of an undergraduate and/or postgraduate student where the generic and specific competences acquired will be demonstrated, which will be recognized as the ways of acting of the graduates, capable of solving tasks and problems present in the different work environments, as well as in their own life.

c) Updating of contents: they refer to the updating of learning and the object of study described in undergraduate and postgraduate programs, they are directly related to the graduate profile, already analyzed above; we must specify in this section the importance they have for the training of students in higher education by describing the contents to be developed, their level of

updating as they are produced in the development of sciences and technologies, and the results of the incorporation in the professional's labor field.

d) Feasibility: the possibilities of the practical proposals are taken into account in the foundation of the undergraduate and graduate programs where the academic conditions, availability of teachers, technological equipment and inputs of any nature (virtual classrooms, laboratories, simulators, didactic videos, technological programs, etc.) for the development of the required curricular process are described.

2- Competences: they can be defined from two points of view: general and specific competences, which respond to a pedagogical and didactic logic and are assumed both for undergraduate and postgraduate programs as the results of professional approach within the general training process. It is important to link these to the graduation profile where the partial and final contributions are provided in the so-called exit profile of the training proposal.

It is interesting to describe that in the formulation of competencies we must include some aspects such as:

a) Action expressed with an infinitive verb representing **know-how**.

b) Conceptual and methodological core that expresses the knowledge **and know-how**, accompanied by a requirement to achieve the expected professional performance.

c) Context where it is intended to be competent in solving problems with the studies achieved according to the problem **to be addressed**.

d) Proposals that express values, professionalizing attitudes that respond ethically, aesthetically and morally according to the expected performance expressed in

knowing how to be and knowing how to live together.

General competence: it is the result of what is intended to be achieved in the professional's graduate profile; it is the goal that is intended to contribute to the fulfillment of the academic program's exit profile, which can be seen in dynamic ways in the curricular design proposal for online training.

Some attitudes that should be mentioned when elaborating the competencies in virtual education may be the following:

- a) Impartiality
- b) Honesty
- c) Modesty
- d) Solidarity
- e) Social responsibility
- f) The spirit of collaboration for teamwork.
- g) Discipline
- h) Laboriousness
- i) Ethics and confidentiality in the handling of information
- j) Tolerance
- k) Critical and self-critical attitude
- l) etc.

Some contemporary authors also include quality parameters; our proposal does not obviate this, but considers quality as an intrinsic tool within the whole process of curriculum design in higher education.

Specific competencies: these constitute another element of curriculum design under the competency-based approach to higher education, which is governed by the aspects analyzed above, where in the specific competencies we must include at least one of these aspects.

We can detail that from this concrete analysis it is convenient, from the pedagogical and didactic approach, to establish the difference between the general competence of a degree course or postgraduate program and the specific competences, since each one proposes actions in different areas from the curricular design.

The analysis of the specific competences, their inductive sense and specificity are given by the context and the action of performance that are more specific, while the general competence is in function of a theoretical-practical field as a form of content, object of learning that includes: the conceptual, procedural and attitudinal; allowing to form competences in a pedagogical logical sequence, from the general to the particular.

To understand the concept of knowledge transfer where the true essence of the constructivist model is concluded is today is the fundamental basis for the formation in higher education of competencies, it must be recognized that for undergraduate careers and postgraduate programs these must assimilate certain conceptual content necessary to achieve the goals and their practical application, In turn, these are associated with thinking skills, skills that justify the specific competencies that can be developed in the

different learning units, the specific competencies characterize in defining the more specific and less complex performances than those that make up the general competency.

From the theoretical and methodological logic of curriculum design, understanding the formulation of the specific competencies, without ignoring other possible interrelationships, is closely related to the determination of the learning units, a step that we will analyze below, which allows us to say that the dynamics of this stage of curriculum design is characterized by an interactive action between both stages, ensuring the formulation of the specific competencies and ensuring that the contents selected in the curriculum design are necessary and sufficient to achieve them and at the same time to achieve the fulfillment of the general competency.

The aforementioned conditions us that in practice, in general, the specific competencies will be associated to certain learning units in a correspondence relationship that expresses what we intend to achieve partially in these groupings of contents; it also allows us a preliminary vision of the pedagogical logic based on the construction of knowledge through the assimilation of conceptual, procedural and attitudinal contents that will determine in a more concrete way the didactic strategies.

Learning units: we refer to the arrangement of the curricular contents in terms of knowledge that will be applied to concrete situations in the context of action, which will allow us to achieve through the transfer of knowledge that higher education students can develop know-how in terms of procedural and attitudinal contents.

The contents are grouped by purposes and are organized in the learning units according to the pedagogical logic and its interrelation with the scientific logic of the area of knowledge to be developed, always starting from the general to develop the particular and from the simple to the complex, it is important to emphasize that the conceptual contents are not actions, therefore they should not be stated using verbs as it is referred to when stating the skills or abilities as the essence of performance.

It should be explained that the content systems are selected taking into account those that are necessary for higher education students to achieve their purposes and competencies declared in the academic program, for the construction we must keep in mind the contents of an area of knowledge, a pedagogical arrangement will always be made towards scientific and/or technological knowledge that aims at specific performance.

We can point out that when carrying out a methodological analysis by learning units, we must keep in mind these two questions:

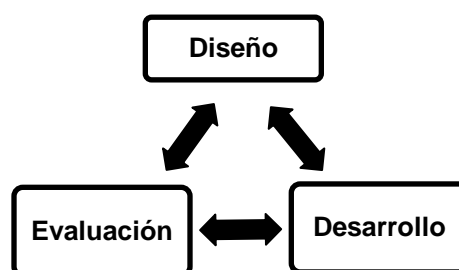
- 1- Is there coherence in the integration of knowledge, is its sequencing and pedagogical ordering clear in the proposed learning units?
- 2- Are the performances expressed in the proposed competencies necessary to achieve the skills and abilities?

Didactic strategies: are the reflection of the creativity of teachers that are born in the application of different methods and techniques of teaching and learning, which are based on their approaches, models, currents and pedagogical and didactic trends supported by other theories of science applied to education such as: psychology,

sociology, philosophy, sciences, epistemology among others, providing an interdisciplinary and in most cases transdisciplinary character that help us to solve problems of how to teach and how to learn when the pedagogical theory is insufficient as a conceptual and methodological system to explain and solve them. Before the situation described above is when we include the use of constructivist strategies or also known as training by competencies, these denominations characterize certain essential approaches of curricular character in our didactic strategies, which allow us to reflect a certain general tendency of theoretical character, but do not express a certain detailed characterization of everything that we take into account to design a didactic strategy.

We point out that within the theoretical model or main currents of pedagogy and curriculum, in practice, multivariate and complex operational methodological instruments are constructed that have a certain specificity based on the context of application and the content to be taught and learned, as well as the multiparadigmatic character, all of which is expressed in the three dimensions of the curriculum:

Figure 3- Curriculum dimensions



As long as the teacher designs his own analytical program for a group of university students in his own context, we consider that these should have their own general methodological orientations that allow each teacher to design his own didactic strategies according to the conditions and context where the teaching-learning process takes place, its characteristics and dynamics of the groups of students, which can almost always be different.

In addition, specific methods and techniques can be suggested for the activities or contents determined according to the expertise of those who have designed and the specific didactics used for the content under study, it is the orientation in general that explains how to teach and learn, according to the levels of assimilation expected to be obtained in the achievement of the declared competencies. Let us remember that at the time of designing the academic program, the orientations should be declared with a certain flexibility that allows the teachers who develop it to apply methodological alternatives according to the concrete conditions of execution, the characterization of the student groups and the specific group dynamics.

We could mention that at the time of curriculum design some of the methodological orientations to be taken into account are:

- 1) The methodological orientations that are planned have general characteristics and allow us to identify the course of the strategies incorporating the didactics in the activities allowing the students to reach their competences in the specific contents.
- 2) When explaining the construction of student learning under the principle of cognitive independence and

applying learning to learn from competency-based education as a current approach and constructivism.

3) It is necessary to provide clear and precise guidance on how to achieve a balance between the different levels of assimilation (reproductive, productive and creative), through the use of teaching methods applied to the different types of classes or teaching activities that are programmed.

4) A general orientation should be carried out to achieve a balance between the activities to be conducted by the teacher and the independent work activities to be developed by the students.

5) We must keep in mind the different teaching activities that the teacher will develop such as: classes, seminars, workshops, consultancies, tutorials, etc.; where the orientation of the contents must be well defined, taking into account: what type of content, when these contents are necessary and why we develop these contents.

6) Methodological orientations should generally follow a criterion that allows students a certain degree of flexibility for practical adaptation.

In order to further clarify the methodological orientations, we propose some methodological techniques to be used:

- a) Expository method by the teacher
- b) Joint elaboration method
- c) Content analysis
- d) Documentary research
- e) Application of group dynamics
- f) Case studies
- g) Discussions in expository seminars
- h) Discussion of results through workshops

- i) Integration of content through projects or integrative courses
- j) Elaboration of the electronic portfolio as a student's work file.

The university teacher will incorporate a tutoring space, by planning specific schedules to be able to attend to doubts and individual differences aimed at solving problems. This tutoring time will be planned depending on the programmed scopes in the different options to be carried out, such as: research, case study resolutions, exercises, team work, etc.

Evaluation System: it is the part within the curricular design that allows teachers to guide the goals to be developed, it is recommended to write it in general terms to allow the development of students in their performance, recognizing a systemic character through different evaluations to be carried out in the planned period, it is also the responsibility of the teachers to describe the measurement instruments for each type of evaluation to be applied.

In the development of the curricular process, evaluations can be categorized as frequent, partial and final, according to the criteria of what we define as formative and summative evaluation.

We will analyze some essential and basic elements that the teacher must keep in mind at the moment of constructing the evaluation system for the curricular proposal:

- 1) The function of any evaluation proposal must allow the verification of the competencies established in the subject or module to be developed and these must be evidenced through its description.

2) Teachers should strike an appropriate balance between formative and summative evaluation expressed in the types of partial and final evaluation.

3) In the formative evaluation, the teacher must clearly and accurately reflect throughout the curricular process a continuous feedback on the results achieved in learning; it is a form of evaluative assessment that is carried out during classes and other systemic activities, which measure progress with respect to the competencies planned in the subject or module, in addition to checking the skills or abilities that are to be integrated into the competencies.

4) During the formative evaluation that is developed with its frequent and common characters from the participation of the students in the different activities in the teaching space (previously mentioned) by the teachers; it is worth mentioning that this type of evaluation does not necessarily issue a grade, but it is advisable to use a control to propitiate a motivating environment in the teaching-learning process.

5) The competency-based approach allows the curricular processes to influence the basic and professionalizing subjects in the final evaluation, due to the fact that the verification of learning acquires a practical character of knowledge referring to (know-how) in terms of professional performance.

6) We could suggest to the teacher the application of different instruments such as: rubrics, portfolios, etc.; these will depend on the scope we have at the time of verifying the formation of competencies in the subjects or modules.

7) Another characteristic that we put in your hands for the evaluation is the tendency to follow in the evaluation system for which we propose an inclination towards the qualitative aspect of the learning results and the formation of competences according to the quality of the expected performances, if we analyze the quantitative aspect this will be represented at the end in figures in percentages that would indicate relative numbers.

It is important to note that there is no reason to confuse learning assessment with grading on a numerical scale; not all assessments must necessarily be quantitatively graded.

8) We express some criteria that could be used at the time of the evaluation with a qualitative tendency:

a) Contextualization and methodological originality to the problems to be solved.

b) Theoretical mastery and updating of the contents expressed.

c) Systemic approach to the contents developed.

d) Level of creativity in the problematic situations presented.

Bibliographic Consultations: these are the sources consulted in an orderly manner necessary for the dissemination of the learning expected by the students; they can include links to Internet sites that provide specialized information on the contents of the learning objects.

Aspects that should support the referred bibliography:

a) It must respond to the contents to be developed in the subject or module, ensuring that they meet the learning needs and competencies to be developed in the students.

b) Appropriate level of updating, it should be noted that this aspect should be analyzed in a flexible manner respecting the classic works that have been published for more than five years.

c) Updating should use works from the last five years and the internet search sites should respond to the sciences.

For the development of a proposal referring to the curricular organization, through the design of the analytical program for the online modality, we propose the analysis and implementation of the following figure:

Table 2- Proposed curricular organization through the design of the analytical program for the online modality.

(IES logo)	Knowledge Area:	Career:
1- General Information.		
Subject:		Semester:
Academic Period:		Code:
Professor Author:		Tutor Teacher:
Distribution of hours of the course for the semester:		
Hours of activities with the teacher:	Hours of practical-	Hours of autonomous activities:

	experimental activities:	
Semiannual total hours:	Number of credits:	
<p>2- Justification.</p> <p>NOTE: These four aspects should be described:</p> <p>a) pertinence: educational social task, describing the future functions to be performed as part of the professional practice, capable of solving and transforming the current problems of society.</p> <p>b) graduation profile: ideal model in the higher education of a student where he/she will demonstrate the generic and specific competencies acquired, which will be recognized as the ways of acting of the graduates, capable of solving tasks and problems present in the different work environments, as well as in his/her own life.</p> <p>c) updating of contents: they refer to the updating of learning and the object of study described, we must specify in this section the importance they have for the training of students in higher education, describing the contents to be developed, their level of updating as they are produced in the development of sciences and technologies, and the results of the incorporation in the professional's labor field.</p> <p>d) feasibility: it takes into account the possibilities of the practical proposals, in the rationale where the conditions are described: academic, availability of teachers, technological equipment and inputs of any nature (virtual classrooms, laboratories, simulators, didactic videos, technological programs, etc.) for the</p>		

development of the curricular process that may be required.

3- Competencies.

3.1- General Competence: (it is the goal to contribute to the fulfillment of the exit profile of the academic program).

3.2- Specific Competences: (they will be associated to the learning units in a correspondence relationship that expresses what we intend to achieve in a partial way in these groupings of contents).

4- Learning Units

Learning Unit No1: (name)

Specific Competency: (describe must be interrelated with those proposed above)

Contents:	Projected learning outcomes:

Learning Unit No. 2: (insert name)

Specific Competency: (describe must be interrelated with those proposed above)	
Contents:	Projected learning outcomes:
Learning Unit No. 3: (insert name)	
Specific Competency: (describe must be interrelated with those proposed above)	
Contents:	Projected learning outcomes:
<p>5- Didactic strategies: (methods that promote levels of productive and creative assimilation of the contents object of study, the curricular development of the subject will be characterized by dedicating more time for the development of seminars and workshops through the application of group dynamics techniques that allow stimulating the use of productive and creative teaching</p>	

and learning methods directed to the reflection of the participants with a critical sense, and also characterized by the analysis and discussion of their own experiences and from research).

3- Evaluation Systems (recognizes the systemic character by means of the realization in the planned period, it is also the responsibility of the teachers to describe the measurement instruments for each type of evaluation to be applied).

6- Bibliographic references (sources consulted in an orderly manner necessary for the learning expected by the students, links to Internet sites can be included).

Title :	Author(s):	Year:	Language:	Editorial:	Link:

Preparation and Approval

	First and Last Names	Signature
Professor Author		

Tutor Teacher		
Knowledge Area Director		

Preparation: Own

Conclusions

The competency-based curriculum design for the ILE modality, which is developed in a virtual learning environment from the holistic and systemic approaches, establishes a relationship between learning theories and educational practices, since the components that make up the learning community are jointly addressed.

In 21st century higher education, curriculum design by competencies should be considered as a process because it has a structure and its own dynamics that responds to a certain methodological logic which characterizes the interrelationships between the structural components, determining an order and hierarchy.

During the design of the competency-based curriculum, interactive actions that are frequently developed within the framework of its execution are presented, which can be explained in the development of each component.

A program model for an undergraduate or postgraduate program to be implemented as a competency-based curricular proposal is developed, contemplating the essential aspects of the critical analysis and the rationale that correspond to each of the components that make up our proposal.

References

- Aristimuño, A. (2008) Competencies in Higher Education: Demon or opportunity? Department of Education. Universidad Católica del Uruguay. <http://www.cedus.cl/?q=node/10255>.
- Bellocchio, M. (2010). Educación basada en competencias y constructivismo: un enfoque y un modelo para la formación pedagógica del siglo XXI. Mexico: (ANUIES).
- Celis, M. (2010) Diagnosis and development of teaching competencies in the school system. Resultados de una experiencia preliminar con el modelo de Gestión escolar de fundación Chile. Revista Iberoamericana de Evaluación Educativa - Volume 3, Number 1e. http://www.rinace.net/riee/numeros/vol3-num1_e/art19.pdf
- Diaz Barriga, A. (2005) Formación por competencias. Keynote lecture given at the Jornada Pedagógica de la Facultad de Pedagogía de la U de C.
- Fingermann, H. (2012). Systemic approach to the Teaching-Learning process. Retrieved from <http://educacion.laguia2000.com/ensenanza/enfoque-sistematico-del-proceso-de-ensenanza-aprendizaje#ixzz3tlavsegp>
- Ruiz Calleja, J. M. (2018) Competence and sub-competencies in the design of subject programs. Semanario El comentario, official publication of the University of Colima, Mexico. 30 April 2018.

**State of the art on problems of financial
tools in the development of
microenterprises in the province of El Oro**

Ruth Maryury Delgado Olaya

Master's Degree in Accounting and Finance, Universidad
Metropolitana del Ecuador
rdelgado@umet.edu.ec
<https://orcid.org/0000-0001-7159-3729>

Mariana Marisol Yáñez Sarmiento

Master's Degree in Taxation and Finance, Universidad
Metropolitana del Ecuador
myanez@umet.edu.ec
<https://orcid.org/0000-0002-1284-1478>

Kenia Lizzeth Carchi Arias

Master's Degree in Accounting and Finance, Universidad
Metropolitana del Ecuador
kcarchi@umet.edu.ec
<https://orcid.org/0000-0003-4023-4015>

Introduction

Decision-making through financial tools represents an indispensable activity for business management in the current context of globalization of modern business, regardless of the size or economic activity of companies that seek to obtain positive results. Likewise, financial management tools are reliable instruments in the control of resources and for competitiveness in the business market, whose purpose is to preserve working capital, increase profitability and maximize the value of the company, for this reason it is essential that companies use financial tools in making accurate and timely decisions.

In the administration of MSMEs it is necessary to have knowledge in financial management since it is not enough to manage empirically to face an increasingly globalized and competitive market and to keep up in the long term. The alternatives for success or failure in companies will depend largely on the information available, especially on inventory, cash flow, sales, credit portfolio, suppliers, among others. This information is obtained when management processes are applied and consolidated from the "Accounting" whose purpose is to provide economic and financial information of the business structure.

The micro, small and medium-sized enterprise sector is considered a fundamental driving force in the growth of countries' economies worldwide; therefore, it has been extensively studied throughout history in research that strengthens its development and business growth. In Latin America, microenterprises are recognized for their high participation in the generation of employment, an entrepreneurial alternative to generate income and an option to combat poverty in times of economic crisis; on the contrary, microenterprises are a key factor in the growth of the economies of countries. (Correa et al., 2018) their participation in the gross domestic product (GDP) reaches only 25% regionally, which evidences their low capacity to contribute to economic growth in each country.

It can be noted that, in Latin America, MSMEs account for 99.5% of the companies in the region of which 88.4% are microenterprises (Correa et al., 2018). Among the difficulties currently faced by small businesses are poor technical and business training, little or no administrative and financial management; i.e., they do not apply administrative management processes, let alone accounting or perform fiscal accounting and therefore there is no business growth (Corporación Andina de Fomento,

2013).. In addition to the above, the lack of resources, inadequate financial structure and poorly qualified personnel are the main reasons for this (Pereira Bolaños, 2019). (Pereira Bolaños, 2019) limits their growth and development. Situation of a large group of micro and small enterprises when making decisions without data that reflect their real financial situation.

In empirical studies (Flores et al., 2016; Santana, 2017; Taxis et al., 2016) the mortality rates of microenterprises are linked to the lack of financial information and the lack of strategic and/or operational plans (Molina et al., 2016)the entrepreneur has not modified the traditional way of managing, since he has based his decision making practically on intuition and experience (Molina et al., 2016). Similarly, in the empirical study of Saavedra et al, (2016) concludes that entrepreneurs do not make decisions based on statistical data; they do so empirically, without the use of financial tools.

In the case of Ecuador (Arguello et al., 2020; Delgado et al., 2021) In the case of Ecuador (Arguello et al., 2020; Delgado et al., 2021), MSMEs back up their transactions with income and expense records, ignoring their working capital and financial performance due to the lack of accounting information, a situation that limits the management process and accurate decision making, thus increasing the uncertainty of growth and development.

When a company obtains financing, whether public or private, it needs to have the information and analysis of its results to evaluate its management performance and profitability. The MSMEs in Ecuador classified in the group of natural persons, most, if not all, are tied to the tax categorization of obliged and not obliged to keep accounting, leaving aside the application of financial tools

that provide information for the analysis and interpretation of the results. For the implementation of a greater activity in management systems in MSMEs. (García et al., 2016) need an organized internal structure with a financial approach that adapts to the economic and social context and the advance of technologies, enhancing greater business benefits.

Microenterprises are an important sector in Ecuador's economy, providing 23% of employment as the first option for Ecuadorians to obtain income, promoted by those who have not been able to enter the labor market. (Delgado-Olaya et al., 2022).. Their contribution to GDP of 1% of total sales differs from the 91.89% representativeness of microenterprises in the total business sector (National Institute of Statistics and Census of Ecuador). (National Institute of Statistics and Census [INEC], 2020).. There are some problems faced by this sector in Ecuador, among them, they do not have a specific unified regulation to operate in the market, in the Organic Code of Production, Commerce and Investment [Código Orgánico de la Producción, Comercio e Inversión] (2010). (2010)and its implementing regulations (2011) are considered a productive unit that any natural or legal person can develop in production activities, trade and / or services; having between 1 and 9 workers and an annual gross income that does not exceed \$ 100,000 dollars. On the other hand, in the legal tax body, it characterizes micro-enterprises including entrepreneurs, with gross income up to \$300,000 dollars and 9 workers prevailing income for its categorization. (National Assembly Republic of Ecuador, 2019). Ecuador occupies the second place with 16.1% with liquidity restrictions which influences access to credit (Cohen, Marcos; Baralla, 2012). considered another factor

affecting the strengthening and development of microenterprises.

In the province of El Oro (Carchi et al., 2021) microentrepreneurs lack tools and processes for optimizing resources and time, limiting their ability to sustain themselves in the long term. Along the same lines (Campoverde et al., 2022) 35% of microentrepreneurs keep track of their transactions in a notebook, 30% using Excel, 13% do it empirically, 16% use an accounting system and 6% use other types of records. Likewise, (Crespo et al., 2020) Lack of knowledge of accounting and administrative management limits the productivity and competitiveness of microentrepreneurs in Orense.

Based on the documentary review, the need to identify the state of the art on the main financial tools that contribute to the strengthening and development of microenterprises in the province of El Oro in order to maintain them in the long term. This work is a product of the research project "Financial Tools directed to the strengthening and development of microenterprises in the province of El Oro" as a contribution from the academy from the Metropolitan University of Ecuador, Machala branch and as a result of its execution.

State of the Art Financial Tools

The term financial tools is derived from finance, which is applied in business administration and management; in this sense, it is necessary to identify the terminology of finance, its origin in economics and its relationship with financial tools.

Evolution of Financial Theory

According to Ricardo de la Luz Domínguez (2008, as quoted in Mariño & Medina, 2009) the word finance comes

from the Latin definition *finacia*, which means payment in money, a term that was used in the thirteenth and fifteenth centuries initially in the most mercantiled country of that time, Italy, and in its main commercial cities: Florence, Genoa and Venice. Subsequently, the term was used in all economic and financial activities involving the use of money as a medium of exchange in all types of transactional operations.

Later, Adam Smith incorporated the term "economics" in his work "The Wealth of Nations", which is characterized as a branch of economic theory that creates value in companies. Finance has been a subject that has been little researched throughout history; becoming more relevant in the 19th and 20th centuries as an indispensable area of analysis in companies; expanding the methods, techniques and their use in the resolution of real problems in the business area. Finance was consolidated at the beginning of the 19th century; where financial managers were dedicated to keep and control the accounting books, setting their main task to look for financing for the companies, limiting the action of finance (López & Ferruz, 1996). This situation becomes contradictory since access to credit takes as a fundamental tool the results obtained by the companies.

After the industrial revolution in England originated by a growth in its economy, the company expands and begins to increase the importance of finances focused on liquidity and are concerned about the financial structure. (Ferruz Agudo, 2000). In 1929 the economy is involved in an international economic crisis that generated financing problems, bankruptcies and business liquidations; at this time what mattered were survival, liquidity, debt reduction and maximization of regulations on the stock markets. (Ferruz Agudo, 2000).

In the 1940s Professor Erich Shneider published his work entitled *Investment and Interest* (1944, as cited in Mariño & Medina, 2009). (1944, as quoted in Mariño & Medina, 2009) in which he elaborates the method for the analysis of investments and the financial decision criteria that lead to the maximization of the company's value. In the same study Shneider expresses an idea that is still valid today: an investment is defined by its collections and payments, i.e., collection in the shortest possible term and payment in the longest possible term. In the 1950s, finance was considered an external factor of the company, rather than an internal factor that strengthens its economy. Also, in this decade the modern financial theory is being cemented, it begins to be aware of cash flows, planning methods, accounting control and capital budgeting, taking greater responsibility for management in the control of money and the management of the assets of the company. (Mariño & Medina, 2009)..

In the subsequent 1960s and early 1970s (Flórez Ríos, 2008) interest in the systematic development of finance was stimulated by factors related to rapid economic and technological development, competitive pressures and changes in markets, which required careful rationing of available funds, leading to advances in the fields of working capital and cash flow management, optimal allocation of resources, expected returns, measurement and projection of operating costs, capital budgeting, formulation of the company's financial strategy and capital market theory. In the 1990s (Del Valle & Schemell, 2011) finance has played a vital and strategic role in companies; financial managers have become an active part of opportunity cost wealth generation, product judgment, investment and operating decisions.

It is in this context that modern financial theory is being instituted as a consequence of market finance and

corporate finance. (Flórez Ríos, 2008). The following is an analysis of finance from the corporate approach.

Financial Tools

There are multiple financial tools that are currently used as a business management tool, each one has a specific purpose; at the same time, it leads to the evaluation of managers, on the efficiency and effectiveness in the investment of resources. The quantitative financial information presented to control agencies, suppliers, investors and others become financial tools that reduce risk and increase business development, by having historical and current information on its financial situation and profitability.

Among the financial management tools that lead to risk reduction and sound decision making are: treasury management, cash flow, budgeting, operating plan, financial analysis, monitoring, financial management indicators and balanced scorecard. (Armijos et al., 2020).. It should be noted that "accounting" is the basis of the financial tools needed for financial analysis, financial management indicators, cash flow and financial ratios, among others. Accounting was born as a need of society to evaluate the economic facts generated by companies. (Vega Alvear & Tello Avila, 2014) in conjunction with the evolution of societies and competitive and free market economies. In this sense, accounting is the process of analyzing, classifying, summarizing and recording each of the transactions executed by a company, chronologically and in a certain period of time; with the purpose of providing real-economic-financial information to internal and external users. In this context, it is established that accounting fulfills a specific role that streamlines the social operative part under logical-mathematical considerations

such as elements, classes, properties and relationships when providing financial statements. (Gil, 2020) These constitute a financial tool that cannot be ignored in business management.

The administration of finance is responsible for economic and financial management in companies through the use of various tools that provide information and influence investment decisions, rectification of processes and the comparison between the projected and the actual that guide the achievement of the objectives set. Currently there is a gap between micro and small enterprises and finance. Due to their size, limited business management skills and low investment, they do not apply these tools as strategies in administrative control given the recovery they could obtain in the future. Therefore, the basic financial statements would be the basis that is recognized as the main tools in any company and as an alternative in small businesses.

Statement of Income for the Period. - This important report is the first one to be made since its final result, whether profit or loss, is reported in the company's balance sheet or statement of financial position. According to the International Accounting Standards Board (IAS 1, 2001) is characterized by presenting the results for the period and the other comprehensive income, the two reports in a single document or separately. The accounts that each one reports vary from one another, therefore such information is specific in each case. In this sense, the statement of income for the period is analyzed as an instrument for application in the microenterprise sector. Its structure is as follows: a) income from ordinary activities; b) financial costs; c) share of income for the year in associates and joint ventures; d) tax expenses; and, e) a single amount for the total discontinued operations. According to its design the statement of profit or loss for the period (Server Izquierdo,

2003) The statement of profit or loss for the period (Server Izquierdo, 2003) is made up of all revenues, costs and expenses related to the economic events of the ordinary course of business and non-operating events. In this report (Mir Fernández, 2008) companies obtain the results of their business management, which are related to the cash flows obtained to meet their short and long-term obligations.

Statement of Financial Position. - The IAS 1 Statement of Financial Position has established itself as the second essential management report in the corporate evaluation process. IAS 1 (2001) defines its structure in current assets, non-current assets, current liabilities, noncurrent liabilities and finally equity. It also emphasizes that other items may be added and modified according to the company's needs and transactions with a view to providing understandable and relevant information on the financial situation of companies. This report represents the history of the company throughout its activity, accumulating the inflows and outflows with an impact on its resources and the financing it receives.

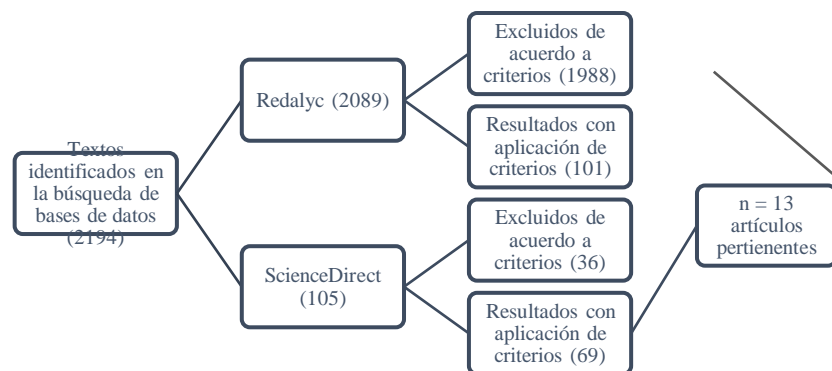
Statement of Cash Flows. - is the third basis of accounting that shows the ability of management, owners or directors to generate cash and cash equivalents and how those resources have been used. (International Accounting Standards Board [IAS 7], 2001).. This same standard establishes its presentation with reference to the inflows and outflows of operating, investing and financing activities. It is considered the most important of the financial reports based on the fact that cash is the main resource in companies to cancel their obligations, costs and expenses; therefore, it is a financial tool that measures whether the organization's objectives are being achieved (Mayor & Saldarriaga, 2001). (Mayor & Saldarriaga, 2016)..

Microenterprises in their administration of resources need knowledge in their management as it influences economic and financial results. (Tarí & García, 2013) as well as in their main objectives: to generate profits, sources of employment and satisfy the needs of the population, contributing to their strengthening and business development.

The study was conducted through a grounded theory qualitative approach (Sampieri et al., 2014). In bibliographic sources, with an exploratory-descriptive design, articles related to financial tools applied to business management were analyzed. The information search was conducted online in two scientific databases recognized for their high impact in the dissemination of scientific knowledge: Red de Revistas Científicas de América Latina y el Caribe (Redalyc); and Revista Ciencia, Salud y Medicina (ScienceDirect) research in five countries: Mexico, Spain, Peru, Chile and Ecuador. The selection criteria for the sample were review articles and management studies published in the areas of accounting, accountancy and business administration between 2008-2022. In order to simplify the search, the keywords "accounting" and "financial statements" were used as a strategy to simplify the search.

The literature review process was carried out in three stages: first a general search in national and international databases; then the criteria were applied to obtain the sample, excluding articles that were not related to the research, and finally the reading, analysis and review of the complete documents, as shown in Figure 1 and the results presented in the Microsoft Office Excel spreadsheet.

Figure 1. *Selection process of scientific studies.*



When searching in the databases, it was found that there is more research in Redalyc (95%) and in ScienceDirect (5%).

Results of the information in databases

Table 1 *Analysis of scientific databases on financial statements*

Title	Author	Place and year	Target	Study sample	Type of study	Conclusion
The impact of fair value of real estate on financial statement profitability: a research note.	Navarro Andrés & Pérez María del Carmen	Spain 2009	To analyze the perception of professionals on the relevance, reliability and feasibility of the financial information obtained from the application of the RV.	n = 151 accounting managers of Spanish companies.	The empirical study.	In small companies the fair value becomes difficult to determine on the relevance and reliability in the financial statements as well as on the feasibility of accounting estimates.
Impact of Financial Reporting Standards on the relevance of financial information in Mexico	Vásquez Quevedo Noemí	Mexico 2013	Evaluate whether the relevance of the financial information has been impacted by the changes that CINIF has incorporated to the Financial Reporting Standards.	n = 41 companies listed on the BMV.	The research is exploratory and correlational, since it seeks a cause-effect relationship between the	The effects incorporated in the financial statements from the International Financial Reporting Standards have an impact on the market value of the largest companies.

					study variables.	
Managerial discourse in financial statement communication. The case of two Chilean companies	Alvear Sandra & Tello José	Chile 2014	Identify, describe and understand the function of the managerial discourse expressed in the letter of presentation of the financial statements.	Corporación Nacional del Cobre and Compañía Manufacturera de Papeles y Cartones, S.A.	Transversal discourse analysis, based on lexical identification.	The discourse presented by the managers on the financial statements seeks to justify the results obtained with the context faced by the company.
Financial statement audit for tax purposes: legal nature, evolution and inconsistencies	Yáñez Jorge & Ávila Héctor	Mexico 2015	To analyze the presumption of veracity conferred to the tax report from the point of view of the duties of the SAT in its capacity as an auditing body.	n = 4,219 individual taxpayers.	Documentary-empirical.	The basic financial statements are the tool for the effective and efficient evaluation of a company's performance and the level of compliance with its tax obligations.
Internal audit and financial reporting	Gras Ester, et. al.	Spain 2015	Analyze whether the structure and characteristics of the	n = 63 entities of the Spanish	Review of previous	Companies with internal auditing present their financial statements with

weaknesses in the Spanish banking sector			IA affect the deficiencies in the accounting information.	Banking Association.	empirical work.	higher quality, as they are linked.
Is the reporting of results neutral?	Suarez Fernández Oscar	Spain 2016	Analyze the neutrality, the quality of the narrative information, focusing on a type of information that is particularly important for the user: the information on the company's financial results disclosed in the management report.	Companies listed on the General Index of the Madrid Stock Exchange 2007, 2008 and 2009.	Longitudinal or panel data.	In order to prepare financial reports, economic transactions must be analyzed objectively, and the presentation must be accurate, relevant and provide explanations rather than justifications.

Continued: Analysis of scientific databases on financial statements

Title	Author	Place and year	Target	Study sample	Type of study	Conclusion
-------	--------	----------------	--------	--------------	---------------	------------

Fuzzy logic and financial risk. A proposal of financial risk classification to the cooperative sector.	Díaz Jaime, et al.	Ecuador 2017	To observe the results of financial ratios with broad perspectives of analysis, showing results that are neither totally irrefutable nor totally non-existent.	Segment 1 cooperative Cooperativa Coprogreso, year 2015.	Case study.	A business tool is management control, used by organizations to evaluate their efficiency, including risk indicators, which are instruments applied to financial statements.
Effect of changes in accounting standards on the quality of information: a case applied to the Mexican real sector.	Garza Sánchez Héctor, et al.	Mexico 2017	Analyze whether changes in accounting regulations improve the valuation relevance of financial information in companies.	n= 141 companies, period from 2000 to 2013.	Quantitative.	Shareholders base their future investments on the accounting information provided by managers, while at the same time evaluating financial performance, which is generally sustainable over time.
Analysis of the application of Accounting Standards and Principles in determining the	Amasifuen Reategui Manuel	Peru 2019	Analyze the application of accounting standards and principles in determining the reasonableness of the	Northeastern Adventist Educational Association.	Descriptive, non-experimental.	The financial statements present quantitative and qualitative information and the criteria for recognition of the

reasonableness of the financial statements of the Northeastern Adventist Educational Association.			financial statements of the Northeastern Adventist Educational Association.			elements of the financial statements.
Hedge accounting: formality to avoid asymmetries or correlation principle?	Sánchez Castaños Leopoldo	Peru 2019	Analyze what hedge accounting consists of, based on the Conceptual Framework for financial information issued by the IASB.	IAS 39.	Documentary-descriptive.	Hedge accounting should not be optional, as this is detrimental to the comparability of the financial information of the different entities.
Environmental accounting and corporate social responsibility in the global sustainable development landscape	Herrera Avellan & Alexandra Nilda	Ecuador 2019	Conduct a descriptive analysis of the implementation of national environmental accounting in Ecuador and its relationship with corporate social responsibility processes that contribute to the achievement of the	Source documents.	Descriptive and a bibliographic type of research.	Accounting not only informs about the economic wealth of a company, it also includes social and environmental wealth, therefore, it analyzes the positive or negative impacts of the use of its resources; directed to the qualitative and quantitative valuation

			Sustainable Development Goals.			of the management of governments and the business sector.
Economic and financial analysis of the Hotel Cabañas Balandra in the city of Manta, 2017-2018.	Toala Susy, et. al.	Ecuador 2020	Improve and make timely and sound decisions of sound management.	Hotel Cabañas Balandra.	Quantitative.	Financial tools provide quantitative information in the analysis of the company's economic performance information obtained from balance sheets and financial statements.
Application of Financial Indicators and Value Inducers as a Tool for Optimizing Strategic Business Decisions	Narea Chumbi Patricia & Guamán Tenezaca Guillermo	Ecuador 2021	Analyze the application of financial indicators and value drivers to evaluate the economic and financial situation of the company that contribute to the generation of business value.	n = 34 companies in the Commercial Sector.	Quantitative, explanatory in scope and non-experimental design.	Financial analysis and value drivers are complementary to each other; it is not certain that the traditional study should be left aside to analyze the financial health of an entity.

There is a variety of international research related to finance linked to financial management tools due to their relevance within companies. The research analyzed in the previous section allows us to emphasize three issues: accounting, financial statements and analysis of financial statements as tools aimed at strengthening and developing micro, small, medium and large companies. 1) Accounting should not be applied only as a legal aspect, in the case of Ecuador as a tax aspect (Romero et al., 2022).but as an imperative need in any company, regardless of its size, corporate purpose or capital constitution. In this line, it can be argued that accounting is a process that provides five financial reports (IAS 1, 2001) statement of income for the period, statement of financial position, statement of cash flow, statement of changes in equity and report to the financial notes; which serve as the basis for the application of any financial analysis in the evaluation of the management of the administrators and quantification of their results, for any user, in the decision making process. Considering that the decisions are linked to the achievement of objectives such as higher profitability for its shareholders or owners, maximizing the growth of the company, social and environmental wealth (Avellán Herrera, 2019)accounting describes and predicts qualitatively and quantitatively the current situation and economic evolution of companies (Pineda et al., 2022).In other words, it is an information system that can be qualified as a financial tool for microenterprise development and strengthening.

Likewise, financial information has been a matter of concern throughout the world since globalization and the free market have opened the doors for it to be consolidated universally through the International Financial Reporting Standards and International Accounting Standards.

(Campoverde et al., 2022).. 2) financial statements are the reflection of the transactions linked to the accounting process, therefore, it is the basic financial instrument that every type of company must obtain; (Elizalde, 2019) through these, the management proposes a value judgment in relation to the management in the different departmental areas. This basic information must reasonably present the financial situation, financial performance, cash inflows, cash outflows and reliably present the economic facts (Estupiñán, 2017).

The analysis of financial statements is based on the responsibility to give a financial response to the economic reality of a company. 3) The interpretation and analysis of financial statements, constitute a mental action that consists in the use of accounting data to discover and reveal economic facts both past and future in relation to the economic activity (Alarcón & Ulloa, 2018); at the same time its importance lies in applying finance as a management tool in the control of economic resources; since, money is the main interest for liquidity in companies.

Conclusions

According to the discussion with other authors and the comparison of the results obtained in this research, it is determined that finance from its beginnings to the present has been considered fundamental for business performance and growth. Regardless of their size, companies should apply financial tools, regardless of their tax status, to show their economic and financial situation in order to make decisions. In the current context of the competitive free market, the use of financial tools is not an option, on the contrary, they are an obligation for the achievement of the objectives and goals set, as well as for those companies that have the vision to develop and grow. Considering the

structure of microenterprises, including the volume of their gross income, as a financial tool they must apply accounting according to their operations and not fiscal accounting. Given the limitations that have been mentioned, the development of flexible, dynamic and easy to understand financial tools for the microentrepreneur in the management of their resources is proposed for future research as an alternative to the application of international financial reporting standards for microenterprises, given their representativeness in Ecuador, Latin America, the Caribbean and the world.

References

- Alarcón, A., & Ulloa, E. (2018). Financial statement analysis: role in managerial decision making. *ResearchGate*.
<https://www.researchgate.net/publication/239950588>
- Arguello, A. M., Torres, L. H., Balón, I. D., Quito, C. E., & Llumiguano, M. E. (2020). Financial accounting management system for effective decision making by small and medium Ecuadorian companies, case study. *Revista Espacios*, 41(5), 1-13.
<http://www.revistaespacios.com/a20v41n05/a20v41n05p01.pdf>
<http://www.revistaespacios.com/a20v41n05/a20v41n05p01.pdf>
- Armijos, J., Narváez, C., Ormaza, J., & Erazo, J. (2020). *Financial management tools for MSMEs and popular and solidarity economy organizations*. 6, 466-497.
<https://dominiodelasciencias.com/ojs/index.php/es/article/view/1156/pdf>

- National Assembly of the Republic of Ecuador (2010). *Organic Code of Production, Commerce and Investments*, COPCI. <https://www.correosdeecuador.gob.ec/wp-content/uploads/downloads/2018/11/COPCI.pdf>
- National Assembly of the Republic of Ecuador (2011). *Reglamento de Inversiones del Código Orgánico de la Producción*. Servicio de Rentas Internas, Executive Decree 757. <https://www.produccion.gob.ec/wp-content/uploads/2019/05/Literal-3.-Reglamento-del-Codigo-Organico-de-la-Produccion-Comercio-e-Inversiones-COPCI.pdf>
- National Assembly Republic of Ecuador (2019). *Organic Law of Simplification and Progressivity of Taxation*. http://gobiernoabierto.quito.gob.ec/Archivos/Transparencia/2019/12diciembre/A2/ANEXOS/PROCU_LOSPT.pdf
- Avellán Herrera, N. A. (2019). Environmental accounting and corporate social responsibility within the global landscape of sustainable development. *ECA Sinergia*, 10(2), 105. https://doi.org/10.33936/eca_sinergia.v10i2.1596
- Campoverde, D., Yáñez, M., Orellana, B., & Delgado, R. (2022). IFRS guidelines for SMEs issued by IASB in microenterprises in the province of El Oro. *Revista Científica Cultura, Comunicación y Desarrollo*. <https://rccd.ucf.edu.cu/index.php/aes/article/view/369/390>
- Carchi, K., Juca, F., Delgado, R., & García, S. (2021). Strategic cost model a competitive advantage of sustainability for banana production. *Revista*

Metropolitana de Ciencias Aplicadas.
<https://remca.umet.edu.ec/index.php/REMCA/article/view/452/470>.

Cohen, Marcos; Baralla, G. (2012). The situation of SMEs in Latin America. *IERAL, of Fundación Mediterránea*, 114, 1-25.
[https://www.ieral.org/images_db/noticias_archivos/2157-La situaci3n de las Pymes en Am3rica Latina.pdf](https://www.ieral.org/images_db/noticias_archivos/2157-La_situaci3n_de_las_Pymes_en_Am3rica_Latina.pdf).

International Accounting Standards Board [IAS 1] (2001). *Presentation of Financial Statements*.
<https://onx.la/ee9d4>

International Accounting Standards Board [IAS 7] (2001). *Statement of Cash Flows*. <https://onx.la/6362e>

Andean Development Corporation (2013). *Entrepreneurship in Latin America. From subsistence to productive transformation*.
<https://www.caf.com/es/actualidad/noticias/2013/07/emprendimientos-en-america-latina/>

Correa, F., Leiva, V., & Stumpo, G. (2018). MSMEs and structural heterogeneity in Latin America. *Economic Commission for Latin America and the Caribbean (ECLAC)*, October, 13-44.
https://www.researchgate.net/publication/328314810_Mipymes_y_heterogeneidad_estructural_en_America_Latina

Crespo, M., Carchi, K., Zambrano, Á., Orellana, D., & González, S. (2020). Continuous improvement in the accounting process and its contribution to the competitiveness of MSMEs in the province of El Oro Ecuador. *ISSN*, 41.

<https://www.revistaespacios.com/a20v41n01/a20v41n01p03.pdf>

Del Valle, S., & Schemell, M. E. (2011). *Development and evolution of finance*. Acta Odontologica Venezuela.

Delgado, R. M., Yáñez, M. M., Orellana, B. L., Camacho, J. M., & Espinoza, K. E. (2021). Cost accounting as a management tool in the microenterprise Yoha's Style. *ConcienciaDigital*, 4(4.2), 60-76. <https://doi.org/10.33262/concienciadigital.v4i4.2.1940>. <https://doi.org/10.33262/concienciadigital.v4i4.2.1940>.

Delgado-Olaya, R., Zambrano-Morales, A., Guamarriga-Valdez, K., & Sánchez-Valle, P. (2022). Tax policies and access to credit in the province of El Oro, microenterprise sector, period 2014-2019. *Innova Research Journal (January-April)*, 7(1), 123-139. <http://revistas.uide.edu.ec/index.php/innova/index>. <http://revistas.uide.edu.ec/index.php/innova/index>

Elizalde, L. (2019). Financial statements and accounting policies. *593 digital Publisher CEIT*, 5-1(4), 217-226. <https://doi.org/10.33386/593dp.2019.5-1.159>

Estupiñán, R. (2017). *Basic Financial Statements under IAS/IFRS*. <https://www.ecoediciones.com/wp-content/uploads/2017/07/Estados-financieros-basicos-bajo-NIC-NIF.pdf>

Ferruz Agudo, L. (2000). *History of the theory of financial decisions*. [On Line] 5campus.Com, Financiación e Inversión. <http://www.5campus.com/leccion/fin016>

- Flores, M. T., Ramírez Urquidy, M., & Aguilar Barceló, J. G. (2016). Social-based microenterprises and their chances of survival. *Scielo. Org. Mx*, 61, 551-567. <https://doi.org/http://www.scielo.org.mx/pdf/cya/v61n3/0186-1042-cya-61-03-00551.pdf>
- Flórez Ríos, L. (2008). Evolution of Financial Theory in the 20th Century. In *Cinzia Ollari* (Issue 27). <https://www.redalyc.org/pdf/3290/329027263004.pdf>
- García, D., Gálvez, E., & Maldonado, G. (2016). Effect of innovation on the growth and performance of MSMEs in the Pacific Alliance. An empirical study Domingo. *Estudios Gerenciales*, 32(141), 326-335. <https://doi.org/http://dx.doi.org/10.1016/j.estger.2016.07.003>.
- Gil, J. M. (2020). Accounting determinism in complexity: introductory hypothesis. *Administrative Sciences*, 16, 068. <https://doi.org/https://doi.org/10.24215/23143738e068>. <https://doi.org/https://doi.org/10.24215/23143738e068>
- National Institute of Statistics and Census (INEC). (2020). *National Institute of Statistics and Census [INEC]. Business Directory*. https://produccion.ecuadorencifras.gob.ec/geoqlik/proxy/QvAJAXZfc/opendoc.htm?document=empresas_test.qvw&host=QVS%40virtualqv&anonymous=true
- López, A. de P., & Ferruz, L. (1996). *Finanzas de empresas* (C. de E. R. ARECES, Ed.).

https://books.google.com.ec/books?id=5lenDAAAQBAJ&printsec=frontcover&hl=es&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

Mariño, G., & Medina, I. (2009). Financial management: a utopia in microenterprises. *Criterio Libre*, 7(11), 123-144.

<https://biblat.unam.mx/hevila/Criteriolibre/2009/vol7/no11/5.pdf>

Mayor, I., & Saldarriaga, C. (2016). *Cash flow as a financial planning tool for the company x*.

https://repository.upb.edu.co/bitstream/handle/20.500.11912/9346/Flujo_efectivo_herramienta.pdf?sequence=1&isAllowed=y

Mir Fernández, C. (2008). Financial derivatives and the statement of comprehensive income. *Universo Contábil magazine*.

<https://www.redalyc.org/articulo.oa?id=117015194007>

Molina, R., López, A., & Schimtt, C. (2016). Factors influencing entrepreneurship problems in MSMEs: an expert perception. *International Journal Management and Finance*, 9(1), 95-113.

https://www.theibfr.com/download/riaf/2012-riaf_2/riaf-v9n1-2016/RIAF-V9N1-2016-7.pdf.

Pereira Bolaños, C. (2019). Actualidad de la Gestión Empresarial en las PYMES. *Revista Científica de Contabilidad, Apuntes Contables*, 39-53.

<https://revistas.uexternado.edu.co/index.php/contabilidad/article/view/5982>.

<https://revistas.uexternado.edu.co/index.php/contabilidad/article/view/5982>

- Pineda, D. Y., Vacca, M. A., & Tiuzo, S. C. (2022). The change of accounting regulations in Colombia and its effect on financial decision making. *Información Tecnológica*, 33(2), 49-58. <https://doi.org/http://dx.doi.org/10.4067/S0718-07642022000200049>
- Romero, M., López, G., Delgado, R., & Carchi, K. (2022). Cost accounting as a management tool for the development of microenterprises, shrimp sector. *Revista Científica Cultura, Comunicación y Desarrollo*. <https://rccd.ucf.edu.cu/index.php/aes/article/view/374/395>.
- Saavedra, M. L., Tapia, B., & Aguilar, M. de los Á. (2016). Financial management in SMEs in the Federal District, Mexico. *Revista Perspectiva Empresarial*, 3(2). <https://revistas.ceipa.edu.co/index.php/perspectiva-empresarial/article/view/107/50>. <https://revistas.ceipa.edu.co/index.php/perspectiva-empresarial/article/view/107/50>
- Sampieri, R., Fernández, C., & Baptista, P. (2014). *Research Methodology*. <http://observatorio.epacartagena.gov.co/wp-content/uploads/2017/08/metodologia-de-la-investigacion-sexta-edicion.compressed.pdf>
- Santana, L. (2017). Determinants of microenterprise survival in Bogotá: an analysis with duration models. *INNOVAR Journal*, 27. <https://doi.org/10.15446/innovar.v27n64.62368>. <https://doi.org/10.15446/innovar.v27n64.62368>

- Server Izquierdo, R. J. (2003). The profit and loss account. Operational conceptual components and specific rules for its formulation, within the scope of the "Draft rules on the accounting aspects of cooperative societies." *Journal of Public, Social and Cooperative Economics*.
- Tarí, J. J., & García, M. (2013) Can knowledge management influence business performance? *Cuadernos de Gestión*. <https://doi.org/10.5295/cdg.100263jt>
- Taxis, M., Ramírez, M., & Aguilar, J. (2016). Social-based microenterprises and their chances of survival. *Contaduría y Administración*, 61(3), 551-567. <https://doi.org/http://www.scielo.org.mx/pdf/cya/v61n3/0186-1042-cya-61-03-00551.pdf>
- Vega Alvear, S., & Tello Ávila, J. (2014). Managerial discourse in the communication of financial statements. The case of two Chilean companies. *Contaduría y Administración*, 59(3), 261-283. [https://doi.org/10.1016/S0186-1042\(14\)71272-0](https://doi.org/10.1016/S0186-1042(14)71272-0).

Effects of electronic invoicing, micro- enterprise sector in the province of El Oro

Martin Andres Romero Lalangui

Bachelor's Degree in Accounting and Auditing,
Universidad Metropolitana del Ecuador
martin.romero.l@est.umet.edu.ec
<https://orcid.org/0000-0002-7465-618X>

Ruth Maryury Delgado Olaya

Master's Degree in Accounting and Finance, Universidad
Metropolitana del Ecuador
rdelgado@umet.edu.ec
<https://orcid.org/0000-0001-7159-3729>

Mariana Marisol Yanez Sarmiento

Master's Degree in Taxation and Finance, Universidad
Metropolitana del Ecuador
mariasolyanez@hotmail.com
<https://orcid.org/0000-0002-1284-1478>

Kenia Lizzeth Carchi Arias

Master's Degree in Accounting and Finance, Universidad
Metropolitana del Ecuador
kcarchi@umet.edu.ec
<https://orcid.org/0000-0003-4023-4015>

Angel Alberto Zambrano Morales

Master SCIENTIAE in Applied Statistics, Metropolitan
University of Ecuador
angelz31@gmail.com
<https://orcid.org/0000-0002-7897-7327>

Introduction

In the course of the last three decades, continuous industrial, technological and digital progress has meant that today companies and institutions, both public and private, support several of their activities and production processes with the use of computer tools and Information and Communication Technologies (ICTs), which have caused a worldwide revolution, streamlining business, crossing borders and promoting real-time connection in the personal sphere, in educational institutions, economic entities and government administrations (Tosca et al., 2021). Technology is here to stay since the emergence of the COVID-19 pandemic, so that several micro, small and medium-sized businesses were forced to become technologically advanced as a means to generate income.

Based on new technological innovations, electronic invoicing was born as a response to the prevailing concern of the tax administrations to have an effective tool to control compliance with the formal duties of taxpayers (González et al., 2016); being an advanced complementary application, based on new information transmission techniques through the use of the Internet, which reduces the disbursements associated with the manufacture, sending and storage of paper, reduces administrative expenses in companies, suppresses the rate of informality and tax evasion, promotes economic integration between distant areas and, in general, is a boost to business, government and environmental sustainability of nations.

At a global level, electronic invoicing represents not only a tool for controlling information at a fiscal level, but also a step in the direction of adapting new technologies organically in the business community; moreover, it is a progressive orientation towards the digitalization of

business operations in society (Delgado & Oliver, 2017). In this sense, in the context of the European Union, electronic invoicing has been promoted and developed for some time, having established a legal reference framework for its issuance and financing new improvement projects in the system, with greater economic, social and environmental sustainability (Kuehne et al., 2017). Similarly, in North American countries such as the United States and Canada, the initial adoption phase of this tool has already been overcome (Koch, 2019); however, work is still being done on the development of standardized Electronic Data Interchange (EDI) formats, where it is possible to transmit information instantaneously from one computer to another. The results of the implementation of the system can be summarized as: favoring the comparability of information of the tax administration, optimizing the flow of information between companies and the tax collection agency, and reducing costs through the automation of processes, among other associated benefits.

At the Latin American and Caribbean level, electronic invoicing has been introduced in at least 10 economies in the region, with Chile, Brazil and Mexico being the leading countries in its adoption, providing various benefits both to their tax administration and to the companies on which this policy is aimed (Díaz & Rodríguez, 2020). According to Rojas (2019), some of its effects are reflected in: lower administrative costs, better integration of billing systems, improved accuracy and security of information, increased tax collection and lower consumption of paper and electricity.

In Ecuador, the leap from paper to electronic invoicing began in 2009 (Días et al., 2016), when the tax administration communicated to citizens the main rules to be followed in the issuance of sales receipts, withholdings

and complementary documents, for anyone wishing to join this new system. Subsequently, in 2013 (Cabezas & Andrade, 2021) the first progressive calendar of obligatory incorporation to the electronic invoicing system of the Internal Revenue Service (hereinafter SRI) was issued, being the issuers and administrators of credit cards, financial institutions regulated by the Superintendence of Banks, special taxpayers with economic activities of telecommunications and paid television, in addition to exporters qualified as special, the first to be obliged to invoice electronically (SRI, 2022a).

Currently, the last communiqué issued on the maximum deadlines that taxpayers have to comply with the electronic invoicing system was determined in Resolution No. NAC-DGERCGC22-00000024 (2022), specifying in its article 2 the following:

Individuals and companies that are not considered taxpayers of income tax but that: i) are obliged to invoice, and ii) that at the effective date of this Resolution, are not yet obliged to issue sales, withholding and complementary documents in the electronic modality, in application of the respective resolutions issued by the Internal Revenue Service, must also incorporate this type of scheme to their activity until November 29, 2022 (p. 3).

It is important to note that in the country, electronic invoicing is a relatively recent innovation in the tax system, which has not yet been adopted by most of the nation's micro and small companies (Tómala et al..., 2021), but which is progressively transforming the transaction processes and granting the IRS greater control power in the exercise of tax collection, and the elimination of informality as is the case of the popular economy sector and the so-called tax category of natural persons obliged and not

obliged to keep accounts, which involves microenterprises (Salazar et al., 2020).

During the year 2020 in Ecuador, microenterprises accounted for 91.9% of businesses; a representative percentage in the country's economy; at the same time, contributing to 26.3% of employment at the national level (Delgado et al., 2022). In the case of the province of El Oro, the situation is even more acute, since one of the direct consequences left by the Covid-19 pandemic has been a large reduction in formal commerce and an increase in informal business activities, a fact that has had a profound impact on the levels of revenue collection in the territory, since the province of El Oro is the 5th with the 5th largest national tax contribution and in its urban core concentrates 45% of productive activities (Yáñez et al., 2022). In addition to this, the high levels of informal commerce have led to greater chaos due to the large amount of waste generated by this type of uncontrolled business, affecting the environmental sustainability of the sector (González et al., 2017).

Based on the above, the effectiveness of electronic invoicing in the country has been proven, having increased VAT collection by 14% on those obliged to issue electronic vouchers, through the increase of subjective risk (Ramírez et al., 2018b); that is, the perception by the taxpayer that the SRI knows in real time the information of their transactions, prompting them to file returns with real information. In response to this, the State is better able to meet the needs of its population, ensuring equity, security and national autonomy, contributing to the development of the territory.

In addition, electronic invoicing is a tool that encourages the generation of new business opportunities through the

acquisition of technology, the hiring of professional tax consulting services and the reduction of manual work, resulting in greater availability of time to invest in the generation of products and services with higher added value, contributing to environmental preservation (Chica et al., 2020). Despite this, there is a conflict of criteria between those who see this tool as a burden that threatens the continuity of microenterprise activities and those who consider it an instrument that enhances the competitiveness of the sector. It is clear that for most of these establishments, the adoption of this type of technology is perceived as an unfavorable imposition (Haag et al., 2013), the origin of this idea, erroneous of course, is based on the fact that, to the extent that the control of the tax administration over the company's information is greater, the economic utility of the business will be lower, due to the apparent impossibility of using this system to record more expenses or less sales than those actually made. Experience makes it clear that although the main interested party in electronic invoicing is the tax collection agency, this does not mean that there are no other incentives for its adoption, such as the reduction of invoicing costs or the increase in administrative efficiency. In turn, a crucial element in the implementation of electronic invoicing (Laines et al., 2017) is that it serves as a tool to boost the modernization of the sector, facilitating the adoption of other ICT tools and thus optimizing its role in the economies.

The objective of this paper is to analyze the economic, social and environmental effects of electronic invoicing in the microenterprise sector as a tool for tax control and sustainable development in the long term, as a result of the mandatory provision of the tax administration. Additionally, this work is a contribution to the limited

literature available on the study of the effects generated by electronic invoicing in the microenterprise sector in Ecuador. This research is a product of the execution of the research project "Financial tools aimed at strengthening and development of microenterprises in the province of El Oro" of the Metropolitan University of Ecuador, Machala branch as a contribution from academia, research and linkage with society in the tax area, for the progressive implementation of digital technologies in governance and efficiency of the public sector.

Microenterprise

At the international level, there is still no consensus on what defines a microenterprise; however, in most countries it is described as a unit of economic exploitation, classified on the basis of minimum criteria of sales, number of workers, amount of assets, net worth and annual net income (González & Becerra, 2021). At the Latin American level, a fundamental aspect according to Correa et al. (2020), is their heterogeneity, since their management is usually based on the need for self-employment, most of them are informal, have low levels of human capital, have difficulties in accessing external financial resources, poor internationalization, are oriented to low productivity sectors and it is normal for them to carry out activities with low technical requirements.

In Ecuador, despite the fact that several organizations and regulations establish classification parameters for microenterprises (Gonzalo et al., 2018); the 2 main variables stand out based on the parameters adopted by the Andean Community of Nations (CAN), which are: number of workers between 1 to 9 and annual gross sales up to \$100,000.00.

Despite the difficulties that the microenterprise sector may face, it is the base that supports a large part of the jobs at the national level and its market share responds to 777,614 establishments (INEC, 2020). Their importance at the tax level corresponds to the amount of total sales they make, which at the end of 2020 were \$1,457,685,200 (only 1% of the national total), having collected \$20,377 million and \$18,501 million respectively in the Simplified Tax Regime (RISE) and the Microenterprise Tax Regime (RIM) for that year (Hidalgo et al., 2022; SRI, 2021).

Natural Person

When speaking of microenterprises at the fiscal level, it is almost inevitable to introduce the categorization that the tax administration dictates in this regard, segmenting businesses by legal units of natural persons or companies (Vera et al., 2019). In the case of natural persons, they are defined as a subject of a legal nature, which has the capacity to exercise and contract rights, as well as to comply with certain obligations.

In other words, a natural person is a resident or foreign individual who exercises a commercial activity in a personal manner within the national territory, becoming responsible for the commitments of the entity created, that is, its debt and capital.

The natural person in turn is segmented into those obliged or not to keep accounting, the characteristics that a natural person not obliged to keep accounting must comply with to be categorized as obliged according to art. 34 of the Regulation for the Application of the Organic Law of Internal Tax Regime (2020) will be:

- They operate with an equity capital that at the beginning of their economic activities or at January 1st of each tax year has exceeded USD 60,000.
- Their annual gross income from these activities in the immediately preceding fiscal year must have exceeded USD 100,000.
- Its annual costs and expenses, attributable to the business activity, of the immediately preceding fiscal year have been higher than USD 80,000.

In Ecuador, the main institutional form that most businesses maintain is that of a natural person not obliged to keep accounts, which is aligned with the weighting of the total number of microenterprises in the territory (Celi et al., 2019).

Electronic Invoicing

At the global level, there is no specific legislation regulating the issuance and control of electronic invoices, so it has been the responsibility of each regional bloc or country to formulate its own laws in this regard. From this point of view, there are various conceptions of what an electronic invoice is or is not.

According to Koch (2019), in the global context, the electronic invoice based on its legal meaning can be understood in 2 classifications, depending on whether the issued voucher adapts to the regulatory information requirements at a strict or broad level.

Table 1. Definition of electronic invoicing based on its legal meaning.

Electronic invoicing in the strict legal sense	Electronic invoicing in the broad legal sense
<p>Full content e-invoice (including at least 8-16 mandatory fields) and authentication of sender and recipient.</p> <p>Normally used by electronic accounting systems.</p> <p>Suitable for electronic transmission and automated processing.</p> <p>Although there may be paper representations of these, they will never be considered as original voucher.</p>	<p>"Simplified low value" e-invoice with reduced content requirements (typically only complying with 4-8 mandatory data fields) and no customer authentication.</p> <p>Customers can sometimes get them electronically by using the transaction code on the receipt.</p> <p>Some examples are payment receipts, airline, train or movie tickets, etc.</p> <p>They are not adapted for automated electronic transfer and process automation.</p>

Source: Adapted based on the book "The e-invoicing journey 2019-2025".

With respect to the Ecuadorian case, the Law of Electronic Commerce, Signatures and Data Messages (2014), defines the electronic invoice as:

Set of logical records filed in supports susceptible to be read by electronic data processing equipment that document the transfer of goods and services, complying with the requirements demanded by the Tax and Commercial Laws and other rules and regulations in force. (p. 18).

A more accessible definition is provided by Jurado (2017), who defines the electronic invoice as a magnetic document that must comply with the guidelines stipulated by the IRS and has the same validity as a physical receipt.

Social Effects

Electronic invoicing has become an instrument of competitive advantage for the company, by automating the processes of sending and processing receipts, offering greater security in the safekeeping of documents and generally reducing the administrative burden in terms of time, expenses and efforts (Oltra et al., 2020), although placing the smallest productive units in a situation of uncertainty, since a great pressure falls on them to overcome their limited culture of innovation, limited economic and human resources and knowledge on the subject (Angulo et al., 2016).

Even so, electronic invoicing systems benefit the tax administration and the companies that implement them, since due to their operability at a digital level, these technologies are a step in the direction of digitalization in the administration of the company, giving rise to obtaining and transferring clear, truthful and real-time information between the agents involved in the economy (González et al., 2016), also enabling the periodic monitoring of their purchases and sales for making the right decisions.

Consequently, one of the main goals of electronic invoicing has been to promote a reduction in penalties and tax

evasion, fostering a taxpayer culture of compliance with formal duties (Pozo et al., 2021).

Economic Effects

One of the major functionalities of electronic invoicing is to serve the interests of the tax collection agency (Antazu & Pezo, 2020) in the effective collection of taxes, reduce costs and increase productivity in the processes of the active subject through greater fiscal pressure. In addition to the foreseeable effects that electronic invoicing may have on national accounts, it has also been shown to bring about greater efficiency in companies' tasks, a reduction in their costs and an increase in savings (Tosca et al., 2021).

In Ecuador, the results of the study by Ramírez et al. (2022) state that as the coverage of the electronic invoicing system increases, so does the amount of taxes incurred, largely as a result of a greater risk perceived by the taxpayer and greater ease in complying with obligations, since all vouchers issued/received on behalf of the taxpayer are systematically registered in the tax administration's database, automatically integrating the values for vouchers issued/received, amounts registered and tax incurred, being only necessary for the taxpayer to verify the accuracy of the values.

The same relationship is present with respect to the variable of cost reduction in companies, since according to Laines et al. (2017), the electronic invoicing process with respect to the manual one means an approximate saving of \$0.20 per receipt, i.e. the higher the invoiced amount of a company, the higher the total amount saved in printing.

Environmental Effects

Similarly, the contribution of electronic invoicing systems to the preservation of the environment, through their

dematerialization function, leads to savings in paper, space and the reduction in the use of chemical substances for printing inks.

In the European context, research by Gomez (2010), states that as of 2008 "95% of European companies continue to print and send their invoices through traditional means, which... generates 2.7 billion euros per year in losses." (p. 28). In relation to this, it is also pointed out on the basis of the estimates of the FEPIME manual of Catalonia that during 2007, for every million electronic invoices issued, an average of 56 trees were avoided to be cut down.

In Ecuador, the SRI's web page (2022) reports daily the total number of electronic receipts issued and their equivalence to trees saved. As of August 22, 2022, a total of 13,602,097,796 electronic receipts have been issued (including invoices, credit and debit notes, remittance slips and withholding receipts), which translates into a contribution of 1,768,273 trees not cut down.

In general, the nature of the research is of a non-experimental type, since there was no deliberate manipulation of the data collected, with a mixed type approach, making use of both numerical and nominal evidence in the face of a problematic reality constituted by objective and subjective properties, based on: 1) the data between the years 2017-2021 from the SRI pages containing results in the application of the electronic invoicing systems of the microenterprise sector, which will be affected by the new impositions, and; 2) The information provided from the INEC database, taking into account the values of table 2 which categorizes the total number of companies in El Oro during 2012-2020 based on the type of legal unit. It can be seen that most of the companies in the province are categorized as microenterprises of natural persons

(85.60%); given this, the tendency of the work emphasizes a descriptive-correlational-projective study (Hernández et al., 2014).

Table 2. Tax categorization of the business sector in El Oro

Company Size	Individuals		Companies	
	N.	%	N.	%
Microenterprise	332.823	85,60%	16.631	4,66%
Small Business	21.092	5,91%	10.311	2,89%
Medium Company "A	1.912	0,54%	2.126	0,60%
Medium Company "B	833	0,23%	1.730	0,48%
Large Company	146	0,04%	1.215	0,34%
Total	356.806	92,32%	32.013	8,97%

Source: INEC Business Directory statistical database (2020).

The empirical study was developed in two phases. In the first quantitative phase, two multiple linear regression models were formulated to explain, on the one hand, the economic effect through the collection achieved from the level of physical and electronic invoicing; and, on the other hand, the environmental effect through the total number of trees saved per electronic vouchers issued, based on the number of electronic issuers. The second phase of the

qualitative work determines the social effects of electronic invoicing on microenterprises in the province of El Oro in the current period. The data collection was carried out through two surveys: 1) 130 micro-entrepreneurs from the database of the NAF Free Tax Advice office belonging to the Metropolitan University, Machala branch, and 2) 58 professionals from the Association of Accountants of El Oro, based on a non-probabilistic election criterion; whose information allowed analyzing the economic, social and environmental effects in this sector. SPSS version 22 and Microsoft Excel were used for data processing and interpretation. It should be noted that, due to the limitations that the SRI database maintains in relation to business classification, the present research takes into consideration a study of the microenterprise seen in relation to the type of legal unit of natural person.

Despite the relative significance between microenterprises and individuals, it should not be forgotten that the latter also include a smaller number of small, medium and large enterprises; therefore, the results of the regressions will also respond to the units of these organizations.

This first phase of the study proposes two multiple linear regression models, based on 5 variables of interest; analyzing the economic impact that electronic and physical invoicing may have on tax collection, as well as the environmental scope of this tool through the study associated with the number of trees saved in relation to the level of adoption of the system.

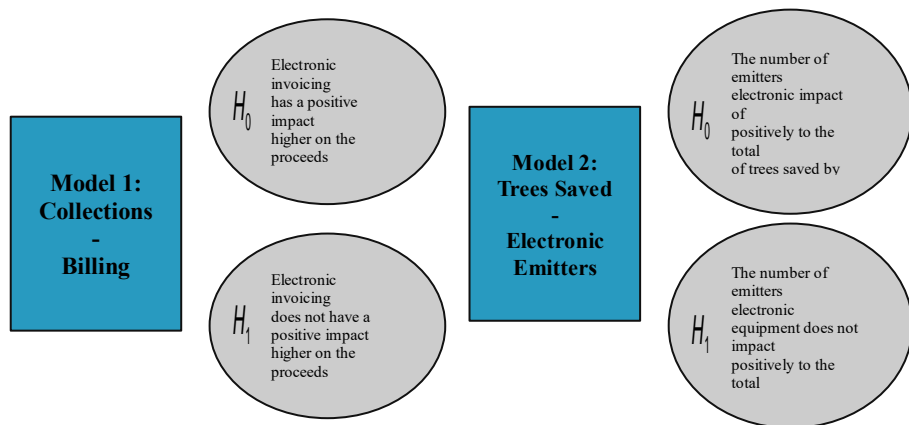
Table 3. Variables used in the regression models proposed.

Variable	Label	Detail
Collections	R	This is the total amount collected by the tax administration through taxes, fines and interest.
Index of electronic receipts issued	FE	It is the number of electronic receipts issued per total number of active businesses.
Index of printed physical authorizations	FF	This is the number of physical authorizations printed per total active business.
Trees Saved	Arb_{salv}	This is the calculation of the total number of trees saved based on the number of electronic receipts issued.
Electronic Emitters	Ems_e	This is the number of companies authorized by the tax administration to invoice electronically.

Source: Own elaboration based on information from SRI Datasets.

Based on these variables, the hypotheses proposed for both regression models are:

Figure 1. Hypotheses to be corroborated from the models presented.



Source: Own elaboration based on applied surveys.

The first step in the development of the model consisted of verifying that the means of the dependent variables studied maintain a significant difference, applying a T-test for independent samples. Thus, for table 4 The results of the T-test show a significance level (bilateral) < 0.05 for both the total collected based on the physical and electronic invoicing indexes, and for the number of trees saved by electronic issuers, grouped by individuals and companies. Consequently, it is affirmed that there is a significant difference between both variables.

Table 4.
Test of independent samples

		Levene's test for quality of variances		t-test for equality of means							
		F	Sig.	t	gl	Sig. (bilateral)	Difference in averages	Standard error difference	95% confidence interval of the difference		
										Inferior	Superior
Trees Saved	Equal variances are assumed	16,16	,000	-16,43	118,00	,000	-234,93	14,30	-263,25	-206,62	
	Equal variances are not assumed			-16,43	100,33	,000	-234,93	14,30	-263,30	-206,57	
Collections	Equal variances are assumed	,02	,881	-7,90	118,00	,000	-6556970	829999,6	-8200595	-4913345	

**Equal
variances
are not
assumed**

-7,90 75,24 ,000 -6556970 829999,6 -8210328 -4903612

Source: Own elaboration based on information from SRI Datasets.

Thus, for the approach of the first regression model, Table 5 gives a summary of the main results of the model from a linear regression of the origin, taking as the dependent variable the normalized value of revenue (*LOGR*) and as independent variables, the standardized values of the physical and electronic invoicing indexes (*LOGFF* y *LOGFE*). From the indicators obtained, an R-squared was found to have an explanatory capacity of 99.4% for the dependent variable, as well as a Durbin-Watson test <2.5, which reflects the non-existence of autocorrelation problems in the model.

Table 5. Summary of the first model

Model	R	R squared^b	Adjusted R-squared	Standard error of the estimate	Durbin-Watson
1	,997a	,994	,994	1,15453	,787

a. Predictors: *LOGFF*, *LOGFE*

b. For regression through the origin (the model without intercept), R-squared measures the proportion of the variability in the dependent variable about the origin explained by the regression. This CANNOT be compared to R-squared for models that include intercept.

c. Dependent variable: *LOGR*

d. Linear regression through the origin

Source: Own elaboration based on information from SRI Datasets.

Subsequently the table 6 determines the coefficients associated with the variables studied, which leads to the establishment of an equation type $Y = 1,89\ln(FE) + 3,65\ln(FF)$ which, when raised to Euler's constant, gives as a result $Y = FE^{1,89}FF^{3,65}$. The model obtained allows us to affirm that physical invoicing has a positive impact on the increase in tax collection, greater than that of electronic invoicing, since when FE varies by 1%, the variable R variable varies by 1.89%, while if the FF varies by 1%, R it will vary by 3.65%.

Table 6. Coefficients of the first model

Model	Unstandardized coefficients		Standardized coefficients	t	Sig.	Collinearity statistics	
	B	Standard error	Beta			Tolerance	VIF
1	LOGFE	1,894 ,158	,331	12,011	<,001	,072	13,962
	LOGFF	3,655 ,148	,681	24,761	<,001	,072	13,962

a. Dependent variable: LOGR[a][b]

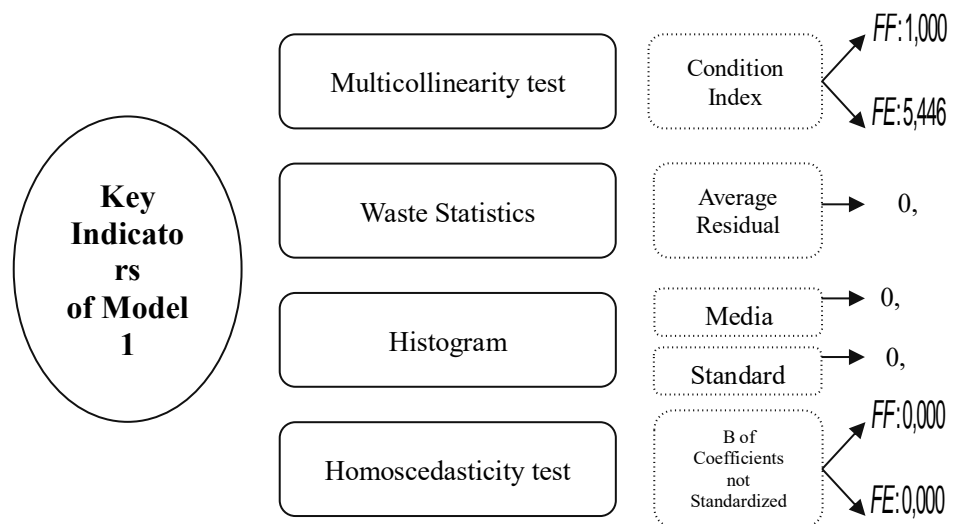
b. Linear regression through the origin

Source: Own elaboration based on information from SRI Datasets.

As a result of this first model, the null hypothesis is rejected and the alternative hypothesis is accepted as true, i.e., electronic invoicing does not have a greater positive impact on tax collection than physical invoicing at the level of individuals in El Oro.

Finally, when evaluating the proposed model based on its key indicators, Figure 2 shows that in principle, thanks to condition indices lower than 15, there are no problems of collinearity in the model, likewise the residual statistics point to a mean residual close to 0, predicting the dependent variable with high accuracy; which together with a B for unstandardized coefficients equal to 0, justify the principle of homoscedasticity and support that the variance is constant. The only principle that is not fulfilled is that of normality in the residuals of the model: nevertheless, it is normal that this factor is an exception for large samples such as that of the present model.

Figure 2. First model indicators for collinearity, homoscedasticity, normality and prognostication tests



Source: Own elaboration based on information from SRI Datasets.

From this first model, it can be inferred that, at the level of the province of El Oro, electronic invoicing has not yet achieved a high degree of acceptance by a large part of the microenterprise sector, since between 2017 and 2021 only small and medium-sized companies were obliged to issue them, and physical receipts continued to be issued as support for most transactions (SRI, 2022). Additionally, it is necessary to take into account that El Oro does not respond to an agglomeration economy, where the territories that concentrate most of the economic activities, and therefore those with taxpayers with higher invoicing amounts, are located in the provinces of Pichincha and Guayas (Urdaneta & Borucci, 2021).

On the other hand, the results of the second regression model, which studies the environmental impact that the level of adoption of electronic invoicing has on natural persons in El Oro, establishes, based on the indicators in table 7. The results of the second regression model, which studies the environmental impact that the level of adoption of electronic invoicing has on individuals in El Oro, establishes an R-squared that explains 97.4% of the dependent variable and a Durbin-Watson test of less than 2.5 for the absence of autocorrelation problems.

Table 7. Summary of the second model

Model	R	R square ^b	Adjusted R-squared	Standard error of the estimate	Durbin-Watson
1	,987a	.974	.974	0.76525	0.808

a. Predictors: LOG_Ems_e

b. For regression through the origin (the model without intercept), R-squared measures the proportion of the variability in the dependent variable about the origin explained by the regression. This CANNOT be compared to R-squared for models that include intercept.

c. Dependent variable: LOG_Arb_Salv

d. Linear regression through the origin

Source: Own elaboration based on information from SRI Datasets.

In the table **8** the coefficients associated with the variables studied are established, which leads to the establishment of an equation of the type $Y = 1,068 \ln(Ems_e)$ which, when raised to Euler's constant, gives as a result $Y = (Ems_e)^{1,068}$. The model obtained allows us to affirm that the level of adoption of electronic invoicing by natural persons has a

positive impact on the number of trees saved, since, when Ems_e varies by 1%, the variable Arb_{salv} varies by 1.068%.

Table 8. Coefficients of the second model

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.	Collinearity statistics	
		B	Standard error	Beta			Tolerance	VIF
1	LOG_Ems_e	1.068	.023	.987	46.963	<.001	1.000	1.000

a. Dependent variable: LOG_Arb_salv

b. Linear regression through the origin

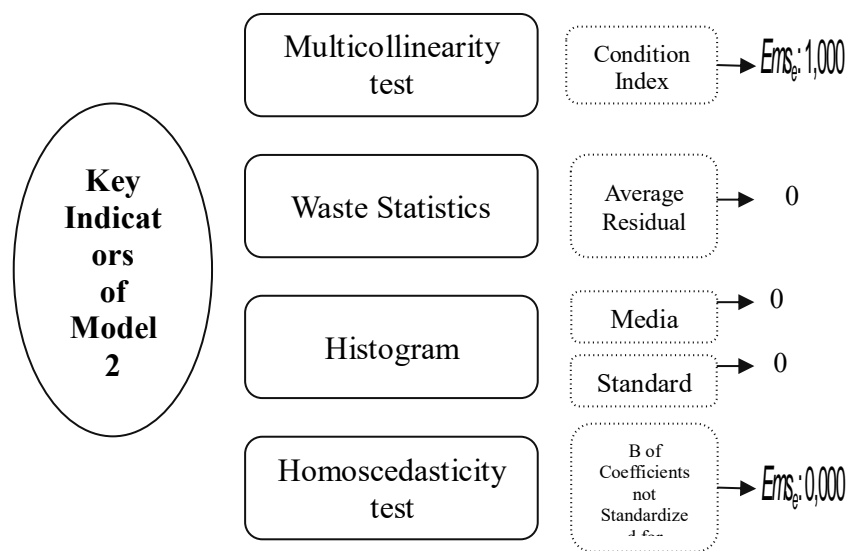
Source: Own elaboration based on information from SRI Datasets.

As a result of the second model, the null hypothesis is accepted as true, that is, to the extent that the coverage of the electronic invoicing system in microenterprises is greater, so will be the number of trees saved by electronic receipts.

Finally, Figure 3 shows that, in principle, thanks to condition indices lower than 15, there are no problems of collinearity in the model, likewise the residual statistics point to a mean residual close to 0, predicting with high accuracy the dependent variable; which together with a B for unstandardized coefficients equal to 0, again justify the

principle of homoscedasticity and support that the variance is constant.

Figure 3.
Indicators of the second model for collinearity, homoscedasticity, normality and prognostication tests



Source: Own elaboration based on information from SRI Datasets.

From the second model proposed, the approach of Laines et al. (2017) was emphasized, in which, depending on the volume of electronic documents issued, the savings generated by unused resources will increase. In the case of the SRI, this establishes a ratio of 7,693 electronic vouchers issued, which is equivalent to 1 tree saved by unused paper, also deriving in an elimination of the need to have physical spaces for the storage of vouchers at a minimum term of 7

years, as provided by the Regulation of Sales, Withholding and Complementary Vouchers.

Results of Surveys Applied to Microentrepreneurs and Accountants in El Oro

For the purposes of the second phase of the study, the analysis of the results will be divided into the interpretations that microentrepreneurs and accountants provide regarding the benefits, effects and consequences that the application of electronic invoicing brings to these small businesses, as seen through the use of bar and pie charts.

Microentrepreneurs

In the first instance, surveys aimed at the microenterprise sector are conducted to gather information directly from the subject of the research study, assessing its most notable characteristics and resolving the main effects of electronic invoicing based on the respondent's relative judgment.

It is observed that 69% of the micro-entrepreneurs surveyed are engaged in commercial activities since, at the level of the province of El Oro in 2020, it is the second activity with the highest market dominance, being that 38.5% of the companies perform them, only surpassed by the service sector with 39% (INEC, 2021); such situation is related to the emergence of the COVID-19 pandemic, where 66.93% of the respondents are women. In the study conducted by Borja (2015) it is agreed that 63% of microenterprises in Machala are women, excelling in business generation; it is evident that their insertion is key in labor participation in the orense economy and in the realization of plans for income and employment generation, respondents respond to a young age, as 58.91% have between 30 years or less. These results reflect how the

current generation looks to microenterprises as an opportunity to generate income.

It can be seen that 80% of respondents do not perform electronic invoicing, but with Resolution No. NAC-DGERCGC22-00000024 (2022) issued by the tax administration, they should begin to operate through this system as of November 30 of this year, depending on the size of the microenterprise and the flow of its activities. In this sense, the issuance of invoices varies, being able to reduce the company's expenses associated with supplies and materials; but on the contrary (Días et al., 2016) there will be greater difficulty in the group of microenterprises since they lack technology and internet access, in addition to maintaining a limited capacity in the use of software and ICTs.

Among the most notorious benefits perceived by microentrepreneurs in the application of this technological tool, as a component of the social effects, it points out that for 17.92% it translates into effective control of information, 16.98% into agility between supplier-client transactions, 15.09% into greater ease in complying with tax obligations and 13.21% into greater security in filling out, sending and safeguarding invoices. As stipulated by Cedillo et al. (2018), electronic invoicing systems are constituted as a safe and efficient way to streamline the invoicing processes in the company, offering greater control over their information and articulating a universal payment mechanism, the inquiry of the main effects that the adoption of electronic invoicing systems have on the microenterprise, it is found that 18.60% experience a streamlining of their administrative and managerial processes, as well as a reduction in environmental pollution; 15.12% indicated that there is no longer a need for storage space for receipts; 12.79% that it encourages the exploration of new e-

commerce opportunities; 11.63% that it improves integration between companies in distant areas and 10.47% that it increases the costs of implementing the system. It is noticeable that the modifications experienced by microentrepreneurs in their activities offer them an advantage in the market and contribute to the progressive disuse of paper and inks, contributing to the environment (Pozo et al., 2021), the most notable reasons why the tax administration promotes the adoption of electronic invoicing in the micro-enterprise sector (according to respondents) are 13.39% for the development of a tax culture, to facilitate audits of taxpayers, to promote economic and technological development in the country; 12.50% to reduce the margin of informality and 11.61% to increase the level of tax collection. As stated by Ramírez et al. (2022), the benefits perceived by the tax administration are recognized as the main motivators, although there is also room for understanding these systems as enhancers of business competitiveness (Tosca et al., 2021).

In addition to the responses from merchants who have already started their e-invoicing activity, the surveys also inquired about the resources available to microentrepreneurs who have not yet implemented this system, but could be ready to start using it.

In response to the micro-entrepreneurs who do not yet invoice electronically, the results show that only 11.35% have received training on the use of electronic invoicing and how to obtain an electronic signature; 8.51% on its advantages, disadvantages and its role as a competitive tool, 6.38% on the use of the SRI platform and training on the use of other systems offered by the market, while 48% have not received any training related to electronic invoicing. There is a lack of information on the relevance of the topic

in question, since it will be the means to support taxpayers' income.

Upon inquiring about the resources that microentrepreneurs have for the implementation of electronic invoicing, it was determined that at least 23.01% of them have an optimal Internet connection, 20.35% have computers, 18.58% have e-mail, 12.68% have contact with people trained in the use of an electronic invoicing system, 9.14% have defenses against viruses and spam in their devices, 6% have tools for the custody of their passwords, 4% have the SRI invoicing system, 3% know how to manage an electronic invoicing system and 2% have a private invoicing system. It is conceived that even though most microentrepreneurs have essential tools to start their incursion into electronic invoicing systems, several are unaware of the alternatives offered by the SRI in obtaining a free system and the learning guides for its use (Laines et al., 2017).

With respect to the competencies that the microentrepreneur maintains for the management of digital systems, the figure below shows that the microentrepreneur has the following skills, indicates that 26.37% know how to perform web searches, which gives them the power to perform self-inquiry regarding the use of invoicing systems, another 23.44% are proficient in the use of computers, 21.61% know how to use Microsoft Excel and 11.72% can navigate the SRI platform. The results obtained contrast with those of the research by Chavarría et al. (2017) where the majority of small traders have insufficient knowledge in the use of electronic invoicing systems.

Counters

From another point of view, the surveys aimed at accountants seek answers based more on the knowledge

and professional experience of the individual regarding the particular use of this technological tool.

In view of this, it is recognized that, of the total number of accountants surveyed, 58.62% intervene in the filling out of electronic invoices within the microenterprise, another 22.41% do it sometimes and 18.97% do not do it at all.

38.27% increase in the company's expenses associated with the adoption of the implementation, 24.69% decrease in administrative costs in the business, 12.35% increase in the payment of taxes, 8.64% increase in the company's savings capacity and 6.17% by favoring access to financing channels and attracting higher income due to increased productivity. At the level of capital, several agents are benefited, from the state, entrepreneurs and by extension their investors and workers, however, it is necessary to take into account the investment requirements to be made and their savings ratio per amount of turnover (Días et al., 2016). The alterations perceived in the operations of the microenterprise by the application of electronic invoicing are deepened, highlighting 18.39% of its contribution in the adoption of new technologies; 16.09% in the improvement of information control and management; 13.22% greater security in the integrity of the information and 10.34% by the adoption of new work methods by operational-administrative processes. As postulated by Hernández & Serrano (2009), the irruption of new technological instruments in the company entails structural changes in the way it operates and conceives the use of these and other ICT's also related to commercial activity, information and security. The main motivators of the tax administration for the implementation of the electronic invoicing system in the micro-enterprise sector, according to the accountant's opinion, were 25.6% to combat tax evasion; 19.64% to reduce informality in the micro-enterprise sector; 18.45%

to exercise better tax control; 15.48% to promote a culture of tax compliance; 11.31% to facilitate the SRI's auditing power and 5.36% as an environmental conservation policy. The impulse given to this issuance scheme is thus circumscribed to be one intimately rooted to tax compliance and environmental care in direct affectation of society (Ibeth, 2016).

Conclusions

The results of the first phase of the work delimit the study of the economic impact in the tax and environmental area that electronic invoicing has on micro-entrepreneurs, seen from the legal category of natural persons. On the one hand, the first regression model proposed satisfactorily explains the collection variable, affected by the physical invoicing index by 3.65% and electronic invoicing by 1.89% each time these vary by 1%, showing that physical invoicing still has a greater effect on collection than electronic invoicing; this fact is explained by the low level of adoption of the system among the micro-entrepreneurial sector in the province. On the other hand, for the second model proposed, it is found that the trees saved by electronic receipts issued are affected by 1,068% each time the number of certified electronic issuers varies by 1%; confirming that the greater the coverage of the invoicing system over the businesses, the greater will be the environmental impact prevented by trees saved.

In the second phase of the study, the qualitative results of the surveys of microenterprises and accountants contrast the inferences of the quantitative study in the first phase of the study, with the majority of the microentrepreneurs surveyed not being subject to the electronic invoicing system. While on the one hand, those who admit that they are not yet using electronic invoicing have sufficient

technological resources and knowledge to begin to familiarize themselves with the use of this tool, most of them are implementing these systems and recognize its benefits insofar as they agree that it optimizes several of the company's administrative operations, safeguards information more securely; Finally, it is emphasized that the main motivator is the IRS for making the use of this system mandatory, it favors their interests, enhances the functions of the companies and pushes the economic and technological development in general.

Therefore, the fundamental point for the adoption of electronic invoicing lies in the imperative need for microentrepreneurs to be trained in the proper use of this tool, for which, although the tax administration has carried out courses on its use, these have not had an adequate impact on the sector, because even though microentrepreneurs normally relate electronic invoicing with higher costs and taxes to be paid, the real benefits of its adoption become evident as soon as it is adopted.

On the other hand, accountants' notions differ slightly from those of micro-entrepreneurs; on the one hand, most of them are familiar with the use of electronic invoices and find that their economic effects respond to a greater need for investment in their adoption, which is compensated in part by lower administrative costs; additionally, the changes caused in micro-enterprises respond to an impulse in the adoption of new technologies, greater control and information security.

In this sense, the accountant as a business component that is directly related to electronic invoicing, conceives a form of investment that, in correspondence, favors benefits linked to the information of the company's transactions, facilitates the exercise of his profession, as well as that of

the tax administration for the suppression of informality by means of a strengthening of the tax culture.

References

- Angulo López, E., Flores Vizcarra, M., & Bernal Domínguez, D. (2016). TIC'S: Financing, Accounting and Electronic Invoicing in Mexico. *Revista Científica Teorías, Enfoques y Aplicaciones En Las Ciencias Sociales*, 9(19), 141-157. <https://revistas.uclave.org/index.php/teacs/article/view/1436>
- Antazu, A., & Pezo, L. (2020). Electronic accounting books and electronic invoicing as a trend in auditing. *Panel Revista de Administración y Economía*, 2(2), 52-69. <https://doi.org/10.33996/panel.v2i2.6>.
- Regulations for the Application of the Organic Law on the Internal Tax Regime, 159 (2020). https://www.gob.ec/sites/default/files/regulations/2020-10/Documento_reglamento_para_aplicacion_ley_de_reguimen_tributario_interno.pdf
- Borja Herrera, L. A. (2015). *Las Microempresas Comerciales: Categoría Tributaria en la Ciudad de Machala* (J. Maza Córdova (ed.); Primera). Universidad Técnica de Machala. http://www.uasb.edu.ec/UserFiles/381/File/MICRO_EMPRESAS_Y_MICROFINANZAS_EN_EL_ECUADOR.pdf.
- Cabezas Guilcapi, V. del R., & Andrade Rodríguez, J. M. (2021). Strengthening tax collection through the implementation of electronic invoicing. *Polo de*

Conocimiento, 6(3), 1617-1625.
<https://doi.org/10.23857/pc.v6i3.2457>

Cedillo, P., García, A., Cárdenas, J. D., & Bermeo, A. (2018). A Systematic Literature Review of Electronic Invoicing, Platforms and Notification Systems. *2018 5th International Conference on EDemocracy and EGovernment, ICEDEG 2018*, 150-157.
<https://doi.org/10.1109/ICEDEG.2018.8372338>
<https://doi.org/10.1109/ICEDEG.2018.8372338>

Celi Mero, L. del R., Cruz Álvarez, J. G., & Rositas Martínez, J. (2019). Impact of accounting information on the survival of family microenterprises in Ecuador. *VinculaTégica EFAN*, 2, 1450-1462.
http://www.web.facpya.uanl.mx/vinculategica/vinculategica_5_2/A.56.pdf
http://www.web.facpya.uanl.mx/vinculategica/vinculategica_5_2/A.56.pdf

Chavarría Hernández, E. J., Zamora Morocho, L. J., & Junco Avellán, W. W. (2017). Advantages and disadvantages of the implementation of electronic invoicing in Ecuador. *Reciamuc*, 1(4), 473-499.
<https://doi.org/10.26820/reciamuc/1.4.2017.473-499>.

Chica Calle, D., Cabrera Mejía, J., & Giler Escandón, L. (2020). Communication network that contributes to the issuance of electronic vouchers for municipal markets in the city of Cuenca. *Journal of Science and Research*, 5(3), 11-30.
<https://doi.org/10.5281/zenodo.3926886>
<https://doi.org/10.5281/zenodo.3926886>

Electronic Commerce, Signatures and Data Messaging Act,
19 (2014).
http://www.wipo.int/wipolex/es/text.jsp?file_id=243546

Correa, F., Leiva, V., & Stumpo, G. (2020). MSMEs and structural heterogeneity in Latin America. In M. Dini & G. Stumpo (Eds.), *Políticas para la inserción de las microempresas y las pequeñas y medianas empresas en cadenas globales de valor en América Latina* (p. 61). Economic Commission for Latin America and the Caribbean (ECLAC).
<http://hdl.handle.net/11362/4932>

Delgado García, A. M., & Oliver Cuello, R. (2017). The Immediate Supply of Information in value added tax. *IDP. Journal of Internet, Law, and Policy*, 25(25), 83-93. <https://doi.org/10.7238/idp.voi25.3113>.

Delgado Olaya, R. M., Zambrano Morales, A., Guamarriga Valdez, K., & Sánchez Valle, P. (2022) Tax policies and access to credit in the province of El Oro, microenterprise sector, period 2014-2019. <https://doi.org/10.33890/innova.v7.n1.2022.1973>

Días Córdova, J., Coba Molina, E., & Bombón Mayorga, A. (2016). Electronic invoicing versus classic invoicing. A study in financial behavior through case studies. *Revista Ciencia UNEMI*, 9(18), 63-72. <http://ojs.unemi.edu.ec/index.php/cienciaunemi/article/view/305/267>.
<http://ojs.unemi.edu.ec/index.php/cienciaunemi/article/view/305/267>

Díaz Delgado, P. A., & Rodríguez Cortés, A. (2020). *Characterization of schemes, standards and*

technologies for the implementation and security of electronic invoicing in real-time transactions in the cloud (Vol. 4, ISSUE 1) [Universidad Católica de Colombia].

<https://repository.ucatolica.edu.co/handle/10983/24909>

Gómez Meneses, F. E. (2010). *Electronic invoicing in Aragonese companies: Financial and technological profile and effects of the implementation* [University of Zaragoza].
<https://dialnet.unirioja.es/servlet/tesis?codigo=86739>

González Bolívar, Y., Marín Acevedo, F. N., & Karina Andrea, T. R. (2016). Main Effects Generated by the Implementation of Electronic Invoicing in SMEs. *Tecnológico de Antioquia*, 15(2), 42.
<https://dspace.tdea.edu.co/handle/tdea/1554>

González Díaz, R. R., & Becerra Pérez, L. A. (2021). SMEs in Latin America: classification, labor productivity, challenges and prospects. *CIID Journal*, 2(1), 570-608. <https://doi.org/10.46785/ciidj.v1i1.100>

González Ordóñez, A. I., Alaña Castillo, T. P., & Gonzaga Añazco, S. J. (2017). Environmental Management in the Competitiveness of SMEs in Ecuador. *INNOVA Research Journal*, 2(8.1), 236-248.
<https://doi.org/10.33890/innova.v2.n8.1.2017.371>

Gonzalo Chávez, C., Campuzano Vásquez, J., & Betancourt Gonzaga, V. (2018). Micro, small and medium enterprises. Classification for their study in the engineering career in accounting and auditing of the Technical University of Machala. *Revista Conrado*,

14(65), 247-255.
<https://conrado.ucf.edu.cu/index.php/conrado/article/view/842>

Haag, S., Born, F., Kreuzer, S., & Bernius, S. (2013). Organizational Resistance to E-Invoicing - Results from an Empirical Investigation among SMEs. *International Conference on Electronic Government, 8074 LNCS*, 286-297. https://doi.org/10.1007/978-3-642-40358-3_24. https://doi.org/10.1007/978-3-642-40358-3_24

Hernández Ortega, B., & Serrano Cinca, C. (2009). What induces firms to adopt electronic invoicing? Effect of perceptions and competitive environment. *Universia Business Review*, 4(24), 96-121. <https://journals.ucjc.edu/ubr/article/view/719>

Hernández Sampieri, R., Fernández Collado, C., & Baptista Lucio, M. del P. (2014). *Research Methodology* (M. Á. Toledo Castellanos (ed.); 6th ed.). Mc Graw Hill. <https://www.uca.ac.cr/wp-content/uploads/2017/10/Investigacion.pdf>

Hidalgo Achig, M. F., Salguero Núñez, C. S., Sánchez Pallo, E. R., & Sandoval Cárdenas, M. V. (2022). Tax regime for microenterprises and its impact on Ecuadorian tax collection. *Revista Venezolana de Gerencia*, 27(99), 1027-1042. <https://doi.org/10.52080/rvgluz.27.99.11>

Ibeth Tatiana, S. A. (2016). *Electronic invoicing and analysis of the factors that motivate its adoption in Ecuador* [Instituto de Altos Estudios Nacionales Universidad de Postgrado del Estado]. <https://repositorio.iaen.edu.ec/handle/24000/5911>

- National Institute of Statistics and Census (2020). *Tabulations of the Directory of Companies and Establishments, Year 2020* (p. 79). Business Directory.
<https://www.ecuadorencifras.gob.ec/directoriodeempresas/>
- National Institute of Statistics and Census (2021). Directory of Companies and Establishments 2020. In *Ecuador en Cifras*.
<https://www.ecuadorencifras.gob.ec//directoriodeempresas/>
- Jurado Matamoros, A. L. (2017). Analysis of the implementation of electronic invoicing in tax management as a tax collection instrument in Ecuador. *Universidad Espiritu Santo*, 7(1), 1-18.
[http://201.159.223.2/bitstream/123456789/1639/1/Análisis de la implementación de la facturación electrónica en la gestión tributaria como instrumento de recaudación de impuesto en el Ecuador.pdf](http://201.159.223.2/bitstream/123456789/1639/1/Análisis%20de%20la%20implementación%20de%20la%20facturación%20electrónica%20en%20la%20gestión%20tributaria%20como%20instrumento%20de%20recaudación%20de%20impuesto%20en%20el%20Ecuador.pdf)
- Koch, B. (2019). *The e-invoicing journey 2019-2025* (Billentis (ed.); May 2019). Comarch E-invoicing.
https://www.billentis.com/The_einvoicing_journey_2019-2025.pdf
- Kuehne, K., Guhr, N., & Breitner, M. H. (2017). Adoption Determinants of Xml-Based Invoices: an Exploratory Investigation. *International Journal of Business, Humanities and Technology*, 7(4), 49-56.
https://www.ijbhtnet.com/journals/Vol_7_No_4_December_2017/6.pdf
- Laines Álvarez, Y. M., Jarrín Salcán, M. E., & Davis Castro, D. (2017). Electronic invoicing in microenterprises

before the tax administration. *Conference Proceedings UTMACH*, 612-621. <http://investigacion.utmachala.edu.ec/proceedings/index.php/utmach>.

Oltra Badenes, R., Guerola Navarro, V., Stratu, D., Oltra Gutiérrez, J. V., & Gil Gómez, H. (2020). Analysis of electronic invoicing in the context of digital transformation in the European Union. *INNODOCT 2019*, 6(8), 939-950. <https://doi.org/10.4995/inn2019.2019.10944>.

Pozo Hernández, F. M., Aldaz Bombón, O. R., Cabezas Arellano, M. J., & Almeida Blacio, J. H. (2021). Analysis of electronic invoicing as a control mechanism and prevention of tax penalties. *Revista Universidad y Sociedad*, 13(S3), 437-446. <https://rus.ucf.edu.cu/index.php/rus/article/view/2502>.
<https://rus.ucf.edu.cu/index.php/rus/article/view/2502>

Ramírez Álvarez, J., Oliva, N., & Andino, M. (2018). Electronic invoicing in Ecuador: Impact assessment on tax compliance. *Inter-American Development Bank*, 33.

Ramírez Álvarez, J., Oliva, N., & Andino, M. (2022). Tax compliance and electronic invoicing in Ecuador: impact evaluation. *Problemas Del Desarrollo. Revista Latinoamericana de Economía*, 53(208), 97-123. <https://doi.org/10.22201/iiiec.20078951e.2022.208.69712>

Rojas Arias, J. C. (2019). The electronic invoice market - justification of its legal creation from the Economic

Analysis of Law. *Con-Texto*, 50, 17-36.
<https://doi.org/10.18601/01236458.n50.03>

Salazar Garcés, G. K., Cárdenas Guevara, E. T., Peñaherrera Veloz, H. L., Borja Mora, L. I., & Castro Villalva, C. R. (2020). Analysis of the decrease in the income tax base due to the effect of virtual stores in Ecuador. *Journal of Sustainable Development, Business, Entrepreneurship and Education*, 6, 37.
<https://www.eumed.net/rev/rilcoDS/06/tienda-virtual-ecuador.html>.
<https://www.eumed.net/rev/rilcoDS/06/tienda-virtual-ecuador.html>

Internal Revenue Service (2021). *Collection Statistics 2020*. Internal Revenue Service.
<https://www.sri.gob.ec/en/web/intersri/estadisticas-generales-de-recaudacion-sri>

Resolution No. NAC-DGERCGC22-00000024, 6 (2022).
<https://www.sri.gob.ec/en/facturacion-electronica>

Internal Revenue Service (2022a, May 27). *Taxpayers obliged to issue electronic receipts*. Electronic Invoicing.
<https://www.sri.gob.ec/en/contribuyentes-obligados-a-emitir-comprobantes-electronicos>

Internal Revenue Service (2022b, August 22). *Electronic Invoicing*. Invoicing.
<https://www.sri.gob.ec/en/facturacion-electronica>

SRI (2022, May 27). *Taxpayers obliged to issue electronic receipts*. Electronic receipts.
<https://www.sri.gob.ec/en/contribuyentes-obligados-a-emitir-comprobantes-electronicos>

- Tómala Pinto, J. J., Zambrano Loor, R. M., & Rivas Cedeño, L. L. (2021). Taxation and administrative efficiency in small and medium enterprises (SMEs), registered in the MIPRO of Manta canton, Manabí province. *Revista Científica Arbitrada De Investigación En Comunicación, Marketing Y Empresa REICOMUNICAR*, 4(8), 2-20. <https://doi.org/10.46296/rc.v4i8edespdic.0031>
- Tosca Magaña, S., Mapén Franco, F. de J., & Martínez Prats, G. (2021). Electronic invoicing as a tool to increase business productivity. *Investigación & Negocios*, 14(23), 6-15. <https://doi.org/10.38147/invneg.v14i23.124>. <https://doi.org/10.38147/invneg.v14i23.124>.
- Urdaneta Montiel, A. J., & Borucci García, E. V. (2021). Agglomeration economies and negative externalities in Ecuador, period 2007-2017. *Cuadernos de Economía*, 40(82), 165-191. <https://doi.org/10.15446/cuad.econ.v40n82.81058>.
- Vera Valdiviezo, N., De Pablos Heredero, C., & Bermejo Ruíz, J. M. (2019). Incidence of transaction costs in informal microenterprises. *Gente Clave*, 4(1), 61-87. <https://revistas.ulatina.edu.pa/index.php/genteclave/article/view/119>
- Yáñez Sarmiento, M. M., Orellana Arévalo, B. L., & Delgado Olaya, R. M. (2022). IFRS guidelines for SMEs issued by IASB in microenterprises in the province of El Oro. *Revista Científica Cultura, Comunicación Y Desarrollo*, 7(2), 126-133. <https://rccd.ucf.edu.cu/index.php/aes/article/view/369>

**Quality management and educational
innovation from postpandemica covid19:
Synchronous and asynchronous classes,
Ecuador.**

Frank Angel Lemoine Quintero

frank.lemoine@uleam.edu.ec ,
Universidad Laica Eloy Alfaro de Manabí "Bahía de
Caráquez Extension".
<https://orcid.org/0000-0001-8885-8498>

Lilia Monserrate Villacis Zambrano

PhD in Administrative Sciences, professor of Tourism at
the Universidad Laica Eloy Alfaro de Manabí, Extension
Bahía de Caráquez, **ULEAM**. Researcher accredited by
the SENESCYT. **liviza@hotmail.com**

María Gabriela Montesdeoca Calderón

Professor, Business Administration Career, Escuela
Superior Politécnica Agropecuaria de Manabí - Manuel
Félix López, Calceta, Ecuador.
magymontesdeoca@gmail.com , <http://orcid.org/0000-0003-4752-260X>

Introduction

Quality in the teaching process has brought Ecuador to direct studies aimed at the search for effective strategies that promote teaching and learning activities in the search for continuous improvement, especially in higher education. In 2009, the National Council for Evaluation and Accreditation (CONEA) carried out the first "university accreditation" and then transferred this activity to the Council for Evaluation, Accreditation and Quality Assurance of Higher Education (CEAACES) which created a table of categories as a kind of ranking that goes from "A" as the highest to "D" as the lowest. This review of university

management has been carried out in the years 2013, 2015 and 2016, in that path, as a result of these evaluations, as analyzed by. (Cardenas, 2016)

The accreditation processes in the first instance in 2009 were carried out only for general processes and basic infrastructure of the universities; this model was complemented with the publication of the Organic Law on Higher Education (LOES, 2010). (LOES, 2010) This model was complemented with the publication of the Organic Law of Higher Education (LOES, 2010), which implied an increase in the minimum quality standards that Ecuadorian universities should meet, not only in their infrastructure and internal management processes, but also in the relevance of their existence in certain geographic territories, the requirements of their teaching staff, student requirements for admission to university studies, even creating four public universities that constitute the paradigm of "high university quality" to which Ecuadorian universities should tend. (CACES, 2020)

In the pandemic situation, quality processes have been retaken, adapting the flexibility and curricular contextualization that should be considered as prioritization of learning objectives and contents that allow to achieve a better understanding of the crisis and to respond to it in the best way, concentrating on aspects related to care and health, critical and reflective thinking without leaving the demands and commitment of students to their classes, whether synchronous or asynchronous, it is true that we must strengthen behaviors of empathy, tolerance and non-discrimination, handling with balance the information that is received dynamically in the teaching-learning process.

(SIIES, 2019) aims to integrate the data required by the Council for Quality Assurance in Higher Education (CACES), the Secretariat of Higher Education, Science, Technology and Innovation (SENECYT) and the Council of Higher Education (CES), for their different purposes. It was born as a joint effort between the three governing bodies of higher education and higher education institutions, with the main objective of making efficient statistical management of information from higher education institutions, to serve both the purposes of public policy and research.

The institutional evaluation policy for universities and polytechnic schools is based on the analysis of previous evaluation processes of universities and polytechnic schools in the country, identifying the characteristics of each moment. Since the evaluation conducted by the National Council for Evaluation and Accreditation (CONEA), under the provision of the Constituent Mandate No. 14 and the successive ones conducted by CEAACES between 2011 and 2018; the priority objective, although not the only one, was the purification of the Higher Education System (SES) (CACES, 2019)

The transit through these experiences has allowed the current Council for Quality Assurance in Higher Education (CACES) to generate institutional reflections and lessons learned to improve the processes under its responsibility and to respond to the current needs of the country's SES. Based on these learnings, this paper presents a new policy approach to institutional evaluation of universities and polytechnic schools in the framework of the Interinstitutional Quality Assurance System (SIAC) conceived in the Organic Law Reforming the Organic Law of Higher Education (LOR LOES). (Horowitz, 2018)

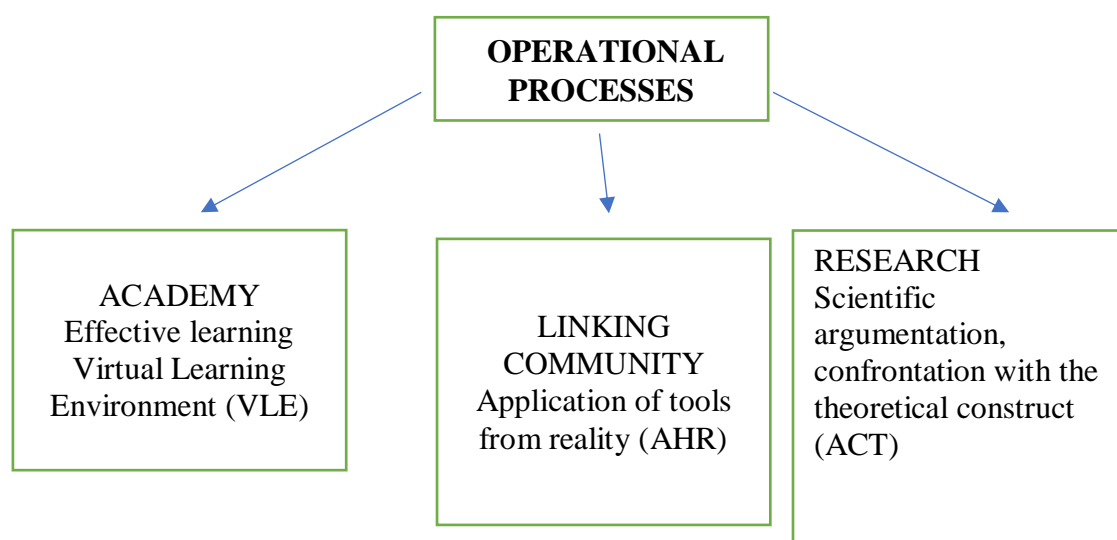
For (Véliz, 2018) it cannot be denied that the current educational situation presents radical changes in the higher education system in Ecuador; this implies for universities to comply with the standards and requirements demanded to ensure the academic quality of the offer of higher education services continue in the search for continuous improvement

We have to recognize that the pandemic has allowed to review methodology, pedagogy from the parameters of quality, to maintain an efficient education, for this certain parameters must be followed, which help to take into account the learning process from synchronous and asynchronous classes, within this context it should not be forgotten that Ecuadorian universities have been questioned by the low quality.

In this situation, questions arise from the configuration of the teacher regarding the preparation and prior knowledge in the use of digital resources and tools to develop a non face-to-face class, but it is also worth asking how the teaching-learning activity is being developed under the non face-to-face modality. In order not to lower the quality and at the same time be productive

The quality of management is being measured by the level of research that an HEI has and its scientific production, from a constructive critical reflection where the protagonist is the student, integrating the 3 substantive processes.

Figure 1: Educational training process



Source: Prepared by authors

Multiple studies show didactic strategies with synchronous and asynchronous activities in the learning of inorganic nomenclature where these didactic strategies applied in the teaching-learning process are mechanisms that allow students to take advantage of the knowledge imparted by the teacher and demonstrate absolute mastery, even more, in times of pandemic when classes were virtual. (Lara-Carrillo & Freire-Aillón, 2022,p.43)

(Stojanovic, 2008) address that communication and information technologies in education related to virtual teaching and learning environments are of great importance for the development of learning, this has been evidenced at present when (Morán et al., 2021) develop an analysis about synchrony and asynchrony activity in university education where they considered the relevance of thinking about transformations in educational scenarios as an alternative to the prevailing situation.

Although technologies have been changing all areas of life and education where a change has been manifested at the level of learning methods and didactics, generating increasingly interactive scenarios, it is important to investigate how the learning process of students evolves (Moreno et al., 2021). (Moreno et al., 2021)

It is recognized that the role of the teacher and the student in virtual education play an interactive role in order to carry out a dynamic and collaborative learning process where (Rizo, 2020) argues that the role of the teacher is fundamental for the success of the learning activity focused on the student and how the student, with his autonomy, can develop skills in the use of technological tools and management strategies that allow him to obtain knowledge and skills necessary in the professional field in which he is being trained.

Other studies conducted by (Machuca et al., 2021) state that in a face-to-face class the teacher makes use of words and paralinguistic functions to transmit the message that has a difference with virtuality because it contains a better interaction, communication and application of knowledge due to the use of technology where (Palma et al., 2021) in his study establishes to what extent technology impacts the synchronous and asynchronous teaching-learning process in the public universities of Manabí, noting that the higher the use of technology, the greater the impact on the synchronous and asynchronous teaching-learning process.

The Sucre Extension of the Universidad Laica Eloy Alfaro de Manabí under pandemic conditions adopted virtual learning policies where more than 450 students from different careers chose to face the current circumstances, teachers also opted for different virtual platforms to achieve learning objectives through asynchronous and synchronous

scheduled activities. In the 2022 educational period, the measures taken were strategically conceived to carry out a teaching-learning process that complies with the requirements, policies and laws in force at the institutional level in favor of the university community.

Among the disadvantages presented, the availability of technology prevails among the students, since they are considered low-income according to previous studies where 57.5% do not have a stable internet service and 81.7% do not have a telephone device that supports different applications to develop the teaching-learning process.

The objective of this study is to analyze the quality of educational management and innovation from postpandemic covid19 in terms of the effectiveness of synchronous and asynchronous activities developed at the university teaching level. It is also intended to determine how synchronous variables correlate with asynchronous variables to measure the level of students' perception of this learning modality.

The research study was qualitative and quantitative due to its characteristics and the context of the research object and field. The method used was the explanatory deductive method that allowed questioning the two moments of learning from the virtual modality considering the synchronous and asynchronous activities, the new connection scenarios between teachers and students.

The research work is carried out from the context of social isolation and from synchronous and asynchronous classes at the Universidad Laica de Eloy Alfaro Extension - Bahía - Manabi Zone 4, with 18 students of marketing, 16 students of tourism, 14 of hotel business administration and 17 of hospitality and hotel management, in total the sample was

of 64 students considering a simple non-probabilistic random sampling by convenience.

The instrument was designed based on reviews of similar studies where it was validated by a group of experts using the Delphi method. The use of the Likert scale was used to generate a better criterion of the results of the questionnaire. The survey was processed through SPSS v. 26 statistical software to measure the reliability of the instrument and verify the null hypothesis.

The survey applied was structured in two dimensions, the first one to measure the students' perception of the planned synchronous activities and a second dimension to measure the perception of the asynchronous activities in order to find out which of these is better accepted by the students. The reliability of the instrument is shown below.

Table 1. Reliability statistic study

<i>Parameters</i>	<i>Cronbach's alpha</i>	<i>Cronbach's alpha based on typed items</i>	<i>N of elements</i>
<i>Asynchronous activity</i>	,826	,829	6
<i>Synchronous activity</i>	,717	,713	6
<i>Both dimensions</i>	,718	,717	12

As can be seen in the table above the reliability results are considered acceptable according to verification of validation studies by the authors (Castillo-Sierra et al., 2018) being the best dimension the asynchronous one (.826) denoting that students have better perception of this dimension and better adaptation to this modality.

Among the studies carried out, the total statistic of elements of each of the dimensions was analyzed, where the asynchronous dimension yielded the following result:

Table 2. Total-element statistics

	Correlation element-to-total correlation corrected	Squared multiple correlation	Cronbach's alpha if the element is removed
How it evaluates the teacher's intervention in terms of effective asynchronous activity.	,730	,726	,767
How it evaluates the use and management of technology as a function of learning.	,732	,903	,765
How important is the audiovisual activity for you as	,501	,837	,816

part of the asynchronous training activities.			
That it is oriented duties to develop it asynchronously.	,497	,802	,818
How do you value the recorded webinars and classes oriented to your learning.	,577	,644	,808
In general, how do you value asynchronous activity for your learning?	,576	,897	,803

As can be seen, all of them yielded reliable results, but it is necessary to verify the results in frequency analysis to check certain criteria in the students' answers in order to manage that the asynchronous classes through seminars, workshops, together with the activities and assignments are effective.

Regarding how they evaluate the teacher's intervention in terms of an effective asynchronous activity, 28.1% chose the neutral option denoting insecurities in opting for another option, another 25% rated it as unimportant and 20% as not important at all, denoting shortcomings in the learning

processes of teachers in relation to students, where an alarming result is also evident in terms of how they evaluate the use and management of technology in terms of learning, where 31.3% of the students responded as unimportant and 29.7% as not important at all. 3 % of the students answered not very important and 29.7% not important at all, showing that 60.9% claim that the use and management of technology in function of the fulfillment of their activities have not been good, so it is determined that they have not been prepared to assume this modality in function of their effective learning activity.

With respect to how the audiovisual activity as part of the asynchronous activities is for them, the results were better since 43.8% remained neutral and 20.3% responded that it was important, another 20.3% rated it as not very important, highlighting that at least there is a value, although not very representative, but of medium interest for the audiovisual activity with respect to the results previously represented.

Two other questions yielded similar results, these were regarding how the asynchronous homework is oriented to develop it, where 37.5% remained neutral in their answers and 21.9% considered it important, while in the answer of how they value the webinars and recorded classes oriented to their learning, 32.8% remained neutral and 34.4% considered it important, observing a little more motivation in these two aspects. Correlating these two variables with the control question is shown in Table 3.

Table 3. Comparative studies

Parameters	Nothing important	Not very important	Neutral	Important	Very important
Homework oriented	18,8%	3,1%	37,5%	21,9%	18,7%
Webinars and recorded classes	0 %	29,7%	32,8%	34,4%	3,1%
General Question	35,9%	28,1%	14,1%	6,3%	15,6%

As can be observed, both activities oriented to students for their training under the asynchronous modality are not considered effective since the most representative values are located in the unimportant and neutral quadrants where it leaves a criterion at the study level that may denote that this modality imposed under pandemic conditions did not contribute positively in students and there was no mastery of virtuality by teachers because there had not existed within the formative aspect the use of virtual platforms as a training tool. The pandemic conditions did not contribute positively to the students and there was no mastery of virtuality by the teachers because the use of virtual platforms as an implement for the development of learning had not existed within the formative aspect, alleging in addition the preference for face-to-face learning, because they do not have the necessary means of connectivity, economically do not allow them to handle

everything related to technology and do not have the necessary materials for the daily connections where the teacher teaches.

Hypothesis of this dimension: Ho. Teacher intervention as a function of effective asynchronous activity has some relationship with oriented duties to develop it asynchronously.

When correlating the two variables we observed that Cronbach's alpha was 0.94 and the study of inter-element correlations was 0.89 where we proceeded to determine the chi-square where the asymptotic significance was 0 and the degree of freedom was 16 according to the results obtained. Relating the degrees of freedom with the level of significance that was 5% in the chi-square table, the value was 170.23, we looked for the correlation observing the limit of the acceptance zone that turned out to be 26.2962 where this hypothesis rejects the hypothesis Ho.

Regarding the dimension of synchronous activity, it was observed that 31.3% considered it important and another 31.3% very important, 21.9% were neutral and only 15.6% not very important. There is a better acceptance of the synchronous modality in this aspect than in the asynchronous activities. In relation to the answer as to whether the orientations of the teachers are useful to develop a criterion of the activity received, 46.9% considered it very important, 14.1% important and 23.3% not very important, so these results should be questioned, as they do not leave a questioning of the evaluated parameter.

Other results worth analyzing are the immediate feedback from the instructor and classmates, which the students rated as very important (32.8%), although 31.3% remained

neutral, denoting insecurity in this aspect, but the question related to the ability of teachers to respond to new technologies for the development of the synchronous activity was rated by 34.4% as unimportant and another 34.4% as neutral, denoting insecurity on the part of the student regarding the handling of technology by the teacher.4% considered it unimportant and another 34.4% neutral, denoting the student's insecurity regarding the teacher's handling of the technology, although in general the student values the synchronous activity as very important (37.5%) in terms of their learning.

The scale analysis to determine the reliability of the synchronous activity by determining the interclass correlation coefficient through the 95% confidence interval yielded the following result.

Reliability statistics

Cronbach's alpha	Cronbach's alpha based on typed items	N of elements
,717	,713	6

The reliability of the six items is accepted according to the expert criteria considered in the study, where Table 5 shows the statistics of the items that confirm this reliability.

Table 5. Total statistic of synchronous activity elements.

	Correlation element-to- total correlation corrected	Squared multiple correlation	Cronbach's alpha if the element is removed
Face-to-face and virtual classes as you value it for your learning.	,504	,333	,663
The teachers' guidance helps them to develop a criterion for the activity received.	,589	,410	,630
Class schedules, tutorials and synchronous follow- ups are considered by you for your learning.	,365	,145	,701
Immediate feedback from the instructor and peers you value.	,514	,286	,657
The responsiveness of teachers to new technologies for the development of	,315	,155	,716

synchronous activity is valued by you.			
In general, how do you value synchronous activity for your learning?	,412	,304	,689

As can be seen, all the elements considered for the study yielded acceptable values, except that the chi-square for two of the elements considered does not contribute to define a viable hypothesis, as shown in the following table

Table 6. Chi-square Tests

	Value	gl	Asymptotic sign (bilateral)
Pearson's Chi-square	100,871 ^a	16	,000
Likelihood ratio	48,176	16	,000
Linear by linear association	14,270	1	,000
N of valid cases	64		

a. 22 cells (88.0%) have an expected frequency of less than 5. The minimum expected frequency is .02.

Many researchers are addressing how to educate in post pandemic times, and in the work done, there are essential elements that should be prioritized to achieve educational and training objectives according to the requirements of the policies and laws in force at the level of the Ministry of Education, organizations and competitive bodies in terms of educational teaching activity, so some studies are considered in relation to the subject under study.

For (Argandoña-Mendoza et al., 2020) in an article entitled "Education in times of pandemic. A Psychopedagogical challenge for the teacher" addresses such a complex epidemiological situation, which has brought to light the enormous difficulties of all systems, and primarily in the educational system. It presents a scenario of uncertainty in which the entire educational community is trying to provide the most appropriate responses to its students. In the world there are 188 countries affected by school closures, involving more than 1570 million students worldwide (92% of the global student population), a figure set out in the latest Unesco report (Guide prepared by the State Education Team of Plena Inclusion with contributions from the Commission of Families for Inclusion, 2020).

According to data compiled by the Regional Bureau of Education for Latin America and the Caribbean (OREALC/UNESCO Santiago), in April 2020 several Latin American countries began to make decisions regarding the administration of large-scale assessments. For example, in Mexico, an alternative assessment has been introduced that compensates for the fact that the tests and assessments of greatest interest, such as the learning portfolio assessment, will not be applied without an end-of-year exam for the current school term. In Ecuador, on the other hand, some

qualification exams for education professionals will be postponed and alternative methods for national student evaluations are being analyzed.

Psychopedagogy and ICT in COVID-19 period, a reflection for meaningful learning was conceived under these pandemic conditions where uncertainty, fear and imposed laws brings with it a cycle of inquiry (Quevedo-Álava et al., 2020) through his study alleges that to know and adapt the educational to new learning styles, in a social stage based on insecurity, breaking the educational paradigm of certainty denotes a new era where the virtual modality will play an important role for the performance of efficient learning.

The causes and effects brought about by covid19 have been evidenced through multiple studies in which (Flores et al., 2022) expose the effects caused in education in Latin America and the Caribbean by covid19 where the lack of electronic devices, the lack of teacher training to be able to teach classes in virtual mode, social inequality and the lack of economic resources at the population level that have not been overcome to date.

In view of all these approaches addressed in this study, it is evident that the students under study do not assimilate asynchronous activities as an option to develop their academic training since they consider that under the uncertainties and problems that prevail due to their low family income levels, poor access to Internet services and a technology that does not respond to their needs, they reject this modality.

It is noted that the synchronous activity has greater acceptance, but it is observed in the studies that under certain economic criteria there are still economic and social

inconveniences to develop a virtual and face-to-face modality in accordance with the regulations and requirements of the university institutions.

Conclusion

In the face of accelerated changes, maintaining quality is one of the great challenges facing education and innovation, which leads to a change in the teaching and learning process surrounding technology, didactics, pedagogy and methodology, along with the use of materials and content to promote synchronous and asynchronous teaching is made difficult by the poor availability of access to Internet services and the deficient technology required to develop virtual, hybrid and technological spaces to carry out a training process that meets the demands of the student community.

In order to maintain quality and achieve innovative management, it is of vital importance to keep in mind that all changes must be planned in processes, services or products, which are evidenced in the improvement of results and in satisfying the demands of the students to whom they are owed, in view of the conditions imposed by the health emergency and that at present there are still shortcomings in the training of teachers to carry out the virtual modality.

The survey ratified that asynchronous activities showed a lower level of acceptance than synchronous activities at the student level where the results showed that each dimension evaluated had the intention not only to know the students' criteria but also to interpret through each element considered in the instrument the prevalence of an obsolete technology at the academic level, a deficient management of virtual platforms and an incorrect follow-up of students

to collaborate with technological aids to strengthen their learning activity.

References

- Argandoña-Mendoza, Ayón-Parrales, García-Mejía, Zambran-Zambrano, and Barcia-Briones (2020). Education in times of pandemic. Un reto Psicopedagógico para el docente. Polo del Conocimiento, 5(47), 820-848. <https://doi.org/http://dx.doi.org/10.23857/pc.v5i7.1553>.
- Bejarano, L. et al. (2010), Más Educación con Calidad, Equidad y Calidez, Ministry of Education of Ecuador.
- CACES (2019). Model for External Assessment of Universities and Polytechnics 2019. CACES 2019. <https://doi.org/http://www.caces.gob.ec/>
- CACES (2020). Higher Education and Society, What's happening with its linkage? CACES Social Communication Unit. <https://doi.org/http://www.caces.gob.ec/>
- CÁRDENAS, A (2016). Design of an implementation guide of a Quality Management System under ISO 9001:2008, in the Department of Economics, Administrative and Commerce of the University of the Armed Forces - ESPE Latacunga Extension, in the period October 2014 - April 2015. <http://dspace.utpl.edu.ec/handle/123456789/14575>
- Cárdenas, A. (2016). Quality in Ecuadorian university management: A latent search for efficiency. Multiciencias, 16(2), 194-201.

<https://doi.org/https://www.redalyc.org/pdf/904/90452745010.pdf>

Castillo-Sierra, González-Consuegra, and Olaya-Sánchez. (2018). Validity and reliability of the Florida questionnaire Spanish version. *Revista Colombiana de Cardiología*, 25(2),131-137, <https://doi.org/10.1016/j.rccar.2017.12.018>

COUNCIL FOR EVALUATION, ACCREDITATION AND QUALITY ASSURANCE OF HIGHER EDUCATION. Adaptation of the Model of Institutional Evaluation of Universities and Polytechnic Schools 2013 to the process of Evaluation, Accreditation and Recategorization of Universities and Polytechnic Schools 2015.

NATIONAL COUNCIL FOR THE EVALUATION AND ACCREDITATION OF HIGHER EDUCATION OF ECUADOR (2009). Constituent Mandate No. 14. Evaluation of institutional performance of the Universities and Polytechnic Schools of Ecuador. CROSBY, P (1987). *Quality doesn't cost. The art of quality assurance*. Compañía Editorial Continental, S.A.

Dussel, Inés; Ferrante, Patricia and Pulfer, Darío 2020a "La educación de pasado mañana. Notas sobre la marcha," in *Análisis Carolina*, June 30. <https://www.fundacioncarolina.es/wp-content/uploads/2020/06/AC-41.-2020.pdf> [Accessed July 31, 2020].

Elige Educar (2020), "Situación de docentes y educadores en contexto de pandemia: reporte de resultados 20 de mayo 2020", Santiago [on line]

https://eligeeducar.cl/wp-content/uploads/2020/05/Resultados_EncuestaEEcovid_SitioWeb_mi.pdf

Student learning experiences in the pandemic: an analysis of synchrony and asynchrony in university education (2021). Morán, Lourdes; Álvarez, Guadalupe, 12(24), 49-71.

<https://doi.org/https://revistas.unc.edu.ar/index.php/vesc/article/view/36311/36640>

Flores, C. J., Remache, H., Carriel, B., & Yépez, E. (2022). The pandemic and the effects caused on education in Latin America and the Caribbean. *Cognosis Magazine*, 7(3), 71-80.

<https://doi.org/https://revistas.utm.edu.ec/index.php/Cognosis/article/view/3362>

García, N. (2020). Nuevas tendencias en la educación virtual. *revista educacion virtual*. Retrieved from <https://revistaeducacionvirtual.com/archives/3306-ministerio-de-educacion-abre-el-curso-deautoaprendizaje-mi-aula-en-linea/> [accessed June 12, 2020].

Horowitz, P. (2018). Ecuador: Ley Orgánica Reformatoria a la ley Orgánica de Educación Superior. <https://www.mondaq.com/compliance/727670/ley-orgnica-reformatoria-a-la-ley-orgnica-de-educacin-superior>

I, M. F.-M. (2020). Education in times of pandemic. A Psychopedagogical challenge for the teacher. *Polo del conocimiento*.

Lara-Carrillo, and Freire-Aillón (2022). Didactic strategies with synchronous and asynchronous activities in the

learning of inorganic nomenclature. *INNOVA Research Journal*,7(2),40-56,
<https://doi.org/10.33890/innova.v7.n2.2022.2003>

LOES. (2010). LEY ORGANICA DE EDUCACION SUPERIOR.

https://www.educacionsuperior.gob.ec/wp-content/uploads/downloads/2014/03/LEY_ORGANICA_DE_EDUCACION_SUPERIOR_LOES.pdf

Machuca, S. A., Sánchez, D. E., Sampedro, C. R., & Palma, D. P. (2021). Student perceptions of synchronous and asynchronous classes one year into virtual education. *Conrado*, 17(81), 270-276.
https://doi.org/http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1990-86442021000400269&lng=es&nrm=iso

Ministry of Education of Ecuador (2020), "El Ministerio de Educación abre el curso de autoaprendizaje 'Mi Aula en Línea'" [on line] <https://educacion.gob.ec/el->

Morán, L., Álvarez, G., & Manolakis, L. (2021). Student learning experiences in the pandemic. An analysis about synchrony and asynchrony in university education. *Virtuality, Education and Science*, 24 (12), 49-71.,
<https://revistas.unc.edu.ar/index.php/vesc/article/view/36311/36640>.

Moreno, F. O., Ochoa, F. A., Mutter, K. J., & Vargas, E. C. (2021). Pedagogical strategies in virtual learning environments in times of Covid-19 pandemic. *Revista de Ciencias Sociales (Ve)*,27(4), 202-213,
<https://www.redalyc.org/journal/280/28069360015/html/>

- Murillo, F. J., & Duk, C. (2020). The Covid-19 and the Educational Gaps. *Rev. latinoam. Educ. Inclusive*, 14 (1). Obtained from
- Palma, A. M., Loor, T. D., Salazar, G. G., & Hernández, L. E. (2021). Technology: impact on the teaching-learning process. *Cuadernos de Educación y Desarrollo*, 13(5), 97-116.
<https://doi.org/https://www.eumed.net/uploads/articulos/6dff02bececc8b854799f993774445ae.pdf>
- Quevedo-Álava, Corrales-Moreno, Palma-Delgado, and Mendoza-Suárez. (2020). Psychopedagogy and ICT in COVID-19 period. A reflection for meaningful learning. *EPISTEME KOINONIA*, 3(5).
<https://doi.org/http://portal.amelica.org/ameli/jatsRepo/258/2581039013/html/>
<https://doi.org/http://portal.amelica.org/ameli/jatsRepo/258/2581039013/html/>
- Rizo, M. (2020). Role of the teacher and student in virtual education. *Multi-Essay*,
<https://doi.org/10.5377/multiensayos.v6i12.10117>
- SIIES (2019). *QUALITY ASSURANCE. USER'S GUIDE*, 18.
- Stojanovic, L. (2008). Communication and information technologies in education: referents for the analysis of virtual teaching-learning environments. *Research Journal*, 32(65), 83-122,
http://ve.scielo.org/scielo.php?script=sci_arttext&pid=S1010-29142008000300006.
- Véliz, V. (2018). Quality in Higher Education. *Caso Ecuador. Atenas*, 1(41), 165-180.
<https://doi.org/https://www.redalyc.org/journal/4780/478055151011/html/>

Financial study of Ecuador's public banks using Camel and Dupont analysis

Freddy Lenin Villarreal Satama

PhD(c), Hemisferios University

leninv@uhemisferios.edu.ec

<https://orcid.org/0000-0001-7883-1718>

María Teresa Bosch Badía

PhD, University of Girona

mariateresa.bosch@udg.edu

<https://orcid.org/0000-0002-1204-1956>

Introduction

The financial system in Ecuador is composed of private and public institutions in which banks, cooperatives, financial companies, mutual societies, mainly being the banks who the largest financial transactions with 90% in the country, promoting and boosting the country's economy with the generation of credits to those for development in different sectors. (Romero, 2015).

Since the covid-19 pandemic, in Ecuador many industries and small businesses had financial difficulties, so public and private banks granted loans for USD 31,334 million since March 2020 where 72% went to the productive sector and 28% to consumption, counting on digital channels that grew 32% compared to 2019. (Asociación de Bancos del Ecuador, 2021)..

Regulation of Ecuador's financial system

In Ecuador, this function corresponds to the Monetary and Financial Policy and Regulation Board (Junta de Política y Regulación Monetaria- Financiera). This body is responsible for monetary, credit and foreign exchange regulation and supervision, supported by the Superintendency of Banks, which is the government entity

responsible for controlling and supervising private and public sector financial institutions to preserve solvency, transparency, liquidity and security (Superintendency of Banks, 2022).

1.2 Public Banking in Ecuador

In Ecuador, public banks are composed of five institutions. Currently, public banks are focused on covering strategic sectors such as the productive sector, infrastructure projects and small and medium enterprises, responding to a specific development model and government plans derived from political factors (Burneo, 2010). (Burneo, 2010).. These are:

Corporación Nacional de Finanzas Populares y Solidarias (CONAFIPS): is a public institution created in 2021, which acts as a second-tier bank, operating through the popular and solidarity financial sector, granting loans to mutuals, savings and credit cooperatives, savings banks, mainly whose mission according to Art. 159 of the Organic Law of Popular and Solidarity Economy is "*The Corporation's fundamental mission will be to provide services*" (**Corporación Nacional de Finanzas Populares y Solidarias, 2021**). (**Corporación Nacional de Finanzas Populares y Solidarias, 2021**)..

Banco Ecuatoriano de la Vivienda (BEV): created on May 26, 1961, its purpose is to meet the housing demand of social interest. Its main objective is to serve the mortgage and financial market. It is present nationwide through offices in Quito, Guayaquil, Cuenca, Ambato and Portoviejo; however, it is in liquidation, which is being carried out by the Monetary and Financial Code. (Banco Ecuatoriano de la Vivienda, 2017)..

BANECUADOR: formerly Banco Nacional de Fomento (BNF), created in the government of Dr. Isidro Ayora, on January 27, 1928 as Banco Hipotecario del Ecuador. On May 9, 2015 it changed to BANECUADOR whose purpose is to provide loans to productive sectors, with an inclusive approach to natural or legal persons engaged in the promotion, production and marketing, preferably agricultural, aquaculture, mining, artisanal, forestry, fishing and tourism activities, promoting small and medium enterprises. (BanEcuador, 2015)..

The National Finance Corporation: is an autonomous public financial institution, with legal personality, whose mission is to Promote the development of the productive and strategic sectors of Ecuador, with financial and non-financial services aligned with public policies. (Corporación Financiera Nacional, 2016).

Banco de Desarrollo del Ecuador: Created on December 30, 2015, previously called Banco del Estado and as BEDE on August 6, 1979, date that it began its operation as a legal entity with social purpose so that the Ecuadorian State has a financial institution that concentrates, coordinates and distributes resources for financing priority projects mainly in the promotion of territorial development to finance public infrastructure, social housing and technical assistance. (Banco de Desarrollo del Ecuador B.P., 2020)..

State of the art

(Terreno, 2013) in his work shows the relationship between Dupont and the asset structure of business results, with the methodology of cross-sectional statistical linear correlation, finding as a result that the correlation of margin and turnover is negative, with companies with higher profits being those with greater immobilization, and

that the higher the asset turnover, the greater the impact on the optimization of administrative expenses, conditions that could be used to infer future profitability.

(Rosillón & Marbelis, 2009). In this study, the objective was to detect possible irregularities in management and generate corrective measures through the Dupont analysis methodology and financial indicators, whose main results consider that this analysis adjusted to inflation allowed observing the financial conditions for a better administration of resources and decision making, implementing conditions for a better business management.

(Cortéz et al., 2015) conducted an analysis of profitability ratios using Dupont, with the objective of determining the levels at which the variables that impact the financial profitability of the main Spanish economic sectors should remain in 79,333 companies, evidencing that the main sources of financial profitability originate in sales margins, effective asset turnover and adequate debt management under the increase of productivity to compensate for the country's economic problems.

(Blessing & Ojona, 2015) analyze the financial statements in United Bank for Africa - Nigeria, with the objective of knowing the role of balance sheets in decision making, based on a sample of ten years with the Dupont indicator method to lead to the MCO and test the transparency of the information obtained which as a result shows that the documentation presented should be audited since investors to make lasting decisions depend on financial statements with high levels of credibility.

(Restrepo et al., 2017) generate a study that quantifies the impact of efficiency and leverage on export performance

using stochastic Dupont with a Monte Carlo simulation and subsequently with a sensitivity analysis that determines the impact of efficiency and leverage on Dupont finding a financial weakness with low efficiency and performance in the use of productive resources.

(Sepúlveda et al., 2018) in their study compares the performance and efficiency of supermarkets established in Mexico using Dupont analysis as a methodology to calculate the coefficients to explain the productivity advantages of foreign companies in relation to Mexican companies of the same line of business, determining that U.S. supermarket companies triple the benefits in profit margin and return on their investments.

(Garcia, 2015) in his work uses the Dupont analysis methodology to analyze the variables that are part of this technique under an administrative perspective as a tool to measure the efficiency of the entities to meet the annual planning and evidence that costs must be properly managed as having higher sales is not synonymous with efficiency under the importance that administrative functions should have, in which their decisions impact on business results. (Bunea et al, 2019) the objective of this paper is to identify the financial indicators that affect the return on equity (ROE) in the Romanian energy industry through linear regression analysis and Dupont revealing that companies that benefit from a higher ROE ratio often have some competitive advantage that allows them to obtain higher profits evidenced in a sample of 1253 companies in the energy industry where the results indicate the asset turnover, price-to-earnings, price-to-book and financial leverage were the key ratios for determining ROE, with asset turnover and price-to-earnings being the most influential in this study.

(Poretti & Yoonjoung, 2022) Using a sample of 1315 observations for 194 listed tourism companies from 2012 to 2019, they generate a firm value impact study using the methodology to analyze the components associated with the market reaction affected by the COVID-19 pandemic. The results show that in the period 2012 and 2019, the association of performance and firm value is given by the asset capacity of companies to be efficient and on the other hand profitability and productivity are significantly associated with firm value.

(Diaz et al., 2017) They apply fuzzy logic to financial indicators and ratios with the objective of observing the economic behavior of the cooperative sector of Ecuador in segment one compared to Camel for its risk classification with linguistic variables from 0 to 1 whose result ensures the level of risk valued in scales towards a range of credit rating membership.

(González & Gutierrez, 2016) generate a study of stress level in European banking with the objective of evaluating the financial solvency expressed in terms of tier 1 capital with the use of variables taken from financial statements and with the multilevel regression methodology especially for European countries of Portugal, Spain, Ireland, Greece and Italy whose results based on the Camel technique offer an excellent criterion for categorical variables confirming that the Camel model explains the level of bank solvency.

It is important to emphasize that the financial risk must be complemented with a social study such as the case of the implication of social indicators and governance of (Gitterio & King, 2023) with a sample of 362 banks in the USA and the EU. Based on this method they obtain as a result the

improvement of the predictive capacity and reduce the probability of financial default that favors financial institutions.

The Dupont identity

This index is named after the Dupont company and breaks ROE down into three parts: 1) the profit margin on sales, 2) the total asset turnover and 3) the equity multiplier. The first component of the Dupont equation indicates the percentage of profit on sales, the second component indicates the number of times total assets are sold in the year, and the third part of the equation indicates how many (dollars or euros) of total assets there are for each (dollar or euro) of shareholders' equity. (Dumrauf, 2003).

Dupont = (*margen de utilidad*)(*rotación activo total*)
(*multiplicador de patrimonio neto*).

$$Dupont = \frac{Utilidad\ Neta}{Ventas} * \frac{Ventas}{Activo\ total} * \frac{Activo\ total}{Patrimonio\ total} = ROE$$

ROA

⏟ ROE

⏟

$$\text{Dupont} = \frac{\text{Utilidad Neta}}{\text{Activo total}} * \frac{\text{Activo total}}{\text{Patrimonio total}} = \text{ROA} \quad \text{Dupont} = \frac{\text{Utilidad Neta}}{\text{Patrimonio total}} = \text{ROE}$$

If we simplify the sales in the first two terms of the equation, we are left with ROA, and if we then simplify the total assets, we obtain ROE. According to (Dumrauf, 2003) the Dupont identity allows us to observe that ROE is affected by economic efficiency, operating efficiency and financial leverage.

Extended Dupont analysis

According to (Ross et al., 2010), it takes a closer look at how key parts of a company's operations fit into ROE. The advantage of the extended Dupont is that it allows several financial ratios to be examined at the same time, giving a better perspective on business performance, while identifying potential items for improvement.

In the Dupont diagram he observes the accounts related to profitability and according to (Bridgham & Houston, 2005) The Dupont diagram shows the areas where Dupont can intervene if its sales grow and it optimizes one more of the cost components, i.e. if it wishes to improve profitability, the Dupont diagram shows the areas where it can intervene.

On the other hand (Ross et al., 2010), refer to the key factors of total asset turnover and it can be said that the reduction

of the inventory makes the current assets account lower and this reduces the total assets, improving its turnover, of course with an efficient financial and administrative management.

Camel risk analysis

CAMEL, which stands for Capital, Asset, Management, Earning and Liquidity, is a financial vulnerability assessment method that takes into account five parameters: capital, assets, management, earnings and liquidity. (Gestiópolis, 2001) These criteria are capital adequacy, which analyzes the risk of capital and reserves to be able to absorb an eventual loss as part of the financial solvency, the quality of the assets on which the assets valued in a suitable way within the financial statements depend, in which it is important to take the necessary provisions in case of devaluation of these, the managerial administration that refers to the level of leadership to make effective decisions, the human talent based on the responsibility to efficiently manage the subsystems of human talent... (Meiderdaniel, 2010). (Meiderdaniel, 2010)

The Utilities with respect to Camel, analyzes four indicators, being the first three quantitative and the fourth qualitative, such as Roe, Operating Efficiency, Roa and interest rate policies and finally the management of liquidity to maintain adequate liquidity to meet in a timely manner the obligations, planning and investments that serve to cover costs and expenses. (Gestiópolis, 2001).

Financial analysis of Ecuador's public banks

Public banking for August 2020 concentrated 14.75% of assets, 13.4% of gross portfolio, 11.12% of liabilities and 36.19% of equity, assets for this month were USD 7,786.19 million, which compared to the same month of 2019 and

2018 reached the figures of USD 8,342.39 and USD 342.13 million respectively. The figure for 2020 is lower by 556.20 million compared to 2019 due to the decrease in public sector investments, mainly predominating the net portfolio account and investments in the composition of assets. The liabilities account for August 2020 had a figure of USD. 472.12 and compared to 2019 and 2018 were USD 5,464.35 and USD 5,399.48. In the same way, a decrease of 8.64% and 1.20% is observed due to the fact that the decrease of deposit or obligations with the public concentrated around 73% of the total liabilities. The unliquidated equity for the same dates presents the figures of USD2,807.96; (0.03%) lower than 2019 which was USD2,807.95 and USD 2628.60 in 2018. (Superintendency of Banks of Ecuador, 2022)..

Regarding the analysis of the public bank portfolio, a detailed analysis of the accounts by type of portfolio for the years 2018 to 2019 is shown. This mainly considers the subaccounts of portfolio due and non-interest-bearing of both the refinanced and restructured amount. In addition, the past due and maturing portfolio is integrated in the same terms of refinanced, restructured with its final allowance account for bad debts. The results are shown figures and then in percentages respectively for the year 2018 in Table 2.4 to Table 1a 4.

Table 1. Horizontal Analysis State Bank/Development Bank 2018-2019.

Horizontal and vertical analysis for each financial institution					
<u>BY TYPE OF PORTFOLIO</u>	STATE BANK / DEVELOPMENT BANK		<u>Horizontal Analysis</u>	<u>Vertical Analysis</u>	
	<u>2018</u>	<u>2019</u>		<u>2018</u>	<u>2019</u>
Portfolio to mature	\$ 185.542,59	\$ -	-100%	13,0%	0,0%
Refinanced portfolio maturing		\$ -		0,0%	0,0%
Restructured portfolio to maturity		\$ -		0,0%	0,0%
Non-interest bearing portfolio	\$ 3.040,33	\$ 1.524,04	-50%	0,2%	0,1%
Past due portfolio	\$ 3.268,10	\$ 466,56	-86%	0,2%	0,0%
Past due refinanced portfolio	\$ 20.087,25	\$ 0,00	-100%	1,4%	0,0%
Past due restructured portfolio	\$ 10.159,12	\$ 5.270,29	-48%	0,7%	0,4%
Portfolio of public investment loans maturing	\$ 1.249.625,19	\$ 1.211.212,88	-3%	87,7%	101,0%
Non-interest-bearing public investment loan portfolio	\$ 2.094,01	\$ 1.682,21	-20%	0,1%	0,1%

Non-performing public investment loan portfolio	\$ 32,86	\$ 35,58	8%	0,0%	0,0%
(Provisions for doubtful accounts)	\$ -49.156,08	\$ -20.399,79	-58%	-3,5%	-1,7%
<i>TOTAL</i>	<i>\$</i>	<i>\$ 1.199.791,78</i>	-	-	-
	<i>1.424.693,37</i>				

Analysis Banco del Estado 2019-2018: Comparing the two years 2019 and 2018, Banco del Estado has reduced to zero the past-due portfolio and the past-due refinanced portfolio, which allows us to deduce that it has improved its collection management, and has also reduced the past-due portfolio to 86%, which has a direct impact on the provision for uncollectible accounts, which dropped to 58%. It should be noted that the portfolio of overdue public investment loans is its financial niche; therefore, this FI has become the state's strategic ally in terms of direct financing.

Table 2.
Horizontal Analysis BANEQUADOR 2018-2019

Horizontal and vertical analysis for each financial institution					
	BANEQUADOR B. P.		<i>Horizontal Analysis</i>	<i>Vertical Analysis</i>	
<u>BY TYPE OF PORTFOLIO</u>	<u>2018</u>	<u>2019</u>		<u>2018</u>	<u>2019</u>
Portfolio To be expired	\$ 1.410.704,64	\$ 1.461.186,17	3,58%	97,09%	94,99%
Refinanced portfolio maturing	\$ 47.146,03	\$ 50.220,56	6,52%	3,24%	3,26%
Restructured portfolio to maturity	\$ 23.475,48	\$ 16.709,94	-28,82%	1,62%	1,09%
Non-interest bearing portfolio	\$ 25.741,68	\$ 92.192,78	258,15%	1,77%	5,99%
Non-interest-bearing refinanced portfolio	\$ 2.569,61		-100,00%	0,18%	0,00%
Non-interest-bearing restructured portfolio	\$ 4.821,60		-100,00%	0,33%	0,00%
Past due portfolio	\$ 17.419,12	\$ 50.848,40	191,91%	1,20%	3,31%
Past due refinanced portfolio	\$ 1.223,55	\$ 7.325,15	498,68%	0,08%	0,48%
Past due restructured portfolio	\$ 2.167,58	\$ 2.671,10	23,23%	0,15%	0,17%

Portfolio of public investment loans maturing		\$ -		0,00%	0,00%
Non-interest-bearing public investment loan portfolio				0,00%	0,00%
Non-performing public investment loan portfolio	-			0,00%	0,00%
(Provisions for doubtful accounts)	\$ -82.212,42	\$ -142.896,99	73,81%	-5,66%	-9,29%
<u>TOTAL</u>	<u>\$ 1.453.056,88</u>	<u>\$ 1.538.257,13</u>			

Analysis BANECUADOR 2019-2018: Upon analyzing BANECUADOR's portfolio during 2018 and 2019, it is concluded: The financial niche that the FI has is the microenterprise - SMEs with 86%. At a general level, the overdue portfolio is equivalent to 97% in 2018 and approximately 95% in 2019, being the most representative item of the total portfolio. The refinanced past due portfolio increased by 499% corresponding to SMEs. The past due portfolio rose by 192% in 2019, which has a direct impact on the increase in the allowance for doubtful accounts, which rose to 74% for 2019. The risk in this type of SME financial niche has a considerable inherent and operational risk given that it depends on the purpose for which the small businessman allocates his resources and whether they depend on state policies, or external factors such as weather conditions in the case of agriculture.

Table 3.
Horizontal Analysis National Finance Corporation 2018-2019

Horizontal and vertical analysis for each financial institution					
<u>BY TYPE OF PORTFOLIO</u>	NATIONAL FINANCIAL CORPORATION		<u>Horizontal Analysis</u>	<u>Vertical Analysis</u>	
	<u>2018</u>	<u>2019</u>		<u>2018</u>	<u>2019</u>
Portfolio to mature	\$ 1.307.887,05	\$ 1.389.439,37	6,24%	83,70%	89,10%
Refinanced portfolio maturing	\$ 80.334,32	\$ 46.674,69	-41,90%	5,14%	2,99%
Restructured portfolio to maturity	\$ 135.969,65	\$ 154.953,27	13,96%	8,70%	9,94%
Non-interest bearing portfolio	\$ 48.165,08	\$ 32.883,73	-31,73%	3,08%	2,11%
Non-interest-bearing refinanced portfolio	\$ 4.918,11		-100,00%	0,31%	
Non-interest-bearing restructured portfolio	\$ 10.459,40		-100,00%	0,67%	
Past due portfolio	\$ 37.775,59	\$ 89.552,11	137,06%	2,42%	5,74%
Past due refinanced portfolio	\$ 765,57	\$ 1.092,44	42,70%	0,05%	0,07%

Past due restructured portfolio	\$ 32.178,69	\$ 64.180,09	99,45%	2,06%	4,12%
Portfolio of public investment loans maturing	\$ -	\$ -			
Non-interest-bearing public investment loan portfolio	\$ -				
Non-performing public investment loan portfolio	\$ -				
(Provisions for doubtful accounts)	\$ -95.929,13	\$ -219.417,11	128,73%	-6,14%	-14,07%
<u>TOTAL</u>	<u>\$ 1.562.524,31</u>	<u>\$ 1.559.358,59</u>			

CFN 2019-2018 Analysis: When analyzing the 2018-2019 periods of the National Financial Corporation -CFN it is deduced: The financial niche of this institution is productive and commercial credit with 53% and 36% respectively. Its portfolio is concentrated in past due portfolio, which increased by 6.24%. The restructured past due portfolio increased 99.45%, especially in commercial loans. The overdue portfolio rose to 137% in 2019, its impact given directly in commercial loans followed by productive loans. The refinanced past due and non-interest-bearing portfolio decreased by 42% and 32%, respectively. The provision increased by 129% since the past due and restructured past due portfolio increased by 137% and 99.45%, respectively. The risk in these lines of credit is high because they depend on several factors, especially tax, commercial, tariff and legal issues, and above all the seriousness in their negotiations.

Table 4.

Horizontal and Vertical Analysis Total Public Banking of Ecuador 2018-2019

Horizontal and vertical analysis for each financial institution					
<u>BY TYPE OF PORTFOLIO</u>	TOTAL, PUBLIC BANKING		<u>Horizontal Analysis</u>	<u>Vertical Analysis</u>	
	<u>2018</u>	<u>2019</u>		<u>2018</u>	<u>2019</u>
Portfolio to maturity	\$ 2.904.134,28	\$ 3.008.748,30	3,6%	65,40%	67,53%
Refinanced portfolio maturing	\$ 127.480,36	\$ 96.895,25	-24,0%	2,87%	2,17%
Restructured portfolio to maturity	\$ 159.445,13	\$ 171.663,21	7,7%	3,59%	3,85%
Non-interest bearing portfolio	\$ 76.947,09	\$ 126.600,55	64,5%	1,73%	2,84%
Non-interest-bearing refinanced portfolio	\$ 7.487,72		-100,0%	0,17%	0,00%
Non-interest-bearing restructured portfolio	\$ 15.280,99		-100,0%	0,34%	0,00%
Past due portfolio	\$ 58.462,81	\$ 140.867,07	141,0%	1,32%	3,16%
Past due refinanced portfolio	\$ 22.076,37	\$ 8.417,60	-61,9%	0,50%	0,19%

Past due restructured portfolio	\$ 44.505,39	\$ 72.121,48	62,1%	1,00%	1,62%
Portfolio of public investment loans maturing	\$ 1.249.625,19	\$ 1.211.212,88	-3,1%	28,14%	27,18%
Non-interest-bearing public investment loan portfolio	\$ 2.094,01	\$ 1.682,21	-19,7%	0,05%	0,04%
Non-performing public investment loan portfolio	\$ 32,86	\$ 35,58	8,3%	0,00%	0,00%
(Provisions for doubtful accounts)	\$ -227.297,63	\$ -382.713,88	68,4%	-5,12%	-8,59%
<u>TOTAL</u>	\$ 4.440.274,55	\$ 4.455.530,26			

Global Analysis: Comparing the public portfolio totals of the three financial institutions in the two periods 2018-2019, it can be observed that the portfolio due in 2019 increased by 3.60% and its representativeness in the two years ranges between 65% and 68%.

The public investment portfolio maturing in 2019 decreased just 3.07%, being the second largest item within the public portfolio ranking between 27% and 28%. The maturing refinanced portfolio dropped significantly to 24% between 2018 and 2019. As well as the non-interest-bearing refinanced portfolio and the non-interest-bearing restructured portfolio, it decreased 100%.

The overdue portfolio in 2019 increased to approximately 141% as BANECUADOR increased to 192% and CFN to 137% its overdue portfolio. The overdue refinanced portfolio drops 62% as Banco del Estado in 2019 reached 0 in this portfolio, while the other banks increased by 499% BANECUADOR and 42% CFN approximately. Provisions for bad loans rise to 68% since the overdue portfolios in BANECUADOR and CFN rose by 192% and 137% respectively, making the portfolio more risky. In the end, it can be concluded that of the three institutions that have been compared, the credit risk levels are high. Banco del Estado must make decisions especially in the public investment portfolios, which are its financial niche and which increased by 100% in 2019, respectively.

BANECUADOR's credit risk is concentrated in the past-due and refinanced past-due portfolio, non-interest bearing portfolio and refinanced past-due portfolio. The NFC, in its past due, past due refinanced and past due restructured portfolios, must have better financial strategies to reduce the risk of non-payment, since it is important that its

commercial and productive credit lines require its support to generate the country's productive apparatus.

The mechanisms can be generated based on programs focused on vulnerable households, support in technological investment taking into account that many jobs can be developed from home teleworking, increasing health services to its citizens, employment preservation in a joint work with private enterprise, taking advantage of the resources that the IDB approved in 2020 for 13.7 billion to mitigate the negative impacts of the pandemic.

Figure 1. DUPONT Analysis Public Banking of Ecuador 2018-2020

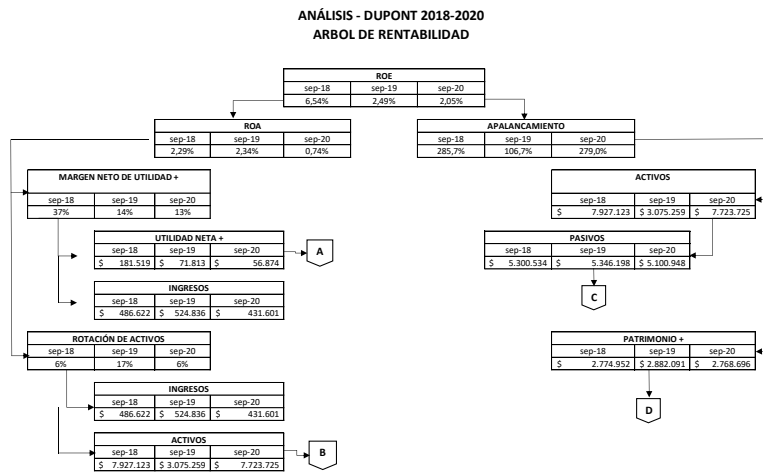
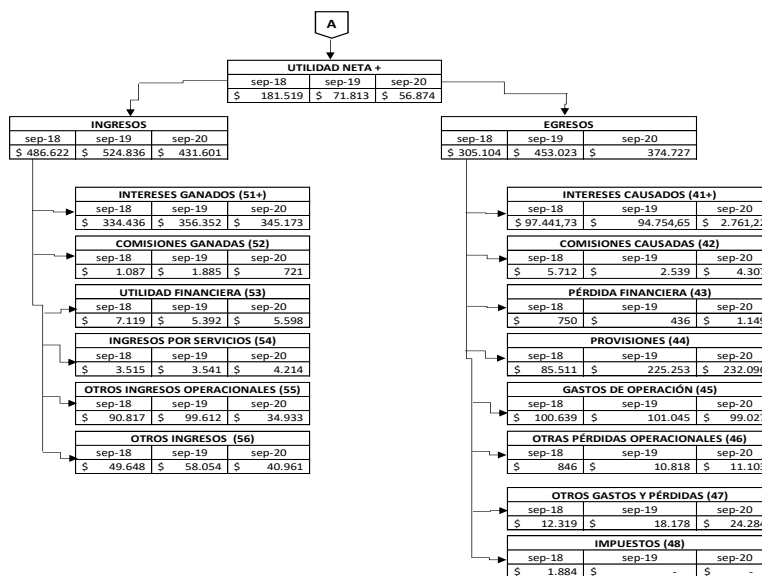


Figure 2. DUPONT Analysis - Net Profit



The Dupont identity for public banks shows that ROE is affected by economic efficiency, measured by the profit margin on revenues, operating efficiency and financial leverage given by the equity multiplier. In the scheme of public banking in Ecuador, as of September 2018 to 2020 with respect to the profit margin indicates that the overall public banking earned 37.30% in 2018, 13.68% in 2019 and 13.18% in 2020 on revenues. Total assets sold at 0.614 in 2018, 0.17 in 2019 and 0.05 times in 2020, which multiplying ROA by the equity multiplier yields ROE.

The Dupont analysis in Figure 1 and 2, shows the ROE for September 2018 is 6.54%, September 2019 2.49% as of September 2019 and 2.05% as of September in 2020, which indicates that for every dollar the state deposits in public banking for 2018, the state gets 6.5 cents return, for 2019 the return per dollar is 2.49 cents and for 2020 is 2.05 cents return on the dollar. For each unit of return on equity. It is observed that this return has been decreasing due to the increase in the portfolio.

ROA: same that determines the return on assets over net profits, for the case of public banking for September 2018 with 2.29%; 2.34% for 2019 and 0.74% for 2020, which indicates that for every dollar invested in assets by the state in public banking, 22.9; 23.4 and 7.4 cents of dollar profitability is obtained, a situation caused not by the performance in efficiency for the generation of money through assets but by lower profit margins from 2018 to 2020.

Leverage: for public banking as of September for the years 2018 to 2020 analyzed, it presents 2.85; 1.06 and 2.79 respectively, which means that for every dollar invested in public banking by the state there is 2.85; 1.06 and 2.79 of debt in each year respectively.

Net profit margin: this value represents the percentage of profit that remains to the public bank once all costs and expenses of the analyzed periods are cancelled. For the case of public banking for the months of September 2018 to 2020 indicates that for every \$100 in sales (loans placed), the overall public banking obtains a final profit of \$37.30; \$13.68 and \$13.18 respectively, values that have been decreased due to the decrease in portfolio recovery.

For the case of global public banking analyzed in the month of September 2018 to 2020, it was obtained 6.14; 17.07 and 5.54 times that the asset generates sales or income for public banking.

Table 5.
Camel Global Analysis Public Banking of Ecuador

CAMEL ANALYSIS - GLOBAL PUBLIC BANKING

INDICATORS		Years					Average	Standard deviation		Years- Number of standard deviations			
Indicators	Formula	2015	2016	2017	2018	2019		2015	2016	2017	2018	2019	
Liquidity	Available Funds / Obligations to the Public	3,59	3,42	3,39	2,54	2,39	3,07	0,56	0,94	0,64	0,59	-0,95	-1,21
Equity (Solvency)	Equity/Assets	0,34	0,32	0,33	0,35	0,35	0,34	0,01	-4,91	-4,94	-4,92	-4,89	-4,88
	Equity growth rate (%)	-	0,015	0,103	0,063	0,004	0,05	0,05	-	-5,49	-5,33	-5,40	-5,51
Profitability	ROA=Year Income / Total Assets	2.5%	2.3%	2.9%	2.9%	0.7%	0,02	0,01	-5,47	-5,48	-5,46	-5,46	-5,50

	ROE= Profit for the year / Equity	0,075	0,070	0,089	0,083	0,020	0,07	0,03	-5,38	-5,39	-5,36	-5,37	-5,48
Delinquency	Past-due portfolio + non-interest bearing portfolio / Total portfolio + provision for bad debts	0,074	0,053	0,054	0,049	0,057	0,06	0,01	-5,38	-5,42	-5,42	-5,43	-5,41
Efficiency	Operating Expense / Total Assets	0,024	0,018	0,019	0,017	0,0183	0,02	0,003	-5,47	-5,48	-5,48	-5,48	-5,48
Asset Quality	Productive assets / Total assets	0,9029	0,9037	0,9131	0,8887	0,9221	0,91	0,01	-3,89	-3,89	-3,87	-3,92	-3,86
	Loan portfolio growth rate (%)	-	0,0417	0,0998	0,1046	0,0435	0,07	0,03	-	-5,44	-5,34	-5,33	-5,44

Table 6.
Camel Global Analysis Public Banking of Ecuador- Weighting

WEIGHTING FACTORS - CAMEL						
Indicators	Formula	Years				
		2015	2016	2017	2018	2019
Liquidity	Available Funds / Obligations to the Public	5,00	5,00	5,00	5,00	4,00
Equity (Solvency)	Equity/Assets	1,50	1,00	1,50	1,50	2,00
	Equity growth rate (%)	0	1,5	2	1,5	1,5
Profitability	ROA=Year Income / Total Assets	1,50	1,50	1,50	1,50	1,00
	ROE= Profit for the year / Equity	1,50	1,50	1,50	1,50	1,00
Delinquency	Past-due portfolio + non-interest bearing portfolio / Total portfolio + provision for bad debts	2,00	3,00	3,00	3,00	3,00
Efficiency	Operating Expense / Total Assets	2,00	3,00	3,00	3,00	3,00
Asset Quality	Productive assets / Total assets	1,50	1,50	1,50	1,50	2,00
	Loan portfolio growth rate (%)	0	1,5	1,5	1,5	1,5

Table 7. Camel Global Analysis Public Banking of Ecuador- Partial Weighting

PARTIAL WEIGHTING PUBLIC BANKING - CAMEL						
Indicators	Formula	Years				
		2015	2016	2017	2018	2019
Liquidity	Available Funds / Obligations to the Public	5,00	5,00	5,00	5,00	4,00
Equity (Solvency)	Equity/Assets					
	Equity growth rate (%)	1,50	2,50	3,50	3,00	3,50
Profitability	ROA=Year Income / Total Assets					
	ROE= Profit for the year / Equity	3,00	3,00	3,00	3,00	2,00
Delinquency	Past-due portfolio + non-interest bearing portfolio / Total portfolio + provision for bad debts	2,00	3,00	3,00	3,00	3,00

Efficiency	Operating Expense / Total Assets	2,00	3,00	3,00	3,00	3,00
Asset Quality	Productive assets / Total assets					
	Loan portfolio growth rate (%)	1,50	3,00	3,00	3,00	3,50

In the case of public bank liquidity analyzed since 2015, it has remained at an optimal level. However, in 2019 this indicator shows a slight decrease, due to the crisis and contraction of Ecuador's economy at that time, there are fewer transactions for deposits with which the country through the government was forced to resort to external credit with the International Monetary Fund to improve 2020 and 2021 in terms of liquidity.

In the case of equity solvency, it has been improving from 2016, which was in a slightly more than regular position, to intermediate between 2017 and 2019.

For delinquency and efficiency, the indicator is at an intermediate level, due to the prevailing crisis in the country since 2012, which was mainly affected by the increase in the unemployment rate and as a consequence of this, family economies and companies are decreasing or losing the ability to meet the obligations contracted in the national financial system, so delinquency has been increasing in the loan portfolio.

Figure 3. Camel Global Public Banking in Ecuador

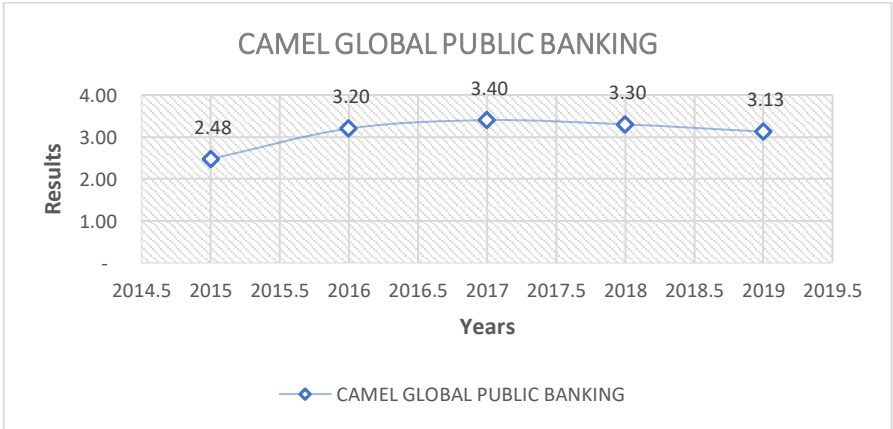
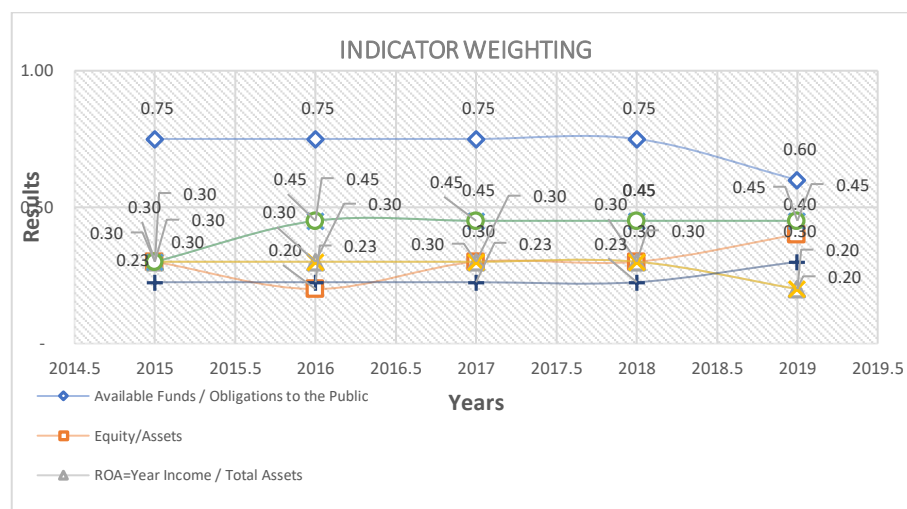


Figure 4. Camel Global Public Banking of Ecuador- Weighting by Indicators



In general, the financial system in the public banking system is weakened due to the contraction of the economy, low production growth, as a consequence of the high indebtedness of the State with bilateral and multilateral organizations, both in external debt with the IMF and the public banks of China, making it necessary to renegotiate the debt.

The high interest rates in Ecuador are a factor that does not allow improving the flow of liquidity in the economy due to the lack of direct competitors with international banks, which increases the cost of money and makes it difficult to obtain credit for production due to the multiple guarantees requested by banks in general. It is estimated that due to the effects of the pandemic caused in 2020 and the presidential elections for the change of government that are close in Ecuador in the first semester of 2021, the economy that has been affected with a contraction of 11%, a possible way out is based on the strengthening of productive credits for entrepreneurship and reactivation of agriculture,

Investments in the oil industry, shrimp, bananas, cocoa and several non-traditional products are expected to grow in the order of 4% to 6% by the end of 2021, which will depend on the efficient management of the pandemic with respect to the vaccination plan that improves the health conditions of its inhabitants.

Oil production has stagnated in parallel with the low oil prices that feed the budget of the country's economy along with tax collection, and as a consequence, loss of jobs under a process of state downsizing, merger of state secretariats, migration of hundreds of people to the United States.

Among the various alternatives are lowering the VAT currently at 12%, lowering the progressive tax on capital outflows of 5% and generating strategic alliances with economic blocs, which will allow Ecuador to open up to various regions in the world such as the Asia-Pacific bloc, bilateral agreements with the main economic partner, the United States, which will allow the country to generate greater exports, have preferential tariffs on various products and zero tariffs.

Conclusions

Public banks in Ecuador, as well as private banks, are governed by the same system of state control carried out by the Superintendency of Banks of Ecuador, in which one of its obligations is to maintain a monthly report of data generated from its internal operations. The control entity maintains standard financial control indicators that are evaluated with respect to liquidity and risk so as not to affect the users of the system. As a development bank, the National Finance Corporation, Banco del Estado-Desarrollo and BanEcuador have their own agenda whose common denominator is to obtain resources from the state to promote credit for strategic activities such as civil

infrastructure works, loans to the different sectors of mining production, banana, oil, fishing, agriculture, social housing, channeling sources of financing in conjunction with private banks in cases where they do not have all the capital requested by corporate groups in large projects and thus promote the economic development of the country.

With the emergence of the pandemic of covid-19 as happened to all countries in the world, economic activities were affected by prolonged measures of confinement, which caused many sectors of the economy are affected in their income but not the food and pharmaceutical sector mainly, However, many jobs were lost due to the closure and in many cases bankruptcy of businesses that were the livelihood of many families, the public banks in Ecuador are serving with credits and preferential rates, so that by the end of 2021 micro enterprises were generated, thus becoming a source of resources for economic recovery.

Public banks should become the main engine for the country's development, a solution that is well regarded by the Ecuadorian society for economic reactivation, which should increase the number of branches, increase financial products, invest in technological banking development for the optimization of processes and operational management, review the interest rate offer to international levels, which could be up to 4% to improve competitiveness and access to larger amounts of credit.

The intermediate level of delinquency and efficiency must currently be improved based on an adequate management and initial processes of credit opening and recovery. The prevailing crisis in the country since 2012 affects this recovery affecting mainly in the growth of the unemployment level and as a consequence of this the family economies cannot respond to obligations that have been

aggravated by the pandemic of Covid-19, in this way the companies lose the capacity to comply with the obligations contracted in the national financial system, reason why the delinquency has been increasing in this item.

The development of entrepreneurship and economic reactivation post Covid-19, is a shared task of civil society and the institutions that represent development banking, as this will generate sources of employment for a better performance of macro indicators and thus minimize migration processes of its citizens in search of social and economic improvement.

References

Asociación De Bancos del Ecuador (March 1, 2021). *The role of Ecuadorian banking during the pandemic: from the important to the indispensable*. <https://asobanca.org.ec/destacadas/el-rol-de-la-banca-ecuatoriana-durante-la-pandemia-desde-lo-importante-hasta-lo-indispensable/#:~:text=Para%20tranquilidad%20tranquilidad%20de%20ocasi%207,del%20Banco%20Central%20del%20Ecuador>.

Banco de Desarrollo del Ecuador B.P. (April 23, 2020). *Introduction to EDB*. <https://bde.fin.ec/introduccion-al-bde/>

Banco Ecuatoriano de la Vivienda. (September 11, 2017). <http://www.bev.fin.ec/index.php/quienes-somos/la-institucion>. Retrieved September 11, 2017, from <http://www.bev.fin.ec/index.php/quienes-somos/la-institucion>

BanEcuador (May 15, 2015). *BanEcuador.fin.ec*. Retrieved November 2, 2021, from <https://www.banecuador.fin.ec/>

Blessing, A., & Ojona, E. (2015). THE ROLE OF FINANCIAL STATEMENTS ON INVESTMENT DECISION MAKING: A CASE OF UNITED BANK FOR AFRICA PLC (2004-2013). *European Journal of Business, Economics and Accountancy*, 3, 12-37.

Bridgham, E., & Houston, J. (2005). *Fundamentals of Financial Management*. Thomson.

Budd, B. (2011). The Value-Relevance Of Internet Web Traffic And Revenue On Top Arab Banks "Comparative Efficiency Performances. *International Business & Economics Research Journal*, 10(2), 39-51.

Bunea, O., Corbos, R., & Popescu, R. (2019). Influence of some financial indicators on return on equity ratio in the Romanian energy sector - A competitive approach using a DuPont-based analysis. *Energy*, 189. <https://doi.org/10.1016/j.energy.2019.116251>.

Burneo, S. (2010). Analysis of public banking in Ecuador, as a promoter of development and corrector of market failures, period 2000-2009. [Unpublished thesis] Pontificia Universidad Católica del Ecuador.

National Finance Corporation (February 15, 2016). Corporación Financiera Nacional B.P. <https://www.cfn.fin.ec/corporacion-financiera-nacional>

Corporación Nacional de Finanzas Populares y Solidarias (National Corporation of Popular and Solidarity Finances) (December 15, 2021). *Who we are*. <https://www.finanzaspopulares.gob.ec/quienes-somos/>

Cortéz, A., Rayo, S., & Lara, J. (May 19, 2015). An Explanatory-Predictive Model of the Financial Profitability of Firms in the Main Spanish Economic Sectors. [Conference] XVI CONGRESO AECA, 2-24.

Díaz, J., Molina, E., & Navarrete, P. (2017). Fuzzy logic and financial risk. A proposal for financial risk classification to the cooperative sector. *Contaduría y Administración*, 62(5),1670-1686. <https://doi.org/10.1016/j.cya.2017.09.001>

Diéguez, A., Blanco, A., & Oliver, M. (2016). Modeling the self-sufficiency of microfinancial institutions using logistic regression based on principal component analysis. *Journal of Economics, Finance and Administrative Science*, 40, 30-38. <https://doi.org/10.1016/j.jefas.2015.12.002>. <https://doi.org/10.1016/j.jefas.2015.12.002>

Dumrauf, G. (2003). *Finanzas Corporativas*. Grupo Guía.

Fang, L., Xiao, B., & Yu, H. (2018). A stable systemic risk ranking in China's banking sector: Based on principal component analysis. *Physica A: Statistical Mechanics and its Applications*, 492, 1997-2009. <https://doi.org/10.1016/j.physa.2017.11.115>. <https://doi.org/10.1016/j.physa.2017.11.115>

Faura, U., Gómez, J., Pérez, M., & Gómez G, J. (2012). Comparison of efficiency rankings using principal

component analysis and DEA. *Estadística Española*, 54(178), 357-373.

García, D., & Fuente, M. (2011). Comparative study of fault detection techniques based on Principal Component Analysis (PCA). *Iberoamerican Journal of Automatics and Industrial Informatics*, 8(3), 182-195. <https://doi.org/10.1016/j.riai.2011.06.006>

García, O. (2015). Du Pont formula and its profitability as seen from the managerial perspective. *Inquietud Empresarial*, 14(2), 89-113
<https://doi.org/10.19053/01211048.3342>

Gestiópolis (June 14, 2001): What is CAMEL risk analysis? <https://www.gestiopolis.com/ques-el-analisis-de-riesgo-camel/>

Gitterio, A., & King, T. (2023). The role of Environmental, Social, and Governance (ESG) in predicting bank financial distress. *Finance Research Letters*, 51,1-7.
<https://doi.org/10.1016/j.frl.2022.103411>
<https://doi.org/10.1016/j.frl.2022.103411>

Godspower, E., & Ojah, K. (2021). Market discipline, regulation and banking effectiveness: Do measures matter? *Journal of Banking & Finance*, 113, 133.
<https://doi.org/10.1016/j.jbankfin.2021.106249>
<https://doi.org/10.1016/j.jbankfin.2021.106249>

González, J., & Gutierrez, C. (2016). Modeling bank solvency in adverse scenarios-application to PIIGS. *Journal of Accounting*, 227-238.
<https://doi.org/10.1016/j.rcsar.2015.11.002>.

Granel, M. (2021). *Dupont system for cost-effectiveness analysis*. <https://www.rankia.cl/blog/analisis->

ipsa/3926169-sistema-dupont-para-analisis-rentabilidad

- Liu, Q., Gui, Z., Xiong, S., & Zhan, M. (December 2021). A principal component analysis dominance mechanism based many-objective scheduling optimization. *Applied Soft Computing*, 113, Part B. <https://doi.org/10.1016/j.asoc.2021.107931>
- Meiderdaniel (March 24, 2010). *THE CAMEL EVALUATION METHOD* <https://meiderdaniel.wordpress.com/2010/03/04/el-metodo-de-evaluacion-de-camel/>
- Olawale, F., & Garwe, D. (2010). Obstacles to the growth of new SMEs in South Africa: A principal component analysis approach. *African Journal of Business Management*, 4(5), 729-738.
- Poretti, C., & Yoonjoung, C. (2022). COVID-19 and firm value drivers in the tourism industry. *Annals of Tourism Research*, 95. <https://doi.org/10.1016/j.annals.2022.103433>. <https://doi.org/10.1016/j.annals.2022.103433>.
- Restrepo, J., Vanegas, J., Sierra, L., & Vargas, A. (2017). A financial approach to the export potential of marketers. *Revista Facultad Ciencias Económicas*, 25(1), 41-56. <https://doi.org/10.18359/rfce.2653>
- Romero, B. (2015) The Structure of the Ecuadorian Financial System. <https://tusfinanzas.ec/la-estructura-del-sistema-financiero-ecuadoriano/#:~:text=El%20sistema%20financiero%20ecuadoriano%20ecuadoriano%20se,compa%C3%B1>

%C3%ADas%20auxiliares%20del%20sistema%20financiero%20.

Rosillón, N., & Marbelis, A. (2009). Financial analysis: a key tool for efficient financial management. *Revista venezolana de gerencia - Universidad de Zulia*, 48, 606-628.

Ross, S., Weaterfield, R., & Jordan, B. (2010). *Fundamentals of Corporate Finance*. Mc Graw Hill.

Salinas, H., Almenara, J., Reyes, A., Silva, P. E., & Abellán, M. (2006). Study of variables associated with skin cancer in Chile using principal component analysis. *Actas Dermo Sifiliográficas*, 97(4), 241-246. [https://doi.org/10.1016/S0001-7310\(06\)73391-9](https://doi.org/10.1016/S0001-7310(06)73391-9)

Sepúlveda, O., Piña, G., & Colado, C. (2018). Financial profitability, applying the DuPont System: The case of three companies established in Mexico. *Congreso Escala*, 179-192. Tecnológico Nacional de México.

Stoica, O., Mehdian, S., & Sargu, A. (2013). The impact of internet banking on the performance of Romanian banks: DEA and PCA approach. *Procedia Economics and Finance*, 20, 610-621. [https://doi.org/10.1016/S2212-5671\(15\)00115-X](https://doi.org/10.1016/S2212-5671(15)00115-X).

Sun, L., Wang, K. X., Zhang, C., & Balezentis, T. (2022). A time-varying distance based interval-valued functional principal component analysis method - A case study of consumer price index. *Information Sciences*, 589, 94-116. <https://doi.org/10.1016/j.ins.2021.12.113>.

Superintendency of Banks of Ecuador (August 27, 2022). *Financial Institutions Risk Rating 2021*.

<https://www.superbancos.gob.ec/bancos/calificacion-de-riesgo-instituciones-financieras-2021/>

Terreno, D. (2013). Empirical analysis of the Dupont relationship. *Accounting and Decisions*,5(1),11-33.

Véliz, C. (2017). *Multivariate analysis, multivariate statistical methods for research*. Cengage Learning Argentina.

Zhong, R., Liu, S., Li, H., & Zhang, J. (2021). Robust functional principal component analysis for non-Gaussian longitudinal data. *Journal of Multivariate analysis*.

<https://doi.org/10.48550/arXiv.2102.00911>.

.

**Evaluation of learning in the Diploma
Course: Methodology in teacher training
for the online modality. University of
Otavalo**

Jesús Francisco González Alonso
Doctor in Pedagogical Sciences
University of Otavalo
Central Institute of Pedagogical Sciences
jesusfgonzalezalonso@gmail.com /
jgonzalez@uotavalo.edu.ec
0000-0001-6761-6588

Introduction

The methodology for the creation of an online diploma course implies to respond to the requirements of the teachings in which it is enrolled because when it comes to this training modality for teachers, a basic learning tool is being built, the attached materials are essential to overcome each of the modules that are integrated in the figure of the diploma course, resulting in a support to the teaching-learning process through the different tools and materials available that are only supported by online resources where the network is the main means of access to information. According to Andrés (2014) "Users of digital technologies can be connected and exchange information in real time. This is manifested in the enormous amount of content and the high reach of its distribution." (p.17), so it can be stated that the use of these in education favors the interconnection with students and teachers strengthening the teaching process through the application of appropriate learning strategies.

This requires a virtual classroom, which according to Barberá and Badia (2005), "is the organized integration of

many digital resources of text, image, sound and animation; there is affordable software that proposes and facilitates its customization, such as webCT, FirstClass or similar applications" (p.3). (p.3). Thus, the virtual classroom for online education, its learning to be categorized as efficient and effective, must be designed with the objective of facilitating teaching and e-learning through the use and interaction of the didactic means and the various members involved in the teaching-learning process: access to teaching materials (these must be dynamic and interactive), contact with colleagues who integrate the proposal of the diploma as: teachers authors, tutors, institutional tutor or coordinator of continuing education and students. The organization and planning of the study, consultations and exchanges of information to be able to develop both individual and group work that allows learning and follow-up to the program.

Based on this, the old concept that the teacher is only the one who knows and manages all the content must be modified. In a process of digital learning interaction, "the teacher must assume a change of protagonism in the teaching/learning process, and his main objective will be to help the student to be an active agent and protagonist of his own learning". (García-Valcárcel and Muñoz-Repiso 2007, p.127).

Within the strategic projection until the year 2020, the University of Otavalo had set as an objective: To design degree programs for the online modality, mainly involving two areas of knowledge, referring to business sciences (with the Business Administration and International Business programs) and education sciences (with the Basic Education program), providing a total of three degree programs that are covered under a study of penitence and labor demand.

When designing a virtual learning environment, in addition to deconstructing the role of the teacher, it is necessary to use evaluation processes that serve as a means for students to participate and interact with each other (Rodríguez Martín & Castillo Sarmiento, 2019). On the other hand, when designing an evaluation process for an online program, it should be considered that it should be reliable, effective and cover the proposed aspects according to their order (quantitative and qualitative). It can be stated that the evaluation of learning is nothing more than the summative and formative result through the different resources that not only aims to inform the student about the progress of the program, but also to benefit learning.

The evaluation for the online modality can be carried out in different ways, therefore the following can be proposed: exams (which should cover different aspects and therefore it is recommended to include open and multiple choice questions), team work (designed to develop problem solving skills), forums, debates and other tools can also be included, depending on the platform used.

Based on this, the vertiginous changes in which education finds itself as a result of the use of information and communication technologies lead to the implementation of new teaching strategies. In virtue of this, a quality education is demanded, which is offered by virtual and online teaching spaces, where the position of the teacher and the student are modified with the purpose of encouraging a more dynamic and real learning, which can be carried out either synchronously or asynchronously.

This new reality requires the training of teachers in the application of online teaching methodologies, so the research is aimed at designing a diploma program for the academic staff of the University of Otavalo in Ecuador. The

first specific objective is formulated to diagnose the training situation of these teachers, to then continue with the design of the program itself and finally culminate with the evaluation.

Thus, the evaluation proposal will be based in theory on what is stated by Covadonga (2019) when referring to the learning analysis process as one that requires the collection, processing and interpretation of data in order to measure it, with the purpose of converting these results into new knowledge, since the purpose of learning analytics is to improve educational practice to broaden the spectrum that covers the teaching-learning process with the use of digital platforms such as LMS (Learning Management System), digital interaction between teachers/tutors and participants, not only in virtual classrooms, but also during teaching practices, both individually and in teams, (Learning Management Systems), digital interaction between teachers/tutors and participants, not only in virtual classrooms, but also during teaching practices, both individually and in teams.

From the theoretical point of view, the research will provide elements to strengthen the design of diploma courses of this type, which are necessary to improve the training of the teaching staff in online teaching. From the practical point of view, it will allow obtaining results that will serve to improve the implementation of didactic strategies in this type of virtual environments.

Online training must constitute a firm solution that guarantees the pedagogical quality of the resources and the teaching-learning process: It should be noted that constructivism has been considered by various scholars of the subject as a new educational culture that encompasses

an integrated set of principles that serve as a guide to the educational process.

In this context, learning becomes an active process and not a mere reception - passive memorization of data: learning implies a reconstruction of the information where the new information is integrated and related to that possessed, resulting in the teacher acquiring a role of facilitator of learning, of academic and personal development, the student is ultimately responsible for his learning process where we consider the results of the same, as a last instance, depend on him, on his constructive mental activity.

Paraphrasing Pedraz Marcos et al. (2014), social sciences start from the knowledge of reality from a scientific perspective, so methodology is essential to mark the path to follow in any research process. Based on this, the proposal, from the methodological point of view, has a route that allows identifying the type of research to be carried out. It constitutes an evaluative study framed in a mixed approach.

The methodology is structured in three phases:

1. A diagnosis of the level of preparation of the academics of the University of Otavalo was made through the application of a questionnaire;
2. The didactic and methodological components for the design of the training program are characterized through field work, group activities and bibliographic review.
3. The results of the diploma course are evaluated.

The population is made up of teachers from the following areas of knowledge: business sciences (34 teachers); education sciences (19 teachers). A non-probabilistic sampling will be applied to define the sample size, which according to Hernández and Carpio (2019), the

characteristics of the sample are based on the researcher's criteria and are chosen intentionally, which favors access to the subjects or their voluntary participation in the study.

The first stage allowed us to diagnose the level of preparation in the online teaching modality of the teaching staff that make up the two areas of knowledge where these proposed careers will start, the instrument to collect, process, present and analyze the information has been a questionnaire validated by three experts in the sciences of education; obtaining the following results:

With reference to how the faculty is composed according to the levels at which they work as teachers, 64% of the professors perform undergraduate activities, while 19% perform undergraduate and graduate activities, leaving 17% who only perform graduate tasks. The percentages show that the undergraduate level is the one with the highest number of professors, which corresponds to the enrollment of the University of Otavalo, since the higher level is also located at this level (Table 1).

Table 1. *Composition of the teaching staff according to the levels at which they teach.*

Level of teaching	Frequency %	
Grade	34	64
Post Graduate	9	17
Both levels	10	19

Source: own

Table 2 shows the degree levels of the teaching staff; as can be seen, 79% of the teachers have master's degrees, while 21% have completed doctoral studies (Table 2).

Table 2. *Description of degree levels of the teaching staff.*

4th level qualification achieved	Frequency	%
Master's Degree	42	79
PhD	11	21

Source: own

The identification of teachers by generations according to age shows two realities that are important to highlight: 21% of teachers belong to generation Y, known as millennials, and 15% belong to the Baby Boomers group; the next group between the ages of 40 to 44 and 45 to 49 years old belong to generation X with 13% each. The generational gap in the teaching staff opens up as a space that allows online teaching, since it requires technological skills and abilities, a fact that seems to be fulfilled with the resulting generations (Table 3).

Table 3. *Identification of teachers by generations according to age*

Teacher's age range	Frequency	%
25 / 29 years old	4	8
30 / 34 years old	11	21

35 / 39 years old	5	9
40 / 44 years	7	13
45 / 49 years old	7	13
50 / 54 years old	6	12
55 / 59 years old	8	15
60 + years	5	9

Source: own

On the other hand, full-time professors represent 68% of the teaching staff at the University of Otavalo, while 23% are hired for professional services and 9% are part-time. This shows that the human capital for online training is concentrated in full professors (Table 4).

Table 4. *Development of time according to the hiring of the teacher at the University*

Time dedicated to teaching	Frequency	%
Full time	36	68
Part-time	5	9
Professional Services	12	23

Source: own

With reference to the value given by teachers to the use of new technologies in the classroom, 7 criteria were proposed, from which teachers were able to select three; the most important were that they improve learning (21%) and that with the use of new technologies there is access to a greater number of contents and resources (17%), as well as an improvement in digital competence (Table 5).

Continuing with the aspects of employment and use of technologies, Table 6 shows the level of employability of digital tools in the classroom, where it can be seen that in the period evaluated, 60% of teachers stated that they applied these tools, while 32% did so in previous periods (Table 6).

Table 6. *Level of employability of digital tools in classrooms according to different periods analyzed.*

Criteria	Frequency	%
In previous periods	17	32
In the current period	32	60
Not yet working	4	7

Source: own

On the other hand, when asked about the teachers' assessment of their students' motivation to use new technologies in class, the indicator showed a high (60%) and very high (29%) tendency, which shows that these technologies increase students' interest (Table 7).

Table 7 *Teachers' evaluation of students' motivation through the use of new technologies in the classroom*

Criteria	Frequency	%
Very high	15	29
High	32	60
Download	5	1
Very Low	1	0
None	0	0

Source: own

In addition, it was shown that 42% of the teachers use technological tools on their own initiative, which reaffirms the fact that teachers are prepared and knowledgeable in the use of these tools, which is also highlighted by 13% who said they knew about them and 24% who said they applied them with the support of the IES (Table 8).

Table 8 *Teachers' employability of technological tools in classes*

Criteria	Frequency	%
On its own initiative	22	42
Through the IES	13	24

Help from friends, relatives, etc.	11	21
I already knew how to use and apply digital tools	7	13

Source: own

The description of the digital content used by teachers in their classes showed that 58% use content taken from the Internet (Blogs, You Tube, Web of open resources), while 23% indicated that they use the product of publishers (digital books, resources and platforms) (Table 9).

Table 9 *Description of digital content used by teachers in their classes*

Criteria	Frequency	%
Publisher content (digital books, resources and platforms)	12	23
Content extracted from the Internet (Blogs, You Tube, Open Resource Web, etc.)	31	58
Self-created content	10	19

Source: own

With reference to the value that teachers give to the application of new educational technologies, Table 10 shows 11 criteria, of which they were able to select 3, where it is indicated that 14% of them improve teacher training, while 13% stated that with the use of these technologies a

greater motivation is achieved in students and 12% stated that they contribute to improve digital competencies in teachers and students, such as increasing academic performance (11%).

Table 10 *Assessment of challenges for the teacher in the application of new educational technology*

Criteria	Frequency	%
Achieving greater student motivation	21	13
Ensure access to resources and infrastructure	12	8
Increased support for the personalization of learning	13	8
Increase education in values and emotional skills.	9	6
Increase academic performance	17	11
Reaching consensus on educational legislation	4	2
Reducing school dropout and failure rates	16	10
Improving teacher training	22	14

Further develop digital competence in teachers and students.	19	12
Improving working conditions for teachers	11	7
Improving competency-based education	15	9

Note: Teachers were able to select three criteria

Source: own

Our stage was marked by the methodological design for the diploma course with the participation of four Doctors of Education (PhD), three directors of substantive functions (teaching, liaison and research), two career directors (business sciences and educational sciences), director of information technology and communications, curriculum coordinator and the vice rector. Providing the following structure for the proposal of the diploma course:

Module No. 1: Legal foundations for the online modality

Module 2: Introduction to online methodology.

Module 3: The teaching function in the online modality.

Module No. 4: Functional design for the virtual classroom and didactic resources in the online modality.

Module No. 5: The role of linking with society in the online modality.

Module 6: The research function in the online modality.

Each module consisted of 8 hours of contact with the professor, 16 hours of self-learning component and 16 hours of experimental practical component, making a total of 40 hours per module for a total of 240 hours, thus complying with the regulations for online, distance and blended learning academic programs, approved by the Higher Education Council (CES) of the Republic of Ecuador.

Within the methodology designed by the aforementioned team, for the development of each module, the following digital documents were prepared:

- 1- Analytical program of the diploma
- 2- Life sheets (teacher authors / tutors)
- 3- Orientation Classes
- 4- Tutoring classes
- 5- Methodological didactic guide
- 6- Diploma student's study guide
- 7- Support activities (2)
- 8- Module evaluation
- 9- Bibliographic references document

This team designed how the virtual classroom would be developed for each module of the diploma course:

A. General

1- Module identification: e.g. Introduction to online methodology (an illustration should be included afterwards).

2- Notice: Students are welcomed (must be developed in each subject and the author teacher and tutor must appear).

3- Resumes: (a summary and all contact information of the author teacher and tutor are presented)

4- Academic Calendar: Rational distribution of time for planning, organization, execution and evaluation of activities.

5- Teaching Schedule: It is the time that, distributed in periods of orientation classes and tutorials, for the development of activities of the teaching-learning process.

6- Bibliographic Document: It is developed according to the textbooks oriented by the author and tutor teacher.

B. Learning Modules Ex. Module No. 2: Introduction to online methodology.

1- Periodic identifier: (data appears in the academic calendar)

Ex. Week No. 1 / December 5 to 10, 2022

2- Orientation classes: They are asynchronous, link is shared

3- Tutorial Classes: They are synchronous, once finished, the link is shared.

4- Methodological Didactic Guide: It is an instrument of great value for the standardization of the work of teachers and students.

5- Student Guide: It has information and orientation on the learning path of the subject per week.

6- Support Activity No. 1 and 2: These activities are oriented to the student to reinforce and expand the knowledge of the subject under study, depending on the hours of practical experiential learning and autonomous learning.)

7- Module evaluation:

It is the verification of the teaching-learning process to determine, in a systematic way, the merit, the significance of a work and the intellectual capacity of the students.

For the development of this project, an academic team from the university was proposed, composed according to the structure presented for each module and shown in Table 11.

Table 11 *Composition of the teaching team for the development and execution of the proposed diploma course*

Module	Professor Author	Tutor Teacher
1	MSc / Director of the Education Sciences Area	MSc/ Director of the Business Science Department
2	PhD / Curriculum Coordinator	PhD / Vice Chancellor
3	PhD / Full-time Professor	PhD / Degree Director

4	PhD: Full-time Professor	MSc: ICT Manager
5	PhD/ Master in Education Coordinator	MSc: Director of Social Outreach
6	PhD / Full-time Professor	MSc: Research Director

Source: own

To evaluate the results obtained in each module, a scale was prepared considering the value of the average grades obtained in each module, as shown in Table 12.

Table 12 *Scale for the analysis of results*

Level	Average values
Very poor	0 a 25
Deficient	25 a 50
Regular	51 a 75
Good	75 a 90
Excellent	91 a 100

Source: own

The results obtained from the evaluation criteria of the modules indicate an average value of 83.17 for the accessibility to the EVA, 88.83 for the communication of the formative space, 90.17 for the presentation of the module, 89.50 for the student's guide, 87.67 for the methodological didactic guide, 88.83 for the sense of educational community, 78 for the support activities, which according to the scale is located at a good level. A value of 91.67 for the evaluative activities, 94.33 for the teacher's role and 93.33 for the tutor's role, which is at an excellent level. The overall average was 88.55, with a standard deviation of 11.266, which allows inferring that most of the teachers who taught the modules of the diploma course are at a good to excellent level, see Table 13.

Table 13 *Descriptive statistics of the module evaluation criteria*

Evaluation criteria	N	Average	Standard deviation	Standard error
Accessibility to EVA	6	83,17	13,776	5,624
Communication of the training area	6	88,83	9,432	3,851
Presentation of the module	6	90,17	14,148	5,776
Student Guide	6	89,50	8,573	3,500

Didactic methodology	guide	6	87,67	9,480	3,870
Support activities		6	78,00	21,005	8,575
Evaluation activities		6	91,67	7,501	3,062
Role of the teacher-author		6	94,33	2,658	1,085
Role of the tutor		6	93,33	7,257	2,963
Sense of educational community		6	88,83	6,735	2,750
Total		60	88,55	11,266	1,454

Source: own

In this sense, it can be seen that there are differences in the average results for each of the modules taught in the diploma course, module 1 had an average of 80.20, module 3, 78.70, module 5, 89.50, which are located in the good level, however, module 2 obtained a value of 93.80, module 4, 94.40 and module 6, 94.70, which are located in the excellent level according to the results of the scale, see table 14.

Table 14 Averages obtained from the evaluations of each module

Modules	N	Average	Standard deviation
Module No 1	10	80,20	18,097
Module No 2	10	93,80	6,546
Module No 3	10	78,70	10,802
Module No 4	10	94,40	3,596
Module No 5	10	89,50	5,255
Module No 6	10	94,70	2,751
Valid N	10		

Source: own

To check if there are significant differences between the results of the averages for the evaluation of each module, an analysis of variance was applied, resulting in an F value of 1.129 with a sig. value of 0.361, which allows us to deduce that there are no significant differences between the average results obtained in each module, as can be seen in Table 15.

Table 15 Analysis of variance for the modules

Modules	Sum of squares	Degrees of freedom	Mean square	F	Sig.
Between groups	1264,683	9	140,520	1,129	,361
Within groups	6224,167	50	124,483		
Total	7488,850	59			

Source: own

The results showed that the use of digital tools favors the teaching-learning process, since the teachers stated that it contributes to teacher training, favors student motivation and allows access to updated materials and content. Similarly, the conformation of the faculty also evidenced the preparation of teachers in 4th level studies, which implies having developed skills and abilities to enhance training in online teaching.

The research allows us to evaluate and replicate the experience in other HEIs, since it has served to implement online careers in a satisfactory manner at the University of Otavalo. Likewise, the study guarantees the continuous training of teachers in order to think about opening other careers in other areas of knowledge, since it would be convenient to ask the following question: Does the continuous training of teachers guarantee the success of the careers offered? It could be discussed whether the human

and technological potential is sufficient to guarantee the long-term sustainability of online teaching.

Conclusions

The executed research analyzed the actions of teachers who develop the virtual modality, the susceptibility to change of teaching praxis in virtual teaching-learning environments; the understanding of the change of teaching role required in virtuality to explain what happens; the interpretation of what should happen; the contribution of their points of view.

The implementation of new strategies aimed at improving the mode of study that allows for the expansion of academic offerings and access to higher education studies will represent a great benefit for everyone, with education as the basis for the development of the country's human talent.

References

- Adams, R. (1969). The technology gap: some of its implications for Latin America. *International Forum*, 10(37), 28-40.
<http://forointernacional.colmex.mx/index.php/fi/article/view/434/424>
- Alva de la Selva, R. (2015). The new faces of inequality in the 21st century: the digital divide. *Revista Mexicana de Ciencias Políticas y Sociales*, 60(223), 265-285.
doi: [http://dx.doi.org/10.1016/S0185-1918\(15\)72138-0](http://dx.doi.org/10.1016/S0185-1918(15)72138-0)
- Andrés, G. D. (2014). A conceptual approach to the "social appropriation" of ICT. *Question/Cuestión*, 1(43), 17-31.
Retrieved from <https://perio.unlp.edu.ar/ojs/index.php/question/article/view/2227>

- Arias Guerrero, M (2012). Didactics and web technology tools in interactive distance education. *Educere*, vol. 16, no. 53, January-April, 2012, pp. 21-36.
- Constituent Assembly of the Republic of Ecuador. Constitution of the Republic of Ecuador. 2008. Quito, Ecuador. Official Gazette. N° 449. Year II, of 10-20-2008.
- Barberá, E., & Badia, A. (2005). Towards the virtual classroom: teaching and learning activities in the network. *Revista Iberoamericana De Educación*, 36(9), 1-22. <https://doi.org/10.35362/rie3692769>
- Covadonga, M. (2019). Presentation. Learning Analytics and Education: Classifying, describing and predicting student learning. *Iberoamerican Journal of Education*, (80), 1, 9. <https://rieoei.org/RIE/issue/view/Learning%20Analytics/vol%2080%281%29>
- Creswell, J. W. (1999). Mixed-method research: introduction and application. In G. J. Cizek, (Ed.), *Handbook of educational policy* (pp. 455-472). San Diego, CA: Academic Press.
- Gabo, F. (2019). Convivencia en Red. <https://fundaciongabo.org/es/blog/convivencias-en-red/ya-estamos-en-una-sociedad-redmanuel-castells>
- García-Valcárcel, Muñoz-Repiso, A. (2007). TECHNOLOGICAL TOOLS TO IMPROVE UNIVERSITY TEACHING. UNA REFLEXIÓN DESDE LA EXPERIENCIA Y LA INVESTIGACIÓN. *RIED. Revista Iberoamericana de Educación a Distancia*, 10(2),125-148. ISSN: 1138-2783.

<https://www.redalyc.org/articulo.oa?id=331427207006>

García, L.; Ruiz, M. & Domínguez, D. (2006). From distance education to virtual education. *Revista Barcelona, Ariel*, 303 pp.

García, M and García, R. (2010). Managing for results in development. *Advances and challenges in Latin America and the Caribbean*. Washington: Inter-American Development Bank. Retrieved from https://com/bchaupas/docs/la_gestion_para_resultados_en_el_desarrollo

Gimeno, J. (2010), What is curriculum? *Revista Sinectica*, (34), 11-43. http://www.scielo.org.mx/scielo.php?script=sci_artext&pid=S1665-109X2010000100009&lng=es&tlng=es

Hernández-Ávila, C. E., & Carpio Escobar, N. A. (2019). Introduction to the types of sampling. *Alerta, Revista científica Del Instituto Nacional De Salud*, 2(1 (January-June), 75-79. <https://doi.org/10.5377/alerta.v2i1.7535>

Organic Law of Intercultural Education (2015). Second Supplement to the Official Gazette No. 417 of March 31, 2011. Reform published in the Supplement to the Official Gazette of 2021.

Martínez, O. (2014). Technological tools to support education. Universidad de la Costa, Barranquilla, Colombia. https://eduvirtual.cuc.edu.co/moodle/pluginfile.php/225284/mod_resource/content/1/HERRAMIENTA

S%20TECNOLOGICAS%20DE%20APOYO%20A%20LA%20EDUCACION.pdf

Ortiz, D. (2015). Constructivism as a theory and method of teaching. *Sophia: collection of Philosophy of Education*, 19 (2), pp. 93-110.

Pedraz Marcos, A., Zarco Colón, J., Ramasco Gutiérrez, M., Palmar Santos, A. (2014). *Qualitative research*. eBook ISBN: 9788490226407. <https://www.elsevier.com/books/investigacion-cualitativa/pedraz-marcos/978-84-9022-445-8>

Pérez, M. (2010). *Teoría, Diseño y Evaluación Curricular*. Compilation. Estado de Hidalgo, México: Universidad Autónoma de Hidalgo. https://www.uaeh.edu.mx/docencia/VI_Lectura/LI TE/LECT62.pdf

Rodríguez Martín, B., Castillo Sarmiento, C. (2019). *Virtual learning environments. Possibilities and challenges in the university environment*. Ediciones de la Universidad de Castilla-La Mancha Colección ATENEA No 14. D.O.I.: <http://doi.org/10.18239/atena.14.2019>

Sabulsky, G. (2019). Learning analytics to improve teaching and monitoring through virtual environments. *Iberoamerican Journal of Education*. (80), 1, 13 - 30. <https://rieoei.org/RIE/issue/view/Learning%20Analytics/vol%2080%281%29>

Sunkel, G. (2006). *Las tecnologías de la información y la comunicación (tic) en la educación en América Latina: una exploración de indicadores*. Santiago de Chile: United Nations.

<https://www.cepal.org/socinfo/noticias/documentos/detrabajo/9/27849/Serie126final.pdf>

Villalobos, M. (2017). Technological tools in education.
https://www.researchgate.net/publication/321070484_Herramientas_Tecnologicas_en_la_Educacion

CO₂ emissions: Effects and mitigation technologies

Melendez, Jesus R. ^{1, 2, 3}

Lowy, Daniel A. ⁴

Mátyás, Bence. ⁵

¹Faculty of Technical Education for Development, Catholic University of Santiago of Guayaquil, Guayaquil, 090615, Ecuador.

² Antonio José de Sucre National Experimental Polytechnic University, Barquisimeto, 3001, Venezuela.

³ Universidad Nacional Experimental de los Llanos Occidentales Ezequiel Zamora, San Carlos, 2201, Venezuela.

⁴ Department of Mathematics, Sciences, Technologies and Business, Northern Virginia Community College, 5000 Dawes Avenue, Alexandria, VA, 22311, USA.

⁵ Genesis Sustainable Future, Ltd., 33 Rákóczi St., B-A-Z, Sáropatak, H-3950, Hungary.

Introduction

At this time, the road transport sector tends to emerge as one of the primary sources of air pollutants due to its high energy intensity and fossil fuels. This has led governments and non-profit organizations to develop and plan decarbonization strategies aimed at sustainable transport (Navas-Anguita et al., 2019). The production of total greenhouse gas (GHG) emissions from the European transport sector in the European Union (EU) in 2017 was

established at 25% of these, 53% of these emissions came from the passenger car and light commercial vehicles, and the quantification of the impact of biofuels on climate change is generally lower than that of diesel and gasoline, with average emissions savings depending on the type of biofuel: 70% for biohydrogen, 63% for improved biogas, 41% for pure biodiesel, between 54% and 7% for bioethanol (Puricelli et al., 2021).

Biomass energy can significantly reduce carbon emissions (CO₂), especially from sectors that are difficult to decarbonize, such as aviation, heavy transport, and manufacturing, including land-intensive bioenergy that often carries emissions of substantial carbon (Reid et al., 2020).

In countries like Malaysia, the commercial production of biofuels such as bioethanol allows biomass that recycles carbon dioxide from the atmosphere (Melendez et al., 2022). It would allow reducing greenhouse gas (GHG) emissions and meeting its GHG commitments in the Agreement from Paris (Szulczyk et al., 2021).

Other research related to the production of bioethanol and its adapted conversion technologies and economic evaluation of the fuel production process in the world provides alternatives for the production of biofuels from date wastes that reduce the production of greenhouse gases (Melendez, 2022a; Taghizadeh-Alisarai, 2019). In this sense, the production of biofuels in a first and second-generation integrated sugarcane biorefinery (1G-2G) represents alternatives with technical and economic feasibility (Pinto et al., 2021). The global trend is to reduce the negative global impact on the environment that occurs in industrialized countries. In this sense, the agro-industrial sector does not escape from this group that

produces goods and services that generate pollution due to fossil fuels used to generate the energy necessary for its industrial processes.

However, there are viable alternatives for energy production that can replace those of fossil origin. Currently, around 330 million metric tons of biomass residues produced per year from agro-industrial processes are estimated (Virmond et al., 2013). Therefore, industrial management accompanied by intelligent monitoring and control tools (Dhanya et al., 2020) could guarantee biofuels as a clean energy alternative, based on the implementation of techniques and methods that allow efficient conversion processes and sustainable manufacturing (Hanssen et al., 2020; Melendez et al., 2021a).

The counterpart of industrial development is the lack of attachment to clean technologies in the face of the need to progress towards greater productive efficiency with decarbonization (Ahuja and Tatsutani, 2009). The greenhouse effect has received the most significant global concern as the leading cause of global climate change (Ekwurzel et al., 2017; Abeydeera et al., 2019).

The United Nations (2018), through the Intergovernmental Group of Experts on Climate Change (IPCC), has pointed out that CO₂ concentrations should be limited to 450 ppm by the year 2100 to avoid warming above (two) 2°C. Therefore, the technological, and industrial approaches and treatment necessary to minimize these effects are based on technological systems and models.

Technological management has been in charge of developing new methods and models that allow reducing the impact of CO₂ on global warming. The engineering models studied by Katelhon et al. (2019); Yang et al. (2018)

have evaluated the co-benefits of using heat and transformation technologies for the chemical and petrochemical industry. Both terms of the legal reference are due to the integration of direct decarbonization in combined cycle plants dedicated to centralized electricity production (Abánades, 2018).

These considerations, in turn, attract the system of reflections on the danger derived from climate change and CO₂ contamination that, worldwide, must be mitigated with carbon capture and storage, as well as through bio-kidnapping, as reported by Singh and Dhar (2019). In the sense of combining enabling technologies: hardware, software, or environmental practices (Gracia and Melendez, 2019) so that all the workers involved (Melendez et al., 2018a) in the electrical energy infrastructure develop processes in a balanced way under the security and sustainable efficiency system.

In this context, this document posed the question: What is the state of knowledge reached about the impact of CO₂ emissions and its mitigation technology management? On this topic, the effects produced by CO₂ emissions on climate change are presented, and we address the technology and industrial infrastructure used within the sustainable scenario to reduce CO₂ production. The scientific literature was systematically reviewed and evaluated to answer these questions, organizing itself into a general category.

Conceptual Framework: CO₂ emissions and global warming

CO₂ emissions must be part of greater control, supervision, and legal monitoring of the States (Sikorska, 2015) to meet the global mitigation objectives (Alcaraz et al., 2019). The business and social trends are in line with the most relevant reflection on the greenhouse effect (Darkwah et al., 2018)

necessary to adjust in each human being, more than the applicability of laws, agreements, preferential trade agreements, alliances, and national and international strategies (Morin and Jinnah, 2018).

The global warming forecast reveals a series of effects on life itself (Butler, 2018), nature, and the planet's survival. It is considered that the decision-making of the different countries with the most significant pollution potential (Panagos et al., 2013), such as China, the United States of America (USA), India, among others, will be decisive for the reduction of CO₂ that directly impacts global warming.

However, total energy consumption is increasingly on the rise (Esen and Bayrak, 2017). Therefore, it is necessary to invest in other angles of technological development and innovation (Zhu, 2019; Li, et al., 2018), which will provide greater effectiveness in producing the different industrial sectors (Melendez et al., 2020). Additionally, compliance with international regulations and the application of sustainable economic models will allow the benefits of the ecological, economic, technological, productive, socio-environmental, and in a frame of reference with social responsibility (Di Vaio and Varriale, 2018; Melendez and Gracia, 2019).

Currently, technological development is focused on research related to the correct development and improvement of CO₂ capture, transport, and storage processes. According to Alcalde et al. (2018), this technology helps countries comply with international protocols and agreements in reducing CO₂.

Study design.

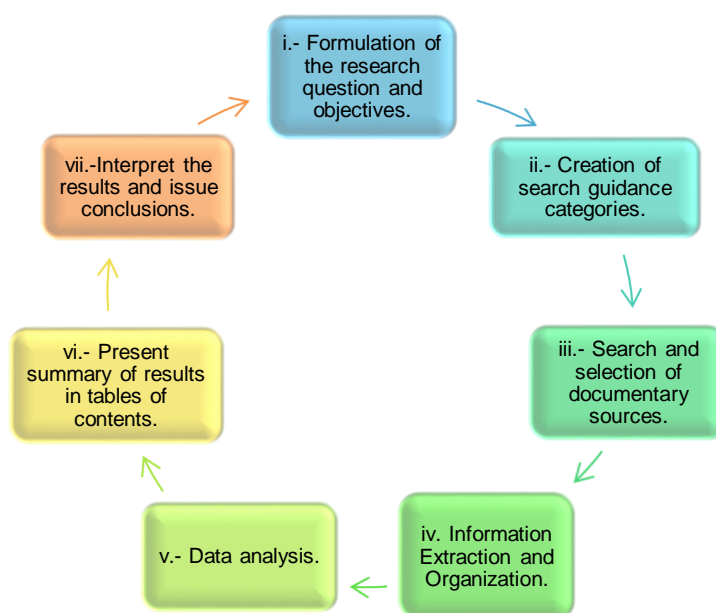
The type of research was focused on a systematic review of the literature (SRL), a question was structured on the main

topic (Beltrán, 2005), and the available evidence for the answer was systematized (Manterola et al., 2013). The study design was based on the adaptability of the established and validated steps of Paré, and Kitsiou (2017): (i) we defined research questions and objectives, (ii) established search guidance categories, (iii) searched and selected documentary sources, (iv) extracted and organized the most relevant information, (v) analyzed data, (vi) wrote the paper, presenting results thoroughly, (vii) interpreted results and drew conclusions. Figure 1 shows a flowchart in which the selection criteria are identified in a systematic and replicable technique to identify the papers that explored the topic.

The approach used was qualitative, with a descriptive and hermeneutical level (Boell and Cecez-Kecmanovic, 2014). The process is dynamic and involves mapping, selection, and interpretation of the opinions of different authors.

The primary interest gained potential by reviewing the abstracts of scientific articles related to the Impact of CO₂ emissions: technological innovation for mitigation, presented in Scopus, Web of Science, and other editorial bases. The period in which the consulted documents were presented includes dates from 2009-2021.

Main processes of completing a systematic review (Adapted from Paré and Kitsiou, 2017).



Data collection and analysis of results.

The documentary source review technique used a systematic structure adapted by phases (Paré and Kitsiou, 2017). The defined category was established as CO₂ emissions: Climate impact and mitigation technologies. The results are presented from the approaches of various researchers considering the gaps in the subject. Additionally, the information on Subcategory, Journal's Authors/year chosen for this review are presented in Table 1-2.

CO₂ emissions: Climate impact and mitigation technologies

Global warming is systemic, holistic, and its study is interdisciplinary. This forces us to evaluate its impact on climate change in various dimensions and indicators and present alternatives for its mitigation. The Paris Agreement (2016) conclusions on infrastructure and fossil fuel production indicate that by 2033, power plants, industrial equipment, circulating motor vehicles, and human activities in the world will be on the way to exceed the maximum permissible limits of CO₂ emissions. Regarding these facts, it already seems that the United States of America (USA) will withdraw for this year 2020 from the aspects expressed in the Paris Agreement on climate change.

The processes related to fossil fuels generate high concentrations of carbon dioxide (CO₂) emissions into the atmosphere. Approximately ninety percent (90%) of human activities are associated with the consumption of this type of fuel (Jackson et al., 2017). However, specific stability has been observed considering energy efficiency events and some conscious mitigation events, such as wind and renewable solar energy based on clean processes and low CO₂ production. Other natural sources that produce high concentrations of CO₂ are represented by the Agricultural activities that release around 30% of total CO₂ emissions. The primary sources of CO₂ emissions from the soil are root respiration and soil microorganisms' degradation of the organic material (Sándor et al., 2020).

However, the countries have been discussed according to the reported concentrations of CO₂ emissions, associated with global warming and perceived in the increase in the average annual surface temperature (Partanen et al. 2017). These factors could connote severe events in the damage of

climate change with irreversible consequences. In some cases, projections from current levels of 385 parts per million by volume (ppmv) to an elevation of 450-600 ppmv over the next century (Haunschild et al., 2016).

In this way, we are in the presence of atmospheric changes that cause the impact of CO₂ emissions on climate vulnerability (Solomon et al., 2009). These are determined and evidenced in elements such as temperature, environmental imbalances, precipitation, greenhouse effect, loss of biodiversity, etc. The contributions by Karmalkar and Bradley (2017) highlight that differences in global warming and the ocean are impacting continental regions of the northern hemisphere. These regions could meet expectations of rates above the global mean temperature. Thus, it is expected to exceed 2° C in about ten to twenty years above the global average temperature.

Global warming has been viewed as a complex issue to be solved, making it necessary to study it systemic, holistic, and interdisciplinary. For these reasons, it is necessary to assess its various dimensions and indicators to mitigate the 2° C estimated to reach in the next two decades in times of industrial development and progress. Bruine de Bruin and Morgan (2019) highlight the importance of this type of collaboration in addressing shared methodologies, for example, when meteorologists require to specify images, models, measurements of winds, humidity, and temperature above ground level geographical areas and resorts. These allow knowledge derived from geography, topography (Weart, 2012), physics, and mathematics (Liu et al., 2018).

The business world that encompasses the different industrial sectors are adopting measures in their production systems, moving from linear economy models

to innovative circular economy models (Resnitzky, 2021). According to the contributions of Melendez et al., 2021b, the designs of sustainable models will be in constant evolution together with the intervention of models and business management strategies that will guarantee the production of products with low environmental impact and social actions. In this sense, producing renewable energy sources based on biofuels such as bioethanol and biodiesel represents an environmentally sustainable alternative (Karagoz et al., 2018).

Global industrial development shows a lack of adoption of clean technologies. However, there is a trend towards greater production efficiency from processes with decarbonization (Ahuja and Tatsutani, 2009), which allows minimizing CO₂ emissions into the atmosphere and their anticipated adverse effects (Ebi and Ziska, 2018).

According to Hilaire et al. (2019), the idea of the technological and systemic revision of the mitigation of CO₂ emissions should be activated, considering the use of negative emission technologies that eliminate carbon dioxide from the atmosphere. These technological implications must be managed from scenarios that can cover the risks and costs of companies that adopt measures to reduce CO₂ emissions (Melendez et al., 2018b).

Some technological advances involved in developing industrial methods that allow mitigating the impact of CO₂ on global warming have been directed towards specific areas. In this sense, one of the benefits found by Rashidi and Suzana (2016) is the applicability of activated carbon concerning chemical absorption technology. This was based on the fact that it avoids a more significant energy penalty identified in regeneration and consumption of corrosive chemicals, such as an aqueous amine-based solvent.

Likewise, Quintella et al. (2011); Songolzadeh et al. (2019), monitoring the technological application in CO₂ capture is valued from absorption, adsorption, and cryogenic processes, enzymatic and hybrid distillation, and membrane separation.

Another upstream end-use model to estimate the mitigation of China's greenhouse gases, without CO₂, has been presented by Lin et al. (2019), who considers that until 2050 the macroeconomic and physical drivers of energy and non-energy demand in sectors such as agriculture, materials and waste generation could join CO₂ reduction plans.

Similarly, the membrane-based CO₂ separation process is assimilated as a substitute model for conventional chemical absorption technology (Wang et al., 2018). This is added to the capture of this gas in coal-fired power plants. They consider the applicability of the most popular afterburning, among the other two process options such as prior combustion and oxy-fuel combustion (Mukherjee et al., 2019; Gruenewald and Radnjanski, 2016).

Given the scenario and indications of global warming, shown as floods, landslides, hurricanes, storms, rising ocean temperatures (Grossman, 2018), which impact life on earth. The contributions by Samet and Woodward (2018) express that countries such as China and India have mobilized to reduce dependence on coal and derive projects that identify a sustainable way of alternative energy. Similarly, Spier (2018) affirms that the United States, for its part, takes advantage of productive considerations around seeking greater fuel efficiency for motor vehicles, establishing programs and clean energy projects, which are intended to mitigate the greenhouse effect by seventy percent (70%) by 2020, which means that despite its

withdrawal from the Paris Agreement, it has not given up its interest in this dynamic of CO₂ impact.

All these circumstances show the emergency in the actions of the States of the world to continue with the decrease in high CO₂ emissions. To this end, political (Spier, 2018; Li A, 2016) and legal antecedents prevail before this reality, such as the case pointed out by Collomb (2014), where it is evident how the Court of Appeal of The Hague issued precautionary measures for the Netherlands to reduce its emissions of greenhouse gases by 2020 by twenty-five percent (25%) compared to 1990.

Expectations continue regarding the control of CO₂ emissions on the planet with the vital management of the industrial-business sector specialized in the generation of efficient methods for reducing CO₂ in parallel with the constant expansion and industrial development.

Summary of subcategories found in the review

The situation presented in Table 1-2 allows us to understand the salient aspects found. In this sense, the subcategories derived from the consultation from the main category were identified: CO₂ emissions, climate impact, and mitigation technologies.

These subcategories highlight the topics that comprise the main category. The issue of CO₂ effects on global warming of the land and ocean is established. This situation is contrasted with the studies by Duan et al. (2019), which allows validating the vulnerability of sea ice and land snow when exposed to the effects of increased atmospheric CO₂.

Other recurring themes are also considered aspects related to global climate change, which stands out according to Fleming (2018). At the same time, Cassia et al. (2018) give

interest to the study of the increase in greenhouse gases, which disrupt the atmospheric balance and cause extreme climate changes (Mendoza et al., 2020), such as floods, droughts, and heat.

Finally, a group of subcategories focused on Technological mitigation and production models for CO₂ mitigation, described as the different technological advances in optimizing industrial processes and reducing CO₂ production through design. Methods that combine different areas of science, along with international commitments and sanctions, are necessary for offending countries.

Summary of Principal Category and subcategories grouped by authors.

	Subcategory	Journal's	Authors/year
CO₂ emissions: Climate impact and mitigation technologies.	Human activities	Environmental Research Letters	Jackson et al., (2017)
	CO ₂ in soil	F1000Research	Sándor et al., 2020
	Palliative measures	Environmental Research Letters	Partanen, et al.,(2017).

	450-600 ppmv elevation	PLoS ONE.	Haunschild, et al., (2016).
	Climate vulnerability	Proceedings of the National Academy of Sciences U S A	Solomon et al., (2009)
	Earth and ocean warming	PLoS ONE.	Karmalkar and Bradley, (2017)

Prepared by authors.

Table 2. *Summary of Principal Category and subcategories grouped by authors (Continued)*

	Subcategory	Journal's	Authors/year
	Mitigation models	Proceedings of the National Academy of Sciences. Sustainability.	Bruine de Bruin and Morgan, 2019; Weart, 2012; Liu et al., 2018;

CO₂ emissions : Climate impact and mitigation technologies		Sustainable Operations and Computers.	Resnitzky, 2021;
	Technological production for CO ₂ mitigation	<p>Renew energy.</p> <p>Sapiens.</p> <p><i>PLoS Medicine.</i></p> <p><i>Spaces.</i></p> <p>Journal of CO₂ Utilization.</p> <p>Energy Procedia.</p> <p>The Scientific World Journal.</p> <p>Scientific Reports.</p> <p>Energy Procedia.</p>	<p>Karagoz et al., 2018</p> <p>Ahuja and Tatsutani, 2009.</p> <p>Ebi and Ziska, 2018.</p> <p>Melendez et al., 2018b</p> <p>Rashidi and Suzana, 2016.</p> <p>Quintella et al., 2011.</p> <p>Songolzadeh et al., 2019.</p> <p>Lin et al., 2019.</p> <p>Wang et al., 2018.</p>

		Journal of Environmental Sciences.	Mukherjee et al., 2019. Gruenewald and Radnjanski, 2016.
	Ocean temperature rise	The American Journal of Comparative Law	Grossman, 2018
	Greater fuel efficiency	American Journal Public Health. Journal of Energy and Natural Resources Law	Samet and Woodward, 2018. Spier, 2018
	The Hague Court of Appeal	European Journal of American Studies.	Collomb 2014

Prepared by authors.

Conclusions

It is concluded that to account for compliance with national and international regulations, agreements, and proposals, they must be carried out with a multidisciplinary approach to their study. However; there is a group that argues some cognitive, social, political, and business barriers in the face of the lack of confidence, uncertainty, and risks based on the need for greater security, few regulations on the geological storage of this greenhouse gas, and another group from the international community, which promises adherence to the global commitment to mitigation (Li, Z et al., 2018) from medium and long-term planning of the national economy and social development to make forecasts that lead to CO₂ mitigation, in the sense of the negative impact that this causes in climate change (Van Meijl et al., 2018).

References

- Abánades, A. (2018). Natural gas decarbonization as a tool for greenhouse gases emission control. *Frontiers in Energy Research*. 6(47).
<https://doi.org/10.3389/fenrg.2018.00047>
- Abeydeera, L., Mesthrige, J., and Samarasinghalage, T. (2019). Global research on carbon emissions: a scientometric review. *Sustainability*. 11(3972).
<https://doi.org/10.3390/su11143972>
- Ahuja, D., and Tatsutani, M. (2009). Sustainable energy for developing countries. *Sapiens*. 2(1), pp. 1-16.
<http://journals.openedition.org/sapiens/823>
- Alcalde, J., Flude, S., Wilkinson, M., Johnson, W., Edlmann, K., Bond, C., Scott, V., Gilfillan, S., Ogaya, X., and Haszeldine, R. (2018). Estimating geological CO₂ storage security to deliver on climate mitigation.

Nature Communications, 9 (2019).
<https://doi.org/10.1038/s41467-018-04423-1>.

Alcaraz, O., Buenestado, P., Escribano, B., Sureda, B., Turon, A., and Xercavins, J. (2019). The global carbon budget and the Paris agreement. *International Journal of Climate Change Strategies and Management*. Emerald insight, 11(3), pp. 310-325.
<https://doi.org/10.1108/IJCCSM-06-2017-012>.

Beltrán, O. (2005). Systematic reviews of the literature, Rincón Epidemiológico, *Revista Colombiana de Gastroenterología*, Vol. 20, No. 1, pp. 60-69.

Boell, S., and Cecez-Kecmanovic, D. (2014). A hermeneutic approach for conducting literature reviews and literature searches. *Communications of the Association for Information Systems*, 34 (12), pp. 257-286. <http://aisel.aisnet.org/cais/vol34/iss1/12>

Bruine de Bruin, W., and Morgan, G. (2019). Reflections on an interdisciplinary collaboration to inform public understanding of climate change, mitigation, and impacts. *Proceedings of the National Academy of Sciences (PNAS)*. 116(16), pp. 7676-7683.
<https://doi.org/10.1073/pnas.1803726115>.

Butler, C. (2018). Climate change, health and existential risks to civilization: a comprehensive review (1989-2013). *International Journal Environmental Research and Public Health*. 15(10), 2266, 2018.
<https://doi.org/10.3390/ijerph15102266>.

Cassia, R., Nocioni, M., Correa-Aragunde, N., and Lamattina, L. (2018). Climate change and the impact of greenhouse gasses: CO₂ and no, friends and foes of plant oxidative stress. *Frontiers in Plant Science*.

9(273), 2018.
<https://doi.org/10.3389/fpls.2018.00273>.
<https://doi.org/10.3389/fpls.2018.00273>

Collomb, J. (2014). The ideology of climate change denial in the United States. *European Journal of American Studies*. 9(5). <https://doi.org/10.4000/ejas.10305>

Darkwah, W., Addae, M., Odum, B., and Koomson, D. (2018). Greenhouse effect: greenhouse gases and their impact on global warming. *Journal of Scientific Research and Reports*. 17(6), pp.1-9. <https://doi.org/10.9734/JSRR/2017/39630>.

Dhanya, B. S., Mishra, A., Chandel, A. K., and Verma, M. L. (2020). Development of sustainable approaches for converting organic waste to bioenergy. *Science of the Total Environment*, 723. <https://doi.org/10.1016/j.scitotenv.2020.138109>.
<https://doi.org/10.1016/j.scitotenv.2020.138109>

Di Vaio, A., and Varriale, L. (2018). Management innovation for environmental sustainability in seaports: managerial accounting instruments and training for competitive green ports beyond the regulations. *Sustainability*, 10 (783). <https://doi.org/10.3390/su10030783>.

Duan, L., Cao, L., and Caldeira, K. (2019). Estimating contributions of sea ice and land snow to climate feedback. *JGR Atmospheres*. 124(1), pp.199-208. <https://doi.org/10.1029/2018JD029093>.

Ebi, K., and Ziska, L. (2018). Increases in atmospheric carbon dioxide: anticipated negative effects on food quality. *PLoS Medicine*. 15(7), e1002600. <https://doi.org/10.1371/journal.pmed.1002600>

- Ekwurzel, B., Boneham, J., Dalton, M., Heede, R., Mera, R., Allen, M., and Frumhoff, P. (2017). The rise in global atmospheric CO₂, surface temperature, and sea level from emissions traced to major carbon producers. *Climatic Change*. Springer. 144, pp. 579-590. <https://doi.org/10.1007/s10584-017-1978-0>.
- Esen, O., and Bayrak, M. (2017). Does more energy consumption support economic growth in net energy-importing countries?. *Journal of Economics, Finance and Administrative Science*. 22(42), pp.75-98. http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S207718862017000100006&lng=es&nrm=iso
- Fleming, R. (2018). An updated review about carbon dioxide and climate change. *Environmental Earth Sciences*. 77(262). <https://doi.org/10.1007/s12665-018-7438-y>
- Gracia, G. E., and Melendez, J. R. (2019). Challenges of strategic planning in corporate social responsibility: A case of the oil sector. *Espacios*, 40(27). <https://www.revistaespacios.com/a19v40n27/19402702.html>.
<https://www.revistaespacios.com/a19v40n27/19402702.html>.
- Grossman, M. (2018). Climate change and the Individual. *The American Journal of Comparative Law*. 66(1), pp. 345-378. <https://doi.org/10.1093/ajcl/avy018>
- Gruenewald, M., and Radnjanski, A. (2016). Gas-liquid contactors in liquid absorbent-based PCC. In Ferón, P. (2016), *Absorption-Based Post-Combustion Capture of Carbon Dioxide*. New York, pp. 341-363.

- Hanssen, S. V., Daioglou, V., Steinmann, Z. J. N., Frank, S., Popp, A., Brunelle, T., Lauri, P., Hasegawa, T., Huijbregts, M. A. J., and Van Vuuren, D. P. (2020). Biomass residues as twenty-first century bioenergy feedstock—a comparison of eight integrated assessment models. *Climatic Change*, *163*(3), 1569-1586. <https://doi.org/10.1007/s10584-019-02539-x>
- Haunschild, R., Bornmann, L., and Marx, W. (2016). Climate change research in view of bibliometrics. *PLoS ONE*. *11*(7), e0160393. <https://doi.org/10.1371/journal.pone.0160393>
- Hilaire, J., Minx, J., Callaghan, M., Edmonds, J., Luderer, G., Nemet, G., Rogel, J., and Zamora, M. (2019). Negative emissions and international climate goals—learning from and about mitigation scenarios. *Climatic Change*. *Springer*, *157*, pp.189-219. <https://doi.org/10.1007/s10584-019-02516-4>.
- Jackson, R., Le Quéré, C., Andrew, R., Canadell, J., Peters, G., Roy, J and Wu, L. (2017). Warning signs for stabilizing global CO₂ emissions. *Environmental Research Letters*. *12*(110202). <https://doi.org/10.1088/1748-9326/aa9662>
- Karagoz, P., Bill, RM., and Ozkan. M. (2018). Lignocellulosic ethanol production: evaluation of new approaches, cell immobilization and reactor configurations. *Renew energy*, *143*:741-52. <https://doi.org/10.1016/j.renene.2019.05.045>.
- Karmalkar, A., and Bradley, R. (2017). Consequences of global warming of 1.5 °C and 2 ° C for regional temperature and precipitation changes in the

contiguous United States. *PLoS ONE*. 12(1).
<https://doi.org/10.1371/journal.pone.0168697>

Katelhon, A., Meys, R., Deutz, S., Suh, S., and Bardow, A. (2019). Climate change mitigation potential of carbon capture and utilization in the chemical industry, *Proceedings of the National Academy of Sciences*. 116(23), pp.11187-11194.
<https://doi.org/10.1073/pnas.1821029116>

Li, A. (2018). Hopes of limiting global warming? China and the Paris agreement on climate change. *CEFC. News Analysis. China Perspectives*. 2016 (1), pp. 49-54.
www.cefc.com.hk.

Li, Z., Song, Y., Yao, Z., and Xiao, R. (2018). Forecasting China's CO₂ emissions for energy consumption based on cointegration approach. *Hindawi. Discrete Dynamics in Nature and Society*. (4235076), pp. 1-9.
<https://doi.org/10.1155/2018/4235076>.

Lin, J., Khanna, N., Liu, X., Teng, F., and Wang, X. (2019). China's non-CO₂ greenhouse gas emissions: future trajectories and mitigation options and potential. *Scientific Reports*. 9(16095).
<https://doi.org/10.1038/s41598-019-52653-0>

Liu, J., Yang, O., Zhang, Y., Sun, W., and Xu, Y. (2018). Analysis of CO₂ emissions in China's manufacturing industry based on extended logarithmic mean division index decomposition. *Sustainability*, 11(1), 226.
<https://doi.org/10.3390/su11010226>.

Manterola, C., Astudillo, P., Claros, N., and Mincir, G. (2013). Systematic reviews of the Literature. What to know about them, *Cirugía Española*, 91, No. 3, pp. 149-155.

- Melendez, J. R. (2022a). Biotechnology and applied management in 1G and 2G bioethanol production. *Journal of Social Sciences*, 28(4 SE-Articles), 415-429. <https://doi.org/10.31876/rcs.v28i4.39139>
- Melendez, J. R., Delgado, J. L., Chero, V., & Franco-Rodríguez, J. (2021). Circular economy: A review from business models and corporate social responsibility. *Revista Venezolana de Gerencia*, 26(Special Issue 6), 560-573. <https://doi.org/10.52080/rvgluz.26.e6.34>
- Melendez, J. R. and Gracia, G. E. (2019). Theoretical perspective of corporate social responsibility in the managerial scenario: Shared implications between the company-stakeholders, *Espacios*, 40(10), pp. 1-14. <http://www.revistaespacios.com/a19v40n10/19401001.html>
- Melendez, J. R., Malvacias Escalona, A. M. and Almeida, A. (2018a). Importance of the participation of the employee in the execution of projects: Management perspectives, *Espacios*, 39(14), 21. <http://www.revistaespacios.com/a18v39n14/18391421.html>
- Melendez, J. R., Mátyás, B., Hena, S., Lowy, D. A., & El Salous, A. (2022). Perspectives in the production of bioethanol: A review of sustainable methods, technologies, and bioprocesses. *Renewable and Sustainable Energy Reviews*, 160, 112260. <https://doi.org/10.1016/j.rser.2022.112260>. <https://doi.org/10.1016/j.rser.2022.112260>
- Melendez, J.R., Peñalver, A., Pincay, P., Pulgar Nelly and Cayo, M. (2020). Determination of factors involved in

the rejection of bananas (*Musa acuminata*) intended for international commercialization, *DRC Sustainable Future*, 1(1): 48-53.
<https://doi.org/10.37281/DRCSF/1.1.6>

Melendez, J. R., Velasquez-Rivera, J., El Salous, A., and Peñalver, A. (2021a). Management for the production of 2G biofuels: Review of the technological and economic scenario. *Revista Venezolana de Gerencia*, 26(93), 78-91. <https://doi.org/10.52080/rvg93.07>.
<https://doi.org/10.52080/rvg93.07>.

Melendez, J. R., Zoghbe Nuñez, Y. A., Malvacias Escalona, A. M., Almeida, G. A., and Layana Ruiz, J. (2018b). Theory of Constraints: A systematic review from the management context. *Espacios*, 39(48), 01. <http://www.revistaespacios.com/a18v39n48/18394801.html>.
<http://www.revistaespacios.com/a18v39n48/18394801.html>

Mendoza B, Guananga N, Melendez JR and Lowy D A. (2020). Differences in total iron content at various altitudes of Amazonian Andes soil in Ecuador, *F1000Research*, 9,128.
<https://doi.org/10.12688/f1000research.22411.1>

Morin, J., and Jinnah, S. (2018). The untapped potential of preferential trade agreements for climate governance. *Journal Environmental Politics*. 27(3).
<https://doi.org/10.1080/09644016.2017.1421399>

Mukherjee, A., Abdelrasoul, A., Okolie, J., Niu, C.; and Dalai, A. (2019). Review of post-combustion carbon dioxide capture technologies using activated carbon.

Journal of Environmental Sciences (JES). 83, pp. 46-63, <https://doi.org/10.1016/j.jes.2019.03.014>.

Navas-Anguita, Z., García-Gusano, D., and Iribarren, D. (2019). A review of techno-economic data for road transportation fuels. *Renewable and Sustainable Energy Reviews*, 112, pp. 11-26. <https://doi.org/10.1016/j.rser.2019.05.041>.

Panagos, P., Van Liedekerke, M., Yigini, Y., and Montanarella, L. (2013). Contaminated sites in Europe: review of the current situation based on data collected through a European network. *Industrially Contaminated Sites and Health*.(spec), 158764, pp. 1-11. <https://doi.org/10.1155/2013/158764>.

Paré, G., and Kitsiou, S. (2017). Methods for literature reviews. In: Lau, F and Kuziemy, C. (Edits.). *Handbook of health evaluation: an evidence-based approach [internet]*.Victoria: University of Victoria.

Paris Agreement (2016). *Signature of the Paris agreement on climate change*. Paris: United Nations Development Program.

Partanen, A., Leduc, M., and Matthews, D. (2017). Seasonal climate change patterns due to cumulative CO₂ emissions. *Environmental Research Letters*. 12(7), pp. 1-9. <https://doi.org/10.1088/1748-9326/aa6ebo>.

Pinto, A. S. S. S., Brondi, M. G., de Freitas, J. V., Furlan, F. F., Ribeiro, M. P. A., Giordano, R. C., and Farinas,

C. S. (2021). Mitigating the negative impact of soluble and insoluble lignin in biorefineries.

Renewable Energy, 173, 1017-1026.
<https://doi.org/10.1016/j.renene.2021.03.137>.
<https://doi.org/10.1016/j.renene.2021.03.137>

Puricelli, S., Cardellini, G., Casadei, S., Faedo, D., van den Oever, A. E. M., and Grosso, M. (2021). A review on biofuels for light-duty vehicles in Europe. *Renewable and Sustainable Energy Reviews*, 137.
<https://doi.org/10.1016/j.rser.2020.110398>.
<https://doi.org/10.1016/j.rser.2020.110398>.

Quintella, C., Hatimondib, S., Santana, A., Freire, S., Silva, G., and de Araujo, A. (2011). CO₂ capture technologies: An overview with technology assessment based on patents and articles. *Energy Procedia*, 4, pp. 2050-2057.
<https://doi.org/10.1016/j.egypro.2011.02.087>.

Rashidi, N., and Suzana, Y. (2016). An overview of activated carbons utilization for the post-combustion carbon dioxide capture. *Journal of CO₂ Utilization*, 13, pp. 1-16. <https://doi.org/10.1016/j.jcou.2015.11.002>.

Reid, W. V., Ali, M. K., and Field, C. B. (2020). The future of bioenergy. *Global Change Biology*, 26(1), 274–286. <https://doi.org/10.1111/gcb.14883>

Resnitzky, M. H. C., Grander, G., da Silva, L. F., and Gonzalez, E. D. R. R. S. (2021). Innovation projects of packaging recycling to a circular economy. *Sustainable Operations and Computers*, 2, 115-121.
<https://doi.org/10.1016/j.susoc.2021.05.005>

- Samet, J., and Woodward, A. (2018). National government denial of climate change and state and local public health action in a federalist system. *American Journal Public Health*. 108(2), pp. S112-S113. <https://doi.org/10.2105/AJPH.2018.304395>.
- Sándor, Z., Kincses, I., Tállai, M., Lowy, D. A., Melendez, J. R., Guananga Diaz, N. I., Guevara Iñiguez, L. E., Cuenca Nevarez, G., Talledo Solórzano, V., and Kátai, J. (2020). Effect of herbicides on soil respiration: A case study conducted at Debrecen-Látókép Plant Cultivation Experimental Station. *F1000Research*, 9. <https://doi.org/10.12688/f1000research.27057.1>
- Sikorska, P. (2015). The need for legal regulation of global emissions from the aviation industry in the context of emerging aerospace vehicles. *International Comparative Jurisprudence*. 1(2), pp. 133-142. <https://doi.org/10.1016/j.icj.2015.12.004>
- Singh, J., and Dhar, D. (2019). Overview of carbon capture technology: microalgal biorefinery concept and state-of-the-art, *Frontiers in Marine Sciences*. 6(29). <https://doi.org/10.3389/fmars.2019.00029>
- Solomon, S., Plattner, G., Knutti, R., and Friedlingstein, P. (2009). Irreversible climate change due to carbon dioxide emissions, *Proceedings of the National Academy of Sciences U S A*. 106(6), pp. 1704-1709. <https://doi.org/10.1073/pnas.0812721106>
- Songolzadeh, M., Soleimani, M., Ravanchi, M., and Songolzadeh, R. (2019). Carbon dioxide separation from flue gases: a technological review emphasizing reduction in greenhouse gas emissions. *Hindawi, The Scientific World Journal*, (828131), pp.1-34.

<https://doi.org/10.1155/2014/828131>.

<https://doi.org/10.1155/2014/828131>

Spier, J. (2018). There is no future without addressing climate change. *Journal of Energy and Natural Resources Law*, 37(2), pp. 181-204. <https://doi.org/10.1080/02646811.2019.1565197>

Szulczyk, K. R., Ziaei, S. M., and Zhang, C. (2021). Environmental ramifications and economic viability of bioethanol production in Malaysia. *Renewable Energy*, 172, 780-788.

<https://doi.org/10.1016/j.renene.2021.03.055>

Taghizadeh-Alisaraei, A., Motevali, A., and Ghobadian, B. (2019). Ethanol production from date wastes: Adapted technologies, challenges, and global potential. *Renewable Energy*, 143, 1094-1110. <https://doi.org/10.1016/j.renene.2019.05.048>.

United Nations (2018). *Global warming of 1.5 ° C, Switzerland, United Nations Environment Program*.

Van Meijl, H., Havlik, P., Lotze-Campen, H., Stehfest, E., Witzke, P., and Pérez, I. (2018). Comparing impacts of climate change and mitigation on global agriculture by 2050. *Environmental Research Letters*. 13 (6).

Virmond, E., Rocha, J.D., Moreira, R.F.P.M., and José, H.J. (2013). Valorization of agro-industrial solid residues and residues from biofuel production chains by thermochemical conversion: a review, citing Brazil as a case study, *Brazilian Journal of Chemical Engineering*, 30(2), pp.197-230.

<https://doi.org/10.1590/S0104-66322013000200001>

Wang, Y., Zhao, L., Otto, A., Robinius, M., and Stolten, D. (2018). A review of post-combustion CO₂ capture technologies from coal-fired power plants. *Energy Procedia*, 114, pp. 650-665, <https://doi.org/10.1016/j.egypro.2017.03.1209>

Weart, S. (2012). Rise of interdisciplinary research on climate. *Proceedings of the National Academy of Sciences (PNAS)*. 110(1), pp. 3657-3664. <https://doi.org/10.1073/pnas.1107482109>

Yang, X., Xi, X., Guo, S., Lin, W., and Feng, X. (2018). Carbon mitigation pathway evaluation and environmental benefit analysis of mitigation technologies in China's petrochemical and chemical industry. *Energies*. 11(3331), pp. 1-125. <https://doi.org/10.3390/en1123331>.

Zhu, G. (2019). Developments on CO₂ -utilization technologies. *Clean Energy*. 3(2), pp. 85-100. <https://doi.org/10.1093/ce/zkz008>

**Strategic Planning for the Hotel School at
the Chirije-ULEAM Research Center
towards Sustainable Tourism: Logical
Framework Matrix MML**

Mayra Espinoza Arauz

Master in Business Management.
Lecturer at the Universidad Laica Eloy Alfaro de Manabí,
extension Bahía de Caráquez, Ecuador.
mayra.espinoza@uleam.edu.ec.
<https://orcid.org/0000-0003-1207-9804>.
[https://scholar.google.com/citations?user=XrEK6HoAAA
AJ&hl=es](https://scholar.google.com/citations?user=XrEK6HoAAA&hl=es)

William Renán Meneses Pantoja

Master in Innovation and Tourism Marketing
Lecturer at the Universidad Laica Eloy Alfaro de Manabí,
extension Bahía de Caráquez, Ecuador.
william.pantoja@uleam.edu.ec
<https://orcid.org/0000-0001-8080-9990>
[https://www.google.com/search?q=perfil++academic+of+
William+Ren%C3%A1n+Meneses+Pantoja&client](https://www.google.com/search?q=perfil++academic+of+William+Ren%C3%A1n+Meneses+Pantoja&client=firefox-a)

Carlos Enrique Chica Medranda

Master in Education and Social Development
Lecturer at the Universidad Laica Eloy Alfaro de Manabí,
extension Bahía de Caráquez, Ecuador.
carlos.chica@uleam.edu.ec
<https://orcid.org/0000-001-8977-8465>

Introduction

The current work is carried out with the purpose of creating a hotel school in the town of Chirije for local tourism development and practical training of service careers of the Universidad Laica Eloy Alfaro de Manabí. Also, it is proposed to: a) Develop a survey of information in the

physical area of implementation of the hotel school project; b). Analyze the existing supply and demand in the catering and lodging sector in the area; c). Develop a market study on the products and services to be offered at the hotel school; d). Propose a design for the infrastructure of the establishment based on real potentialities identified; e). Request the architectural design to professionals from the Universidad Laica Eloy Alfaro de Manabí; f). Establish the organizational design and strategic planning for the administrative structure; g) Determine the technical study of the operational business model and the determination of the material, human, technical and institutional resource needs of the project; h) Create a marketing plan for the creation, dissemination, commercialization and positioning of the service brand to be offered; i) Prepare the economic and financial structure of the project in order to determine its feasibility over the project's useful life; j) Carry out the socialization with those directly and indirectly involved in the project (natural and legal persons), including the site community, the academic and scientific community, pertinent authorities, among others; and k) Implement the project in the study area according to the specifications and previous, concurrent and feedback controls that are presented in the actual construction.

Ecuador is a country full of natural, cultural and mixed resources, likewise its geographical location in the middle of the world, has made it the guardian of valuable and attractive regions, such as the coastal region where the province of Manabí is located. This is a privileged province for its weather conditions, for the variety of agricultural production and consequently its gastronomy. In addition, being a coastal region, it has localities which have witnessed the first settlers and the arrival of the conquerors, as well as

archaeological sites. In fact, the town of Chirije is a witness of the past with its evidence present in this place.

On the other hand, taking into account that university careers are created according to their relevance to the territory, that is to say, that the coastal towns are the preferred destination for many tourists, being, therefore, the ideal place to create careers related to this activity, Tourism. For this reason, the Universidad Laica Eloy Alfaro de Manabí, Bahía de Caráquez extension, has precisely created the Hospitality and Hotel and Tourism careers.

Therefore, the students of the mentioned institution require spaces where they can apply their theoretical knowledge and develop the necessary skills required by a professional of the mentioned studies. That is why it requires scenarios where students can be in contact with real customers, the so-called Hotel School. "The Hotel-School is made up of two areas of interrelation: the Curricular area and the Organizational area, which, unavoidably, have to concur for the best setting and the greatest effectiveness for the achievement of behaviors and capacities in the students." (Castañeda, 1995, p. 109)..

It is relevant for the student the real space which will be their daily place to develop their work activities while expanding their knowledge accompanied by teachers specialists in this field, thus, as Castañeda mentions "One of the main problems of hotel schools is the lack of adequacy of its facilities so that students can learn to solve situations and problems that they must know how to solve in the immediate labor reality" (1995, p. 106). (1995, p. 106).

World Tourism Situation

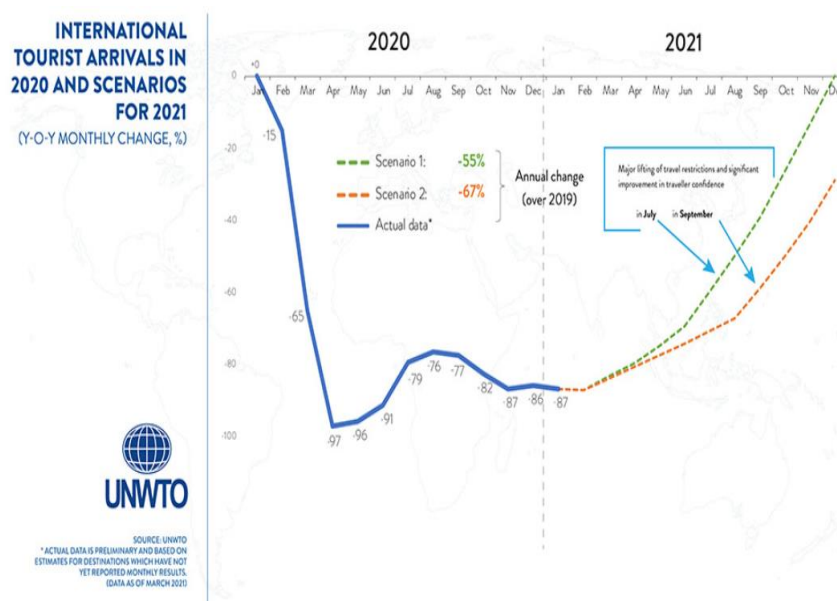
Since the pandemic appeared, the activities that have been strongly affected have been those related to tourism, having

clear that tourism is conceived as the mobility of people from one place to another for various reasons, which has been limited, affecting transportation, accommodation, food, intermediation, local tourism activities, events, among others.

Likewise, the forecasts for the recovery of tourism in the American region are foreseen for the year 2024, according to the projections made by the UNWTO" (UNWTO, 2021). (UNWTO, 2021) However, this will depend on the measures applied by governments regarding mobility restrictions; as is known, each country has made its own decisions in this area, according to the results of infected people and their respective risks of spreading the virus to vulnerable groups, including unvaccinated age groups.

In 2020, tourism activities were almost completely paralyzed, leading to a very difficult scenario, as the pandemic continued to spread throughout the world and vaccines did not arrive. Below is an image of the possible scenarios for covid 19 proposed by the UNWTO.

Figure 1 International tourist arrivals in 2020



Source: UNWTO (2021)

As can be seen, the future of tourism is framed for a slow recovery in the year 2021 and extending this recovery in subsequent years, as stated in the UNCTAD report "Experts do not expect to return to pre-pandemic levels of international tourism inflows until 2023 or even later" (UNWTO, 2021). (UNWTO, 2021) cited by (United Nations Conference on Trade and Development, n.d.)

However, it is considered that recovery may require between two and four years. However, this is good news, since the growth of the Tourism sector and all the activities it entails can be appreciated. In addition, it should be noted that the recovery implies the incorporation of jobs and the creation of new ones, due to the fact that a "New Normality" is being built, as it is currently called, that is to say, with other requirements on the part of the tourist to which the activities providing services must be adapted.

From another point of view, this recovery period can also be an opportunity to innovate activities, but also time to prepare new tourism projects, as would be the case of the Uleam Chirije Hotel School.

Tourism Growth in Ecuador

In 2019, worldwide activities developed normally, despite the existence of confirmed cases in the first foci of contagion, as was the case in Wuhan-China. However, the lack of knowledge of the danger of the virus allowed the continuity of activities, which began to slow down once it became known the contagion capacity and the effects caused to health, which could be deadly, causing immediate closure of borders and paralyzing activities, keeping only the necessary ones.

For this reason, the influx of tourists to Ecuador was severely affected, in 2018, there were 2'427,660 tourists; in 2019 a decrease was noted, with 2'043,993 tourists entering; in 2020, already declared a pandemic by the WHO, 468,894 tourists entered. So far this year 2021, 322,031 tourists entered until the month of August, that is, 4 months would be missing to have the final data for the year, however, we can see a slow recovery of the entry of tourists, which represents an encouraging outlook for tourism in Ecuador. (Ministry of Tourism, n.d.)

Likewise, the government of Ecuador articulated the parameters of entry to tourists in order to facilitate the arrival from other destinations, taking into consideration that either the PCR test or the complete vaccination are the necessary requirements to enter the country, taking into account that other countries are ahead of Ecuador in percentage of vaccinated people. (Ministry of Tourism of Ecuador, n.d.)

Precisely, with respect to tourist arrivals, these will gradually increase, not only due to the lifting of restrictions by the countries of origin and destination, but also due to the vaccination plans. In Ecuador, initially there was a lot of uncertainty due to the execution of a poorly organized vaccination plan, however, this has changed and the country already has 57.30% of people with complete vaccination. (Datosmacro.com, 2021) This means that this is an encouraging data that undoubtedly influences the confidence of tourists to choose Ecuador as a destination to visit.

It should be taken into account that herd immunity will be achieved when 75% are fully vaccinated with any of the vaccines available and approved by the World Health Organization, as mentioned by Andrew Badley, professor of molecular medicine at the Mayo Clinic in the United States, quoted in BBC (BBC, n.d.). This data shows that the country is on the right track to reach the required percentage and be a safe destination for tourists.

Determination of material resources for existing infrastructure at Chirije

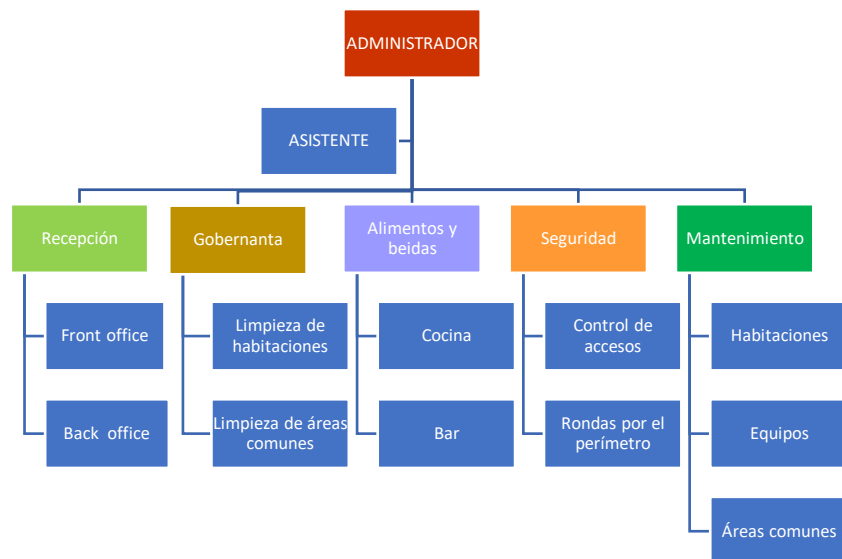
It is considered that for the opening of the school hotel in the current facilities and with the existing infrastructure, the lodging services will be enabled in the cabins of said place, which will have a capacity for 26 people; and the food and beverage service will have a capacity for 32 people in a single shift, taking into consideration the current architectural structure.

According to the visit to Chirije, the requirements for the establishment to be operational at the site visited have been reflected, taking into account that it requires a study to determine the state of the materials that make up the

physical infrastructure, which is not taken into consideration in this document. The following organization chart is proposed below:

Organization chart

Figure 2 Organization chart for Hotel Escuela



Research project

This research will contribute to the knowledge about the reality of the current situation of the community El Pajonal and its development for sustainable tourism to undertake productive activities in order to gradually develop activities that allow them, in addition to having more income, contribute to the academy, research and linkage with society. In addition, it is important to mention that the current original article derived from institutional research project of the Universidad Laica Eloy Alfaro de Manabí in its extension Sucre 1016 E01 (Bahía de Caráquez) entitled:

"Sustainable entrepreneurship from the educational practice in training processes to promote professional and organizational activity, ULEAM Sucre" and the project "Museum of History, Archaeology and Paleontology as an instrument of local development: Cases Chirije and San Isidro".

Logical Framework Matrix MML

The following Logical Framework Matrix is a general one applicable to the entire project, which will be presented specifically for each Area/Unit to be implemented, such as: Hotel School; for the Ecuadorian Tropical Dry Forest Research Unit; for the Meteorological and Climate Change Research Unit; and others.

Table 1 MML

NARRATIVE SUMMARY	INDICATOR	MEANS OF VERIFICATION	ASSUMPTIONS
<p>End</p> <p>Contribute to Science and Sustainable Development through Scientific Research and to the Cultural, Archaeological, Historical, Environmental, Tourist, Academic and Economic growth of the</p>	<p>- At the end of the project, 30% of the beneficiaries will have improved living conditions, scientific-academic and economic development, and cultural tourism.</p> <p>- The measurement of project</p>	<p>- Registered and Published Scientific Advances.</p> <p>- Number of students and teachers participating in the project.</p> <p>- Plans and projects implemented.</p>	<p>- Significant levels of contribution to the SDGs: (In some indicators more than others, such as: End Poverty; Health and Well-Being; Quality Education; Affordable and Clean Energy; Decent Work and Economic Growth;</p>

Ecuadorian Littoral.	results will contribute to the achievement of the <i>SDG targets</i> and <i>indicators</i> in which the project is directly and indirectly related.	<ul style="list-style-type: none"> - Published Scientific Production. - Trademarks, Patents and Registered Literary Works. - Tourist market capture index (Market Share). - Index of national and international researchers from specialized centers and universities doing research at the Center. 	<p>Industry, Innovation and Infrastructure; Sustainable Cities and Communities; Responsible Consumption and Production; Climate Action; Life of Terrestrial Ecosystems; Partnership to Achieve the Goals.</p> <p>- The beneficiaries are interested in continuing to participate in the programmed activities.</p>
<p>Purpose</p> <p>Create the Chirije Tropical Dry Forest Research Center - Uleam for the development of the Ecuadorian Littoral.</p>	<ul style="list-style-type: none"> - The Public Institutions of interest of the project contribute with enormous resources for the development of the project (Researchers, Archaeologists, etc.) in the years of useful life of 	<ul style="list-style-type: none"> - Number of participating institutions. - Scientific production index - Rate of students participating in internships, internships, and degree programs. 	<ul style="list-style-type: none"> - The support of the entities involved is maintained during the project development and implementation process.

	<p>the project 2022 - 2026 (Resettable date).</p> <ul style="list-style-type: none"> - The University's scientific research is strengthened by 60% in the areas of culture, archeology, history, gastronomy, agroecology, business, environment, among others. - Thirty percent of Uleam's educational community that is doing pre-professional practices and internships participates in the project. - 25% of Uleam's educational community is involved in this project. - The degree units develop 30% of projects 	<ul style="list-style-type: none"> - National and international recognition. 	
--	---	---	--

	for the development of technologies, programs, manuals, marketing plans, business plans, communication plans, and others that provide deliverable products to improve the project's operability.		
COMPONENTS	INDICATOR	MEANS OF VERIFICATION	SUPPOSITION
1. - Manage with the relevant authorities the legal documents of acquisition (donation), creation of the company and others for its operation in the scheduled times.	- 100% compliance with legal documents for operation.	Deferred Assets: Formation expenses: - Ruc - Operating permits - Articles of Incorporation: Capital Structure (Company). - Municipal Patent - Civil Contract	- The acquisition of the legal requirements for the legalization of the project is facilitated, given the scientific, archaeological, environmental and economic importance for the area.

		<ul style="list-style-type: none"> - Commercial Registration - Legal Professional Services - Trademark Registration - Others 	
<p>2. - Negotiate with the pertinent entities the development of a Soil Study to determine the location of the different areas to be built on the site.</p>	<p>- Soil Indicators (Here)</p>	<p>- Soil and Vulnerability Study.</p>	<p>- Soil conditions are adequate and/or improved (e.g. soil change and others) for constructive safety.</p>
<p>3. - Conduct an Environmental Impact Assessment (EIA) to measure the impact on the environment and the development of prevention and mitigation measures to protect the primary natural components</p>	<p>- The environmental impacts generated will be a minimum quantitative maximum of 5% in the area of the work and its radius of action.</p> <p>- Other Environmental Indicators (Here)</p>	<p>- Environmental Impact Assessment (EIA)</p>	<p>Less (-) consumption of: Matter, energy (in the whole life cycle).</p> <p>2. Plus (+) Renewability: of materials, energy, product, waste, emissions (throughout the life cycle).</p>

(water, soil and air) and its approval by the MAE and relevant entities.			More (+) Service: Service Extension; and Increased Functionality. 4. Minus (-) Nocivity: Human Health (Agroecology); and Ecosystems.
4. - Conduct a field investigation of the market served by the project to define the consumer profile, habits, tastes and preferences of potential customers, as a basis for developing a marketing plan for the project's products.	- Service acceptance level of at least 70%. - Long-term market share of 15% (gradual growth)	- Market Research - Consumer Profile - Determination of Unmet Demand	- Market segmentation with potential customers who like agro-ecological, cultural, archaeological products and services, and who like representative environmental protection.
5. - Conduct a study to know the existing supply and demand of vacancies, conditions of	- The projected demand for the products offered by the "Chirije" project covers 5% of the Unsatisfied	- Supply and Demand Study - Demand Determination (Projected)	- Existing market supply is insufficient or does not meet quality/quantity/price/other standards to

physical establishments, number of employees, sales, strategies implemented, difficulties, among others, in the restaurant and lodging sector.	Market Demand.		provide access to the project's products.
6. - Design the Project Infrastructure Plan for the digital design and layout of the facilities, spaces and different resort-type areas of the project.	- The land space can cover 100% of the infrastructure for the planning of facilities and travel and recreation areas.	- Digital design of the facilities - Project Model	Attractive and unique design of the infrastructure of the project areas that allow the functionality of the activities with technical criteria.
7. - Coordinate with the Faculty of Architecture of the Uleam Matrix for the Technical Design and validation of professionals of the physical infrastructure for its subsequent civil construction.	- The Architectural Design allows to have a High Level of Security of the Work. (Specific Indicators for Architects and Civil Engineers)	- Architectural Drawings	- The architectural plans respond to the needs of the project's capacity and other requirements. - The condition of the soil allows for constructive safety.

<p>8. - Develop the organizational structure and functions and procedures (manuals and regulations) for each of the areas of interest for the efficiency and effectiveness of staff performance.</p>	<p>- Horizontal organizational structure for process management that allows performance evaluations to be higher than the defined minimum-acceptable values.</p>	<ul style="list-style-type: none"> - Organizational Structure - Functions Manual - Procedures Manual - Internal Regulations - Tourism Operations Manual - Quality Management Manual - Protocols and others 	<p>The defined organizational structure allows for Horizontal Coordination to maximize results.</p>
<p>9. - Develop an Organizational Diagnosis based on a Strategic Analysis, Reference Studies, Competency Studies, and others to identify, mainly, the strengths, limitations, and potentialities</p>	<p>- The Strategic Analyses are evaluated qualitatively and quantitatively, in which the weighting shows superior levels of Strengths and Opportunities over Constraints and Threats with an average</p>	<ul style="list-style-type: none"> - Fola Strategic Analysis - Reference Market Analysis - Competitor Analysis - Others. 	<p>The market shows optimal conditions: the analysis of attractiveness and accessibility so that the project's products enter the market to compete and the entry barriers are not high.</p>

and threats that may arise.	difference of at least 0.5.		
10. - Elaborate a Strategic Planning based on the Organizational Diagnosis for the development of the Organizational Philosophy, Objectives and Corporate, Departmental and Operational Strategies to obtain a Competitive Advantage in the Market.	- Achievable corporate objectives of the project's business units/areas: 10% annual market growth; 15% annual long-term profitability; 10% annual organizational growth.	- Organizational Philosophy Design - Structure of objectives and strategies at the Organizational Levels.	- Products and services with superior quality than the competition. - Market differentiation. - Trained and motivated personnel. - Best Cost Pricing.
11. - Develop the Technical Study through the design of the service, production process, plant capacity, determination of demand and selection and classification of	- Design of the services according to the Optimal Size of the Project that allows meeting the Projected Sales Plans to cover the expenses.	- Service Design - Procedures Manuals - Determination of Installed Capacity and Utilized Capacity. - Detailed project requirements and specifications.	- The Used Capacity of the Project allows to cover the Sales Plans, which are in accordance with the Projected Demand.

<p>the service technology.</p>	<ul style="list-style-type: none"> - Design of Production, Service and other main processes that are standardized to guarantee an adequate Management in the Quality of the Tourist Service, with the maximum acceptable waiting time margins for each process. - Use of the capacity utilization of at least 50% of the installed capacity (facilities, tables, seats and others). 		<ul style="list-style-type: none"> - The standardization of internal operational processes allows for quality service while meeting acceptable waiting times.
<p>12. - Design a Marketing Plan for product development, pricing strategies, promotional media, advertising and</p>	<ul style="list-style-type: none"> - Marketing budget covering a maximum of 60% of Sales Expenses. - Patent and Trademark Expenses are 	<ul style="list-style-type: none"> - Marketing Plan Document - Marketing Budget - Registration of Patents and Trademarks with 	<ul style="list-style-type: none"> - The advice of the teaching staff specialized in the Marketing area creates the Marketing Plan, and with it the digital designs,

dissemination of the good/service to be offered, as well as strategies for personalization , processes, participation and physical evidence.	part of the Intangible Assets of the project to protect the Investment with a 2% value.	the National Service of Intellectual Rights.	strategies to create the brand, spread it and achieve the positioning in the long term in the market.
13. - Develop a budget of the project requirements and specifications.	- In the budget, the project's investment costs and expenses in terms of assets, MO, materials and other requirements are covered at least 80% by the financing sources.	- Budget	- The budget with information on the Income/Expenditure of the project will allow to have resources to cover as much as possible with the minimum acceptable in the medium term and sufficient in the long term.
14. - Elaborate the Economic Financial Structure, such as Initial Investment, Balance Sheets, C/B, NPV, IRR and others to	- Obtain a C/B above the minimum acceptable - The NPV to cover the initial investment over	- Financial Statements - Financial Analysis - Resources/Credits credited/liquidate	- Financial Institutions have open credit lines related to the project. - Interest rates are reasonable

<p>determine the feasibility of the project in quantitative and qualitative terms, measurable and reasonable, to present to Financial Institutions and obtain financing.</p>	<p>the years of useful life.</p> <ul style="list-style-type: none"> - The IRR is higher than the Interest Rate payable as the minimum acceptable value. - Obtain a diverse financing structure that allows covering a minimum of 30% from non-reimbursable sources and 70% from reimbursable sources. 	<p>d to the project's coffers.</p>	<p>and credit conditions are viable for the project.</p> <ul style="list-style-type: none"> - There are Non-Reimbursable Sources of Funding for Social, Economic Development and Scientific Projects to apply for. - Consider the Contributions in the company, with the estimation of Deferred Assets such as Incorporation and Project Development Expenses in monetary terms so that the contribution of the institutions is known.
<p>15. - Socialize the project with the main stakeholders as any social project,</p>	<ul style="list-style-type: none"> - To have the legal permits from the municipal authorities, Fire Department, 	<ul style="list-style-type: none"> - Satisfaction Survey with minimum levels of 70% stakeholder acceptance. 	<ul style="list-style-type: none"> - In order to obtain the legal and other permits, the financial resources to pay

<p>including the site's inhabitants, university community, scientific community, the area of culture, history and archeology, entities (GAD, MinTur, MAE, INPC, among others).</p>	<p>Superintendence of Companies, Ministry of Tourism, Ministry of Environment, and others.</p> <ul style="list-style-type: none"> - Obtain a Project Acceptance Level of at least 80% of the main <i>Involved Parties</i>. 		<p>for them must be available by that time.</p> <ul style="list-style-type: none"> - Stakeholders show interest and positive acceptance, especially from the Chirije community for local development.
<p>16. - Develop the implementation of the project from the study of soils, civil works, operability of the areas of interest taking corrective measures <i>ex-ante</i>, during and subsequent adjustments with: resources, time and efforts planned.</p>	<ul style="list-style-type: none"> - Construction is proceeding according to plan with a 12% contingency margin. - The project moves from the "planning" phase to the "execution" phase. The latter has control mechanisms and a contingency margin of 12% and a delay time (if any) of less than six months. 	<ul style="list-style-type: none"> - Soil survey - Physical infrastructure - Material resources acquired - Complete legal documentation. 	<ul style="list-style-type: none"> - Construction of the physical works according to plan with minimal adjustments. - Business operation according to plan with adjustments that do not significantly affect the project. - Financial resources are allocated on time and achievable/sufficient to cover

			the ideas/theoretical proposals.
--	--	--	----------------------------------

Own elaboration

Conclusions

In the present work, the context of tourism worldwide is addressed with a focus on hotel services post pandemic, in order to demonstrate that the sector is recovering and augurs positive prospects in the medium term.

The approach of the Logical Framework Matrix LFM for the project of creating a Hotel School as part of the Research Center allows a holistic approach from the perspective of legal permits, EIA study, market study, technical study, economic and financial study and others to provide a vision from the macro to the micro process of creating this proposal for the education of accommodation services.

The expected impacts of the proposal are: academic, because it is part of the practices in real scenarios of the students of the Hospitality and Hotel and Tourism careers; tourism, since it is part of zone 4 and focused on the tourism sector; and scientific, since activities can be carried out with research results that allow contributions from the scientific point of view.

References

BBC. (n.d.). *Coronavirus vaccine: what level of vaccination is needed to return to "normal life"* - BBC News World. 2021. Retrieved September 30, 2021, from <https://www.bbc.com/mundo/noticias-55058162>

Castañeda, R. E. (1995). Instituto de Estudios Turísticos

Secretaría General de Turismo THE HOTEL-SCHOOL EXPERIENCE. *Estudios Turísticos*, n.º, 128, 105-115.

United Nations Conference on Trade and Development (n.d.). *The world economy could lose more than \$4 trillion from the impact of COVID-19 on tourism | UNCTAD*. 2021. Retrieved September 30, 2021, from <https://unctad.org/es/press-material/la-economia-mundial-podria-perder-mas-de-4-billones-de-dolares-por-el-impacto-del>

Ministry of Tourism (n.d.). *Tourism in Figures - MINTUR Services Portal*. 2021. Retrieved September 30, 2021, from <https://servicios.turismo.gob.ec/8-turismo-en-cifras>

Ministry of Tourism of Ecuador (n.d.). *FROM JULY 1, 2021 THE APPROVAL OF REQUIREMENTS FOR ENTRY INTO THE COUNTRY COMES INTO EFFECT - Ministry of Tourism*. 2021. Retrieved September 30, 2021, from <https://www.turismo.gob.ec/desde-el-1-de-julio-de-2021-entra-en-vigencia-la-homologacion-de-requisitos-de-ingreso-al-pais/>

UNWTO (2021). International travel largely on hold despite May rebound. *Barometer*, 2019, 1-39. <https://www.unwto.org/es/taxonomy/term/347>.

Linares, H. L., & Morales Garrido, G. (2014). *Sustainable tourism development to local development. Its complex behavior*. 12, 453-466. www.pasosonline.org

Martínez Rodríguez, M. D. los Á., Pelegrín Naranjo, A., Pelegrín Naranjo, L., & Naranjo Lluport, M. R. (2021). Good environmental practices in hotels case study: iberostar grand trinidad. *ECA Sinergia*, 12(2), 69.

https://doi.org/10.33936/ECA_SINERGIA.V12I2.3506.

https://doi.org/10.33936/ECA_SINERGIA.V12I2.3506.

UNWTO. (2022). *Sustainable development : UNWTO*.
<https://www.unwto.org/es/desarrollo-sostenible>

United Nations United Nations. (2015). *The 2030 Agenda and the Sustainable Development Goals: an opportunity for Latin America and the Caribbean. Global Goals, Targets and Indicators | Publication | Economic Commission for Latin America and the Caribbean*.

<https://www.cepal.org/es/publicaciones/40155-la-agenda-2030-objetivos-desarrollo-sostenible-oportunidad-america-latina-caribe>

Ortiz Pabón, J. D. (2019). Sun and beach tourism: tourism impact on the ecosystems of the Ayangué commune, to improve the management of tourism activity in the province of Santa Elena. *Revista Científica y Tecnológica UPSE*, 6(2), 82-90.
<https://incyt.upse.edu.ec/ciencia/revistas/index.php/rctu/article/view/494/423>.
<https://incyt.upse.edu.ec/ciencia/revistas/index.php/rctu/article/view/494/423>.

Periplo Sustentable, E., López Velasco América Rodríguez Herrera Carmen Barragán Mendoza Carmelo Castellanos Meza Rolando Palacios Ortega Marcela Martínez García, R., Barragán Mendoza, C., Palacios Ortega, R., López Velasco, R., Castellanos Meza, C., Martínez García, M., & Rodríguez Herrera, A. (2012). Tourism and environmental pollution in the urban periphery of Acapulco: Ciudad Renacimiento. *El*

Periplo Sustentable: Journal of Tourism, Development and Competitiveness, ISSN-e 1870-9036, N° . 23, 2012, Pp. 113-141, 23, 113-141.
<https://dialnet.unirioja.es/servlet/articulo?codigo=4028574&info=resumen&idioma=ENG>

Master Plan for Sustainable Development QROO 2030. (2019). *Master Plan for Sustainable Tourism in Quintana Roo 2030*.
<https://sedeturqroo.gob.mx/pmts2030/turismo.php>

Tourism Management School (2021). *What is sustainable tourism according to the UNWTO?*
<https://www.ostealea.com/Actualidad/Blog-Turismo/Sostenibilidad/Que-Es-El-Turismo-Sostenible-Segun-La-Omt>.
<https://www.ostealea.com/actualidad/blog-turismo/sostenibilidad/que-es-el-turismo-sostenible-segun-la-omt>.

**Agro-ecotourism management through
circular economy in Sucre canton -Manabí-
Ecuador**

Jessica Mariela Zambrano Cedeño

*Dra.C. en Ciencias, docente de la Universidad Laica Eloy
Alfaro de Manabí, Extensión Sucre-Bahía de Caráquez,
provincia Manabí, Ecuador
jessica.zambrano@uleam.edu.ec
<https://orcid.org/0000-0003-1370-5934>*

Frank Ángel Lemoine Quintero

*Dr. C. en Ciencias Económicas, docente titular de la
Universidad Laica Eloy Alfaro de Manabí, Extensión
Sucre-Bahía de Caráquez, provincia Manabí, Ecuador
<https://orcid.org/0000-0001-8885-8498>*

Odra Carolina Guerrero Escalante

*Mg. en Planificación y Gestión de Proyectos
Agroturísticos y Ecológicos, docente Carrera de
Tecnología Superior en Gestión de Operaciones Turísticas
del Instituto Superior Tecnológico Tena.
<https://orcid.org/0000-0001-7265-6023>*

María Fernanda Oñate Pazmiño

*Mg en Planificación y Gestión de Proyectos
Agroturísticos y Ecológicos,
docente Universidad Regional Amazónica Ikiam
<https://orcid.org/0000-0003-1968-7650>*

Introduction

According to Zurab Pololikashvili, "Globally, poverty is staggeringly rural. If we really want to boost growth and development, we must look outside our cities and work together to help even the smallest community to enjoy the many and varied benefits that tourism can bring."

Returning to the author's message, it is conceived to approach as a sample 9 farms of the rural parishes of the Sucre canton of the province of Manabi, to develop a diagnosis on the production, culture and management of natural resources in order to determine the dimensions of rural tourism that allow the development of the Agroecotourism typology as an increase in their daily activities and improvement of income.

Agroecotourism arises from the integration of two typologies of rural tourism, ecotourism and agrotourism in Latin America. According to Ramírez Castellanos, Agroecotourism, as a tourism modality, internalizes the dimensions of sustainable development based on the conservation of the natural and cultural environment, which, combined with rural and nature activities, constitute a differentiated and holistic typology of tourism, which finds in biodiversity its greatest product.

A strategy based on the circular economy is proposed for the management of agroecotourism development on farms in the rural area of the Sucre canton. A circular economy is a positive continuous

development cycle that preserves and increases natural capital, optimizes resource yields and minimizes system risks, managing finite stocks and renewable flows. It works effectively at any scale. (EMF, 2015a and 2015b).

In the Ecuadorian context dissimilar is the conception and practice of ecotourism and agrotourism, the first is properly developed in protected areas where its main activity is the research and enjoyment of natural environment with environmental awareness , the second has its deployment in farms, haciendas, communities where their main income is the agricultural exploitation and the delight of tourists is to live that experience from crops to the processing of raw material enjoying the native culture. According to Medina, J (2018), Ecotourism in general terms can be said to be beneficial for Ecuador due to the fact that it is one of the answers to the effort of sustainable development and its three main objectives: ecological, economic and social, providing various advantages and also possible disadvantages that need to be minimized.

According to the National Tourism Plan 2030, agrotourism is related to the provision of tourism services (lodging, gastronomic and leisure activities) related to agricultural activities, where tourists can participate. Agritourism offers farmers and rural communities the opportunity to integrate their agricultural work with tourism and leisure activities. In addition, these activities enhance the value of

traditional and artisanal work, promoting the conservation and dissemination of cultural heritage. The promotion of agro-tourism can also help to make visible and encourage good practices, promoting the sustainable development of the rural environment.

Agroecotourism is a modality of rural tourism with a relationship of interdependence of agricultural activities that manages ecological policies in its production and lifestyle, guaranteeing the conscious use of natural resources, conceived from the conceptions of Agrotourism and Ecotourism. In order to develop Agroecotourism activities, rural environments with natural and cultural richness are needed, sustained by friendly management and production guided by state and community policies of equity and respect for nature and human beings.

In Sucre County, there are conventional farms that offer agritourism services and very few that offer true ecotourism, leaving ecotourism for protected areas where the characteristics of the service provided are appropriate. The landscape conditions and agricultural activities are conducive to the management of agro-ecotourism destinations, but despite this, the linear economy is a limiting factor in the management of this type of tourism.

The unsustainability of a linear economy has been experienced and is the dominant pattern of development in recent times, generating waste of natural resources, pollution and waste; knowing that the economy and the environment are

interdependent, the linear economic model becomes unsustainable and threatens life itself. According to Roca, J, (2000), the linear production system is the dominant economic model on the planet today. It is a system open to the entry of materials and energy, which are the only resources that sustain human activities.

For improvements of that economic conception and practice, a circular economy strategy model is proposed. According to wbcSD, (2017), The Circular Economy moves away from the traditional "take-make-dispose" economic model to one that is regenerative by design. The goal is to retain as much value as possible from products, parts and resources to create a system that allows for long shelf life, sharing, digitization and resource recovery. This would be to reduce unnecessary consumption that threatens primary and secondary forests and in them the flora, endemic fauna and human beings; reuse of solid - liquid waste from agro-industrial production, food consumption and transformation through waste generating by-products; this circular economy serves as a strategy to form rural destinations conducive to strengthening Agroecotourism.

With the implementation of a circular economy strategy, it will be possible to create conditions for the consolidation of Agroecotourism from the rural communities of Sucre county.

The production of goods and services requires a constant flow of natural resources, without which the production of goods and life itself would be threatened. The strategy proposes the involvement of government, community and private actors to act in favor of the circular economy, thus generating changes that benefit the host communities, nature and the visitor, for the management of sustainable destinations where creative agroecotourism activities are deployed according to demand, this being another component that nurtures the service sustained in proactivity.

The present study was developed through a qualitative approach in four phases: the first phase is a documentary analysis, the second and third phases are field studies and the fourth phase is a cross analysis.

PHASE1:

The documentary analysis and synthesis with its indicators (management- Agroecotourism) and (strategy- circular economy) using reliable sources from Scopus and other Latin American connotations.

PHASE 2:

Field research focuses on data collection from primary sources based on participatory observation in 9 farms in rural areas of the canton Sucre belonging to the province of Manabi-Ecuador, its indicators to observe were: the identification of the state of natural resources, culture and traditions of local communities- music, gastronomy, dialect, idioms. through the MINTUR 2017 file.

PHASE 3:

Interview through a colloquial dialogue with community leaders obtained data on sources of income of local families, management of primary and secondary forests- conservation and use, participation of the Ministries of Environment and Tourism on management of these resources, importance of tourism activity for the family economy.

PHASE 4: With the cross-referenced information from the first three phases, it was determined how to manage agro-tourism through the circular economy strategy.

1. Agroecotourism management was characterized through the circular economy strategy.

2. Lack of categorization of some natural resources such as endemic flora - secondary forests and cultural resources of the farms such as insitu archeology, folklore and gastronomy. The integration of the decentralized autonomous government GAD-Sucre, Ministry of Environment and Tourism is needed to implement sustainable management policies by training communities before operating as a tourist destination, on issues of forest conservation, developing innovation for the creation of cocoa husk by-products (flavoring for handmade soap, craft beer, etc.), bagasse (cattle feed), crafts with seeds, rooting of culture and importance of sustainability, food security in provision of ancestral gastronomy, rescue of Montuvian folklore.

3. The main economic activity on the farms is agriculture, generating income from it and the commercialization of wood and fruits, some agroindustrial activities minimally processed crops and coral animals as micro-enterprises that are not legally consolidated as microenterprises. Fruits are lost at harvest time because the price paid is very low, which reduces the family's income. Tourism activity is still in its infancy with little participation from MINTUR and the GAD to consolidate the rural tourism destination, especially Agroecotourism, through the preparation of the communities.

4. There are natural and cultural resources conducive to Agroecotourism activity, it is necessary to develop empathy for nature in the inhabitants of the farms and develop activities with minimal processes to avoid waste of fruits, also train to serve with community and gastronomic accommodation, locate signs at each destination and establish agreements with institutions of higher education to achieve micro-enterprises, training and dissemination of Agroecotourism activity through the use of ICT.

Agroecotourism is an activity that is projected to be sustainable, for which the circular economy is visualized as a strategy that exerts a direct connection between nature and the economic system to ensure harmony between nature, economic generation, quality of life of the host communities and the tourist,

projecting itself as a permanent foreign exchange generator.

The Ministries of Environment and Tourism of Ecuador should work together with the local government to channel the guidelines for conservation and sustainable management in rural natural environments, generate training for farm owners to raise awareness about the care and use of natural and cultural resources in a sustainable manner and use of the entire production chain, update the inventory of tourist attractions highlighting the farms as scenarios for sustainable agroecotourism in the circular economy that will improve the economy of the communities permanently.

REFERENCIAS

- Wbcsd. (2017). Circular Economy guide. Retrieved from <http://www.ceguide.org/>Weigend, R. (2017, Julio 14). Economía Circular: Consejos de cómo implementarla en las empresas en América Latina. ECOR Europa. Retrieved from Plataforma Economía Circular. <https://www.unwto.org/es/desarrollo-sostenible/ecoturismo-areas-protegidas>
- EMF (2015a). Towards the circular economy. Business rationale for an accelerated transition. Ellen MacArthur Foundation, Isle of Wight
- EMF (2015b). Circular economy overview. <http://www.ellenmacarthurfoundation.org/circular->

economy/overview/concept). Acceso el 2 de mayo de 2016

Ramírez Castellanos, E.D. 2014. Agroecoturismo: aportes para el desarrollo de una tipología turística en el contexto latinoamericano. *Turismo y Sociedad*. 15, (nov. 2014), 223–236. DOI:<https://doi.org/10.18601/01207555.n15.13>.

Jessica Patricia Medina Villacrés (2018): “El ecoturismo en Ecuador: Actualidad y perspectivas de desarrollo”, Revista Observatorio de la Economía Latinoamericana, Ecuador, (enero 2018). En línea: <http://www.eumed.net/coursecon/ecolat/ec/2018/ecoturismo-ecuador.html>

https://www.turismo.gob.ec/wp-content/uploads/2020/03/PLAN-NACIONAL-DE-TURISMO-2030-v.-final-Registro-Oficial-sumillado-comprimido_compressed.pdf

Roca, J. (2000). “La economía, la ecología y la crisis de la economía convencional”. En Medina, M. y Kwiatkowsnka, T. (eds.). Ciencia, Tecnología /Naturaleza, Cultura en el siglo XXI. Barcelona: Anthropos <https://www.ambiente.gob.ec/wp-content/uploads/downloads/2020/08/ACUERDO-MINISTERIAL-ESTATUTO-ORGANICO.pdf>

The "Taking of Venezuela": analysis of the conflict in the political contest

Santiago Andrés Ullauri Betancourt

Msc, Hemisferios University.

santiagou@uhemisferios.edu.ec

<https://orcid.org/0000-0003-0858-3178>

Introduction

The political crisis in Venezuela is a conflictive tissue where the question arises from the premise of how did the Caribbean country reach this point, equivalent to countries affected by wars such as Syria, Sudan and Yemen? A key lies in the strategies applied by the Government and the opposition, thus, with the death of Chávez, a new stage in Venezuelan politics emerged and, after the victory of the opposition in the 2015 parliamentary elections, an emerging relationship of forces that have intensified the political, economic and social crisis.

In this way, the topic takes on greater relevance, because its crisis illustrates the value of democracy and the different nuances of the social and political behavior of the forces that interact in the mentioned phenomenon. Therefore, the intentionality of the study is framed in the analogy with the Hawk-Pigeon model of game theory, since it allows the demonstration of two positions that must be avoided or reduced, otherwise, they can generate a spiral of violence or anti-politics from which it is difficult to get out, where Venezuela is a clear example of it. (Abramson, 2006). Therefore, the purpose of the present research is an approximation to the understanding of the nature of the current Venezuelan government; the modern paradigm of governance advocates a democratic behavior of political actors and game theories allow to better visualize when an

actor is playing in favor of his own interests only and to the detriment of the collective ones, or when he is betting on zero-sum results and does not play for win-win results.

This manuscript begins with a review of the theoretical framework of game theory and the hawk-dove dilemma developed by John Maynard Smith, and then contextualizes the political situation in Venezuela, which has experienced an escalation of the conflict since the death of Hugo Chavez. Finally, under the mentioned paradigm, the Venezuelan situation is analyzed through the classification of the actors and an analysis of the strength of each one of them.

The Venezuelan situation, by the end of 2016, was at a peak within a critical context that presented several edges; the political authors, weeks before, made a call for a large mobilization that would provoke a strong intimidation in the national government of Nicolás Maduro, this concentration was called, by its conveners, as "Take Venezuela", which was intended to protest against the constitutional rupture that represented the decision of the National Electoral Council (CNE) and prevented the referendum against the president from taking place in that year (Reichenbach, 2016).

In this sense, the call of the opposition leadership with the massive support of the citizens, to whom high expectations had been created with a change in the political and economic leadership, brought hundreds of thousands who went out to protest leaving one dead (police officer) and several wounded (BBC Mundo, 2016) This action was the last known action of the Unity Roundtable (MUD) before its disintegration. Likewise, another important aspect was the 2016 national strike called by the MUD for the end of October, to which the different economic sectors of the country strongly affected by the economic, political and

social situation were called. This strike was considered as a demonstration of the rejection of the national government, and its satisfactory compliance added more strength to the opposition that envisioned the cessation of the government of Nicolás Maduro. On the part of the ruling party, it was conceived as another sign of the economic war that the economic sectors have been waging for years against the country (Portal Misión Verdad, 2016).

Regarding the atmosphere prior to the November 3 march, it must be taken into account, on the part of the ruling party, that they had the confidence of being an institution elected by democratic means, in such a way that their actions were within the framework of the Constitution of the Republic, in preserving democracy and subverting order; this did not represent an attack against Chavismo *per se*, but an attack against the Magna Carta and the democratic system.

Therefore, the defense of the *status quo* of the ruling party served to argue that the opposition, irresponsibly, wanted to lead the country to a confrontational scenario. (Telesur Portal, 2016). This is important because it meant that the ruling party was not willing to give in to the opposition's non-peaceful path and, if they incited violence, it would be forced to respond with violence.

The Application of Game Theory

In general terms, game theory consists of studying situations of conflict and cooperation which are called games, where rational subjects (players) interact, and the behaviors and predictable outcomes are analyzed, through decisions either individual or agreements between the players; if it is individual, it is not played cooperatively and, if it is agreed, it is played cooperatively (Pérez et al., 2004). It is considered that game theory represents an important analytical material used in rational choice, thus, more than

a theory (it lacks hypotheses), it is an approach or a way of conceiving a certain social reality (Sánchez-Cuenca, 2009). In short, it consists of carrying out an exercise using specific rules, actors, strategies, punishments and rewards to analyze or predict the behavior of certain actors in particular contexts.

The Hawk-Pigeon model emerged with John Maynard Smith, who used game theory to explain the behavior of some species of the animal kingdom that escalate in conflict, but, when they reach physical contact, one of the animals gives in and abandons the fight... (Abramson, 2006). (Abramson, 2006). Applied to human reality, the appreciation of hawk and pigeon is simplified because, when used to explain social conflicts, two species are not used (both contenders are of the human species), moreover, the pigeon can also escalate, bluff or *bluff*; nor is the prize for the fight food, territory or control of females, and there is not necessarily a physical fight where someone gets hurt.

The most important for the development of this research is the relevance of the hawk-pigeon theory as a way of understanding politics with the defense of democracy, in this sense, the hawk-pigeon analogy could be called in the different manifestations of both actors, government and opposition, in terms of a duty to be, in the way of doing politics to defend and preserve democracy, with review of the behavior of both actors in the framework of the principles framed in the Constitution and the relevant international instruments of the context. (Requíiz, 2006).

Such principles establish that a) victory or recourse should not be achieved to the detriment of the other, but strategies should be oriented to mutual benefit; b) concessions or offers should be proposed rather than demanded; c) interests should be explored and open to flexibility; d) one

should act in a clear and transparent manner; e) accept unilateral losses as a way to reach agreements; f) if one has to yield, one yields in accordance with the principles, not because of the pressures or arbitrary wills of the other (Requííz, 2006).

In politics or any other field, it is not difficult to label certain human attitudes as hawkish or dovish, in fact, it is possible to take it to another example if you like: two drivers in their cars driving opposite each other on the same road, each driver has the choice of continuing or swerving. A hawk driver will naturally drive and not pull off the road, while a pigeon driver, as the distance shortens, will increase his desire to pull off; the hawk driver is fearless, reckless and reckless (greedy for the resource), while the pigeon driver is prudent (puts the resource before his own integrity). (Sánchez-Cuenca, 2009).

Hence, it is clear that the hawk-dove theory can serve to better explain and understand power relations in a certain case, such as Venezuela, but it must be reiterated that it does not mean that hawk and dove are models to be applied in politics; on the contrary, the idea is to identify and correct or avoid such types of behavior in politics.

Finally, when referring to the term political conflict, we take as a basis the approaches of Tilly et al. (2004), who understand it as an episodic, public and collective interaction between the creators of claims and their objects, when at least one government is a claimant, an object of claims or a part of the claims, if realized, will affect the interests of one of the claimants. Thus, the episodic is the non-continuous and excludes votes or elections where rallies may serve, subsequently, for political conflict; the public, on the other hand, does not take into account what happens in churches or companies, and the figure, the

Government, either as object, as claimant or mediated. Political conflict or contention can take the form of contingent or transgressive, developing through collective actions and social mobilizations that are related to the political context that encourages or discourages them, so it corresponds, in this research, to identify the type of political conflict that occurs in Venezuela according to the approaches of Tilly et al (2004).

Context of the Mobilization "Toma de Venezuela"

The Venezuelan situation, by the end of 2016, was at a peak within a critical context that presented several edges; the political authors, weeks before, made a call for a large mobilization that would provoke a strong intimidation in the national government of Nicolás Maduro, this concentration was called by its conveners as "Take Venezuela", which was intended to protest against the constitutional rupture that represented the decision of the CNE and prevented the referendum against the president to be given that year (Reichenbach, 2016).

However, such point was nothing more than the result of a conflict situation that had been escalating since the death of Hugo Chávez in 2013; the Venezuelan caudillo who had come to power for the first time in 1999, ran in October 2012 for reelection for a third consecutive term, election that he would win despite his delicate health condition generated by the cancer that affected him, a medical situation that would precipitate his death five months later. Chávez would be succeeded by his vice-president, Nicolás Maduro, who would have to face new elections, a process plagued with irregularities that would end up giving him the victory with a tight margin of less than 1% over the opposition candidate, Henrique Capriles.

From that moment on, the political situation in Venezuela went from a tense calm to an escalation of the conflict that would continue, incessantly, until 2016. In October 2016, a national strike was called by the MUD, to which the different economic sectors of the country affected by the economic, political and social situation were called. This strike was considered as a sign of the rejection of the national government, and its satisfactory compliance added more strength to the opposition that envisioned the cessation of the government of Nicolás Maduro; on the part of the ruling party, it was conceived as another sign of the economic war that the economic sectors have been waging for years against the country (Portal Misión Verdad, 2016).

In this order of ideas, the different actors, in every conflict situation, intervene and have different levels of protagonism; Among those who have played a preponderant role in this crisis are Nicolás Maduro, President of the Republic, whose trigger has been the defeat of the parliamentary elections in 2015, which has led him to design authoritarian strategies (abuse of power), but based on political dialogue, with the purpose of delaying the time and to calm down the protests, likewise, with the media, he makes his followers believe a state of normality and tranquility that does not really exist, for which he seeks to preserve power and prevent the recall referendum, as well as the march to Miraflores, for which he used dissuasive and intimidating methods; His role, together with that of his closest political circle, was to resist the latent situation of conflict aimed at removing him from power.

Thus, Henry Ramos Allup (secretary general of Acción Democrática [AD] and president of the National Assembly) played a leading role, since he supported the actions of activating an impeachment trial by declaring the abandonment of office, and requested a dialogue as long as

some fundamental conditions were met, within the framework of political change for the country, in a transition to democracy and restitution of the constitutional thread. His own arrival to the presidency of the National Assembly has been his trigger, which automatically placed him as the counter-figure of Nicolás Maduro. On the other hand, it has also been Ramos Allup who declared the suspension of the November 3 march, which, in the end, was not going to take place, this brought him into conflict with the most radical wing of the opposition.

Thus, Leopoldo López (leader of Voluntad Popular) had a limited role because he was in the military prison of Ramo Verde, however, he was still an important figure within the political scene of the country and the leadership within the party he formed, Voluntad Popular, with a radical stance against Maduro. López came from leading a political movement called "La Salida" (The Exit), to remove Maduro from power, thus, his radical position in the conflict caused a distancing with other members of the opposition. In this sense, during 2016 he maintained the same position, as did María Corina Machado; since the 2013 elections, he has been more in favor of the non-electoral struggle to get rid of Maduro, however, at the beginning of 2014, he voluntarily surrendered to the State authorities, a significant fact for the Venezuelan opposition.

Therefore, the defense of the *status quo* of the ruling party was used to argue that the opposition, irresponsibly, wanted to lead the country to a confrontational scenario. (Telesur Portal, 2016). This is important because it meant that the ruling party was not willing to give in to the opposition's non-peaceful path and, if they incited violence, they would be forced to respond with violence.

Therefore, the protests of previous years, specifically those of 2014, showed the firm position of the Government not to give in to any kind of threat from the opposition. Representatives of the ruling party, with a really hard position, such as Diosdado Cabello, assured that the opposition march was not going to reach Miraflores because the ruling party would take to the streets to defend its president (Peña, 2016). For this political leader, who many believe is the power behind the power, the right wing -the opposition- is desperate and seeks to attack the people regardless (Peña, 2016). Thus, the officialism abrogates not only legality, but the welfare of the people and manifests to do everything possible to defend it. Therefore, it cannot be overlooked that the ruling party counted on the loyalty of the country's armed forces, which were at the disposal of the President of the Republic to repress opposition protests.

A no less important element is that Jorge Rodríguez, another of the strong men of the current government, when he was mayor of the Libertador municipality of Caracas, issued a decree declaring that municipality a fascism-free zone and, since then, the opposition has not been able to march in that area of the capital, where the Miraflores palace is located. (Rodríguez, 2016). Thus, the opposition was limited to protest in the east of Caracas and trying to do so towards the west represented a challenge and a provocation to the forces of the ruling party.

Analysis of the Venezuelan Political Conflict under Pigeon Hawk Game Theory

In order to carry out the pertinent analysis of the Venezuelan case, game theory is used as a point of visualization of this multidimensional conflict that has been part of the thematic agenda in the region, based on conflicts of interest and the consequences derived from the growing diaspora. In this order of ideas, a 'game' is a situation "in

which players (participants) make strategic decisions, that is, decisions that consider the actions and responses of others" (Restrepo, 2009, p. 159).

Thus, the outcome of the specific situation depends, closely, on the consequential sum of the decisions made by the individuals who are part of that event; however, some are constituted from roles and others from the strategies exercised by one of the parties involved. The final basis of the game in question is the performance and quality of the actions taken by the participants, in which process there may be levels of responsibility and conflicts of interest implicit in the decision making process. (Restrepo, 2009).

In the specific case of the hawk-pigeon game, **hawks** would be represented by individuals or entities that always carry out aggressive attack actions in order to hurt or neutralize their prey, while **pigeons** appear as the participants who are based on prudence to avoid receiving the least possible damage; in these cases, it should be noted that there may be conflicts between entities belonging to one of the two categories.

For example, if a hawk and a dove meet, the former will tend to attack and the latter to leave, within which the hawk implicitly obtains the victory. Secondly, between two pigeons there is usually no confrontation, because both tend to retreat, so the element for which the conflict is initiated is obtained by the one that visualizes it first. Third, if two hawks meet, there is a high probability of confrontation, where there is a cost to pay (wounds, for example) and whoever wins the confrontation (the nature of which varies), gets the resource in question. (El Cedazo Portal, 2011). In this sense, a matrix is presented below to situate the actors involved in this socio-political phenomenon, in order to then apply the principle of the

falcon-pigeon game and understand the event from this space of enunciation.

In the first term, there are a series of collective political actors based on the need to maintain the *status quo* in Venezuela (for example, the Government), while another sector aspires to radical changes in the policy that, by 2016, would have been marked by 17 years of the movement promoted by Hugo Chávez and continued by Nicolás Maduro, under a socialist line, polemic and questioned by the nature of its processes, specifically, in the mandate of the successor, Maduro. On the other hand, the opposition has maintained protest processes in representation of the civil society dissatisfied with the different social problems that have been accentuated in the last years.

In a second term, some of the main social actors in terms of political representation in this contest are presented, in which case, Nicolás Maduro and the former Spanish President Zapatero (to give an example), those who choose to lead processes whose purpose is to maintain the *status quo* in the country, Venezuelan opposition politicians, whether belonging to the MUD or individuals (as in the case of María Corina Machado), who request support from international and institutional actors to reach a peaceful solution where the maintenance of Maduro in power would be non-negotiable. However, a more impartial or diplomatic arbitration is presented, where the figure of the Supreme Pontiff, Pope Francis, stands out, who chooses to promote dialogue and negotiation as the figure that would avoid bloodshed in Venezuela.

Regarding the hawkish actors, seen individually, it is possible to highlight that the predominant belonging to this group is the Venezuelan Government headed by Nicolás Maduro, before whose disposition are placed the State

security agencies, some political parties, other agencies such as the Ombudsman's Office and the Local Committee for Supply and Production (CLAP) as a mechanism to coerce the population from the supply of basic subsistence food at regulated prices (based on high inflation and shortages for 2016).

Regarding the opposition, the main hawkish leadership is represented by María Corina Machado, leader of the center-right political party Vente Venezuela (as opposed to the social-democratic opposition), who would support a potential foreign intervention as a way out of the crisis the country is going through, as she considers Nicolás Maduro as usurper of power in the country.

Secondly, the United States of America, the world's leading power, has applied numerous sanctions against the Venezuelan government in response to, among many other issues, the repression of civil society and the economic crisis, which, in its opinion, is not being addressed.

In the case of the Venezuelan government, its main international allies and the media stand out as mechanisms of disinformation and distortion of reality in these contexts of civil protest.

However, this typology is dominated by the opposition sector, where the MUD, the main party coalition antagonistic to the Government, has been characterized by the promotion of peaceful protest as a mechanism to pressure the Government and a hesitant attitude towards the taking of military actions by other countries as a way out of the crisis.

Regarding the potential level of strength of the political actors in question, it is necessary to highlight their

relevance when it comes to situating, in a practical way, the coalition between these two sectors of Venezuelan politics (and allies of each side), in the case of the opposition, the United States stands out as the actor with the greatest strength and scope in a practical context, but diminished by the controversy of a military action against a government that other countries with a similar degree of power (China and Russia) approve of. In the internal case of Venezuela, María Corina Machado stands out as another hawkish actor, who, in a hypothetical situation in which she would be the leader with the greatest legitimacy and followers, would opt for an indefinite strike as a mechanism of local pressure on the Maduro government.

In the case of the dove actors, with a lesser capacity for action, international organizations such as the Organization of American States (OAS), the United Nations (UN) and the Inter-American Commission on Human Rights (IACHR) stand out, which have used legal mechanisms of less pressure on the Venezuelan Government and have opted for dialogue actions to reduce the tension between both parties. Finally, and with actions of polemic effectiveness, the MUD stands out, under issues such as peaceful and focused protest, and its reiterated dialogue processes with the Government.

Regarding the pro-government actors, the most powerful is Nicolás Maduro's coalition with the Armed Forces, a component that responds to his political, economic and ideological interests and has the capacity to easily disperse protests by continuously acquiring weapons and repression material. In second place, as another hawk-like actor, is Diosdado Cabello, second in command of Chavismo, who has multiple sanctions by the international community for his alleged links to drug trafficking. This actor has a wide offensive scope at the domestic level, by legitimizing

repression, the holding of opposition and student political prisoners, and the delegitimization of opposition political leaders.

Secondly, as dove actors, there are countries with interests in Venezuela, mainly Cuba and Russia, which, although they show a clear position of support towards this South American country, do not take direct actions to maintain the *status quo*, but implicitly through Nicolás Maduro's commercial relations with them. At the same time, the media are added to this equation, which frame the reality in a favorable way to the Venezuelan government, either by omitting content concerning the protests or by exalting facts relevant to the government.

Now, in a hypothetically applicable context, the main actors in the political contest are presented separated by typology. This implies a clear advantage for the ruling party, which has at its disposal the finances of the State, the power of the Armed Forces and the bureaucratic apparatus of the country under its management, as potential mechanisms of coercion and dependence of civil society on the Government (for example, the CLAP, a public policy of food supply to the most disadvantaged families). Although the United States is a country with great influence in world politics, foreign military intervention as a way out of the crisis has been seriously discussed, based on the participation of this country in conflicts in the Middle East and the countervailing pressure from other powers such as Russia and China. Thus, the scope of this country would have been limited in a practical context, beyond the economic sanctions to Venezuelan government officials, and to all natural and legal persons who carry out economic transactions related to them.

As regards the Venezuelan opposition, a clear conflict of interests is evident, where a radical segment is headed by María Corina Machado, as opposed to a more cautious or pacifist sector, the MUD, which would have lost legitimacy in contexts of protests after which it tends to engage in dialogue processes with the government. This has been repeatedly questioned by María Corina and put into practice by the other part of the opposition, as a safe-conduct endorsed by 'neutral' actors such as the Holy See represented by Pope Francis, to give a clear example in the matter.

Conclusions

The political crisis in Venezuela is shown as a situation of escalating conflict where the parties have opted for a strategy of radicalization, moving from recognizing the other as a legitimate political opponent to using physical violence as a means to achieve their objectives. This context is compounded by the intervention of other international actors that have failed to help find a negotiated solution to the crisis.

Regarding the atmosphere prior to the November 3 march, it must be taken into account, on the part of the ruling party, that they were confident that they were an institution elected by democratic means, so that their actions were within the framework of the Constitution of the Republic. For Ayala (2010), although there is a generous constitutional framework that guarantees and supports the right to protest in Venezuela, in practice, there are several restrictions, including a triangle of power (Public Ministry, criminal courts and security forces) that is used to intimidate those who intend to exercise their right to demonstrate. Thus, thanks to legal reforms, such as the

Penal Code, criminalization and criminal prosecution have been facilitated.

The external participation of the IACHR and the International Criminal Court is crucial to determine a possible violation of rights that have been violated for many years in the Venezuelan territory, however, the applicability of the reports issued by these bodies could become inapplicable and ineffective, due to the evident lack of commitment of the country with the norms of International Law.

Game theory consists of studying situations of conflict and cooperation, which are called games, where rational subjects (players) interact, and the predictable behaviors and outcomes are analyzed through individual decisions or agreements between players. In the specific case of the falcon-pigeon game, the **falcons** would be represented by the individuals or entities that always carry out aggressive attack actions in order to hurt or neutralize their prey, while the **pigeons** appear as the participants who are based on prudence to avoid receiving as little damage as possible.

In the case that concerns the present work, it is possible to note the presence of hawkish actors seen individually, where the predominant belonging to this group is the Venezuelan Government headed by Nicolás Maduro, before whose disposition are placed the State security agencies, some political parties, other agencies such as the Ombudsman's Office and the CLAP. Secondly, on the opposition side, the United States of America, the main world power that has applied numerous sanctions against the Venezuelan Government, stands out.

As for the dove actors, in the case of the Venezuelan Government, its main international allies and the media

stand out, despite this, this typology is dominated by the opposition sector, where the MUD has been characterized by the promotion of peaceful protest as a mechanism to pressure the Government and a hesitant attitude towards military action by other countries as a way out of the crisis.

The government of Nicolás Maduro is still in office despite the discontent and international pressure, due to the fact that it has a greater tactical capacity at the internal level (where the game is played), whose hawks are stronger than those of the opposition. Likewise, at the international level, they have the support of two economic powers that limit the reach of the United States in their actions and limit them merely to economic sanctions or freezing of assets linked to Chavism in that country.

In view of this, from a tactical and operational point of view, there is evidence of a highly strategic and effective capacity on the part of the Venezuelan government, regardless of the nature of its actions, since, by managing to maintain the *status quo*, it remains in power, increasingly silencing opposition political actors.

References

Abramson, G. (2006). *Introduction to game theory*. Centro Atómico Bariloche.

Ayala, C. (2010). The criminalization of protest in Venezuela. In E. Bertoni, *Is the criminalization of social protest legitimate? Criminal law and freedom of expression in Latin America* (pp. 209-234). University of Palermo.

BBC Mundo (2016). *"Takeover of Venezuela": hundreds of thousands take to the streets to protest against the*

government of Nicolás Maduro.
<https://bbc.in/3w8RdkI>

Peña, R. (2016). *Diosdado Cabello to the opposition: On November 3 they will not make it to Miraflores.*
<https://bit.ly/3ZFRdX1>

Pérez, J., Jimeno, J., and Cerdá, E. (2004). *Teoría de juegos.* Pearson Education.

Portal El Cedazo (2011). *Game theory XXVIII - Hawks and pigeons (Hen II).* <https://bit.ly/3klhqdp>.

Portal Misión Verdad (2016). *National Strike: The MUD recognizes that it depends on the economic war.*
<https://bit.ly/3GRnceu>

Telesur Portal (2016). *Venezuelan opposition suspends November 3 march to Miraflores.*
<https://bit.ly/3w6GabT>

Reichenbach, B. (2016). Venezuela facing 2017: crisis with no way out in sight. *Nueva sociedad*(266), 57-71.

Requíz, M. (2006). *Group dynamics and conduction workshop.* Universidad de Los Andes.

Restrepo, C. (2009). Approach to game theory. *Revista Ciencias Estratégicas*, 17(22), 157-175.

Rodríguez, I. (2016). *The right to march to Miraflores.*
<https://bit.ly/3ZEebhj>

Sánchez-Cuenca, I. (2009). *Game theory.* Centro de Investigaciones Sociológicas.

Tilly, C., Tarrow, S., and McAdam, D. (2004). *Dynamics of Contention.* Cambridge University Press.

Impact of the Covid 19 pandemic on the values of university students in the Amazon region.

Luis Oswaldo Manosalvas Vaca

PhD Doctor Business Administration

Amazon State University

lmanosalvas@uea.edu.ec

<https://orcid.org/0000-0002-4659-8090>

Introduction

The COVID-19 pandemic has created disruption on a scale unprecedented in recent history and has impacted the health and well-being of millions of people worldwide. Levels of stress and worry have increased considerably since the onset of the pandemic surveys indicate that up to 50% of respondents in representative samples experience clinical levels of stress, depression, and anxiety (Taylor et al, 2020a; 2020b). Since 2019 the coronavirus pandemic has disrupted society, economies, and lives. Unfortunately, there may be additional long-term effects of the disease, with clinical dysfunction prevailing in some patients at least 6 months after infection (Lechien et al, 2021). Indications of neurocognitive deficits lingering long after recovery from acute symptoms were initially based on anecdotes, case studies, and self-reports (Lu et al, 2020), but are causing concern according to the U.S. Centers for Disease Control and Prevention (CDC). The CDC indicates that some patients report thinking and concentration difficulties ("brain fog"), smell and taste problems, sleep problems, and memory problems. Some cognitive impacts are plausible

because a virus that can cause atrophy of the olfactory bulb and loss of smell could also affect other areas of the brain and thus affect other senses and cognitive abilities (Klironomos et al, 2020; Miners et al , 2020). Cognitive effects may also be due to virus-induced damage outside the central nervous system (Ritchie, Chan & Watermeyer, 2020). There are studies that indicate an impact affecting individuals' motivational beliefs, i.e., their personal values (Fischer et al, 2021). Values have been defined as relative beliefs about what is important in life (Schwartz, et al, 2012).. Values are broad desirable goals that define how people select actions, evaluate other people, and explain their behavior. Values are goals that serve as guiding principles in people's lives. Schwartz's value theory specifies 10 universally and motivationally distinct value types and an integrated structure that results from conflicts and congruencies among all values.

1. Security: security, harmony and stability of society, relationships and oneself.
2. Conformity: restraint of actions, inclinations and impulses that may annoy or harm others and violate social expectations and norms.
- Tradition: respect, commitment and acceptance of customs and ideas provided by traditional culture or religion.
4. Benevolence: preservation and enhancement of the well-being of people with whom one is in frequent personal contact.
5. Universalism: understanding, appreciation, tolerance and protection of the well-being of all people and of nature.
6. Self-direction: independent thought and action
7. Stimulation: excitement, novelty, and challenge in life.
8. Hedonism: pleasure and sensual gratification for oneself.
9. Achievement: personal success by demonstrating competence in accordance with social norms.

10. Power: social status and prestige, control or dominance over people and resources.

According to Schwartz, individual values are responses to three universal requirements of human existence, the needs of people as biological organisms, agreements in social actions, and the survival and well-being of groups. Individual values are subjective beliefs of individuals (a) associated with affect, (b) that refer to goals that motivate action, (c) that transcend specific situations, (d) that serve as standards of evaluation, (e) that are ordered according to their relative importance, and (f) that guide the action of individuals (Schwartz, 2012). Individuals are likely to differ in their hierarchies of values, which reflect both social influences and personal experiences. Values determine what is really important, guide people's behavior, and reflect real differences between cultures, social classes, occupations, religions, and political orientations (Maslova et al, 2020). Most cross-cultural researchers consider values to be one of the main causes of differences between people and societies. Although they are quite stable throughout life, values can change according to changes in economic development or personal life events (Maslova, 2018). They have been shown to be a series of social and political variables important for the functioning effective modern democratic societies. There is evidence that values may change in the context of the current pandemic, especially among those individuals concerned about the spread of Covid 19 (Daniel et al., 2021). Global research has demonstrated the existence of a near-universal set of personal values, organized by a set of motivational aspects (Schwartz et al., 2012). The order of values represents motivational conflicts and compatibilities, which are summarized in two basic dimensions: conservation values (the motivation to maintain order and security, resistance to change) versus values of openness to

change (the motivation to promote creativity, independence, novelty and excitement) and values of self-transcendence (the motivation to promote concern for the well-being of others) versus values of self-improvement (the motivation to promote self-interest, success and mastery) (Daniel et al., 2021).

Values tend to remain relatively stable (Schuster et al., 2019), even during significant life transitions such as the start of college life or occupational change (Bardi et al., 2014). Systematic changes in population-wide values have been reported following major existential threats, such as the 2008 financial crisis (Sortheix et al., 2019), exposure to war (Daniel et al., 2013) and the 9/11 terrorist attacks (Verkasalo et al., 2006).. In each of these cases, the values of security and tradition increased in importance. In contrast, there was a decline in the values self-direction, stimulation, and hedonism (Daniel et al., 2013; Sortheix et al., 2019). Evolutionary theory suggests that infectious diseases may have a particularly high probability of inducing behavioral and thus value adaptation (Thornhill & Fincher, 2014). This pandemic is likely to induce collective behavioral reactions that reduce the spread of disease by activating avoidance behavioral systems compatible with conservation values (Wolfin & Bardi, 2018). This activation decreases outgroup contact, openness to novel experiences, and self-directed thought and action. Similarly, existential threat induced through a pandemic is likely to increase mortality thinking (Pyszczynski et al., 2020), which has been shown to increase conservative attitudes. (Burke et al., 2013). Restricted mobility may also reduce opportunities to engage in some value-expressing behaviors. Some value changes have been observed to follow behavioral changes (Benish-Weisman , 2015)..

The main objective of the study was to examine the similarities and differences in basic human values and their

representation expressed by students of a university located in the Ecuadorian Amazon, considering variables such as gender and socioeconomic level. The following hypotheses were proposed:

- 1) There is a significant impact of the coronavirus pandemic on the values of university students in the Amazon region.
- 2) Significant differences exist between male and female values for the impact of the Covid 19 pandemic.
- 3) There are significant differences between values and socioeconomic levels of students by the impact of the Covid 19 pandemic.

The research has a quantitative route, responding to a positivist epistemology through a descriptive method in a cross-sectional horizon, to obtain the information was used the version of the European Social Survey of the Portrait Value Questionnaire (Schwartz, 2012), previously translated and adapted to the Spanish language, in a population of students of a University located in the Amazon region of Ecuador, a sample of 297 students from different careers of the University was obtained applying a stratified sampling process.

To determine the reliability of the instrument, Cronbach's alpha was used to calculate the values that determine the internal consistency of the instrument.

In order to fulfill the first objective, a statistical analysis of the Likert scale was carried out to group the results in the established dimensions and to find the strong or weak dimensions based on the hypothesis proposed.

For the development of the second objective, a Student's t-test was applied to determine the significant differences in the dimensions of the value construct and the gender of the sample.

The third objective corresponding to socioeconomic levels was analyzed with the dimensions of the value construct by means of a one-factor ANOVA to identify differences in the constructs.

Table 1. Reliability analysis

Cronbach's alpha	N of elements
,913	41

The reliability analysis indicates a value of 0.913 which determines that the Portrait Value Questionnaire applied is very reliable.

Table 2. Analysis of the dimensions of the construct Value

Dimension	Result	Gender (t-test)	Socioeconomic level (ANOVA)
Tradition	Weak-Medium: 77.8% Strong: 22.2% Weak-Medium: 77.8% Strong: 22.2% Weak-Moderate:	$p= 0.959$ No significant difference	$p= 0.878$ No significant differences

	77.8% Strong: 22.2%		
Benevolence	Weak-Medium: 78.8% Strong: 21.2% Weak-Medium: 78.8% Strong: 21.2% Weak-Moderate: 78.8% Strong: 21.2%	$p= 0.095$ No significant differences	$p= 0.770$ No significant differences
Compliance	Weak: 17.8% Medium-Strong: 82.2% Weak: 17.8% Medium-Strong: 82.2% Weak: 17.8% Medium-	$p= 0.915$ No significant differences	$p= 0.962$ No significant difference

	Strong: 82.2%		
Universalism	Weak: 19.2% Medium-Strong: 80.8% Weak: 19.2% Medium-Strong: 80.8% Weak: 19.2% Medium-Strong: 80.8%	$p= 0.074$ No significant differences	$p= 0.339$ No significant differences
Self-address	Weak-Medium: 76.2% Strong: 23.8% Weak-Medium: 76.2% Strong: 23.8% Weak-Moderate: 76.2% Strong: 23.8%	$p= 0.898$ No significant differences	$p= 0.235$ No significant difference

Stimulation	<p>Weak: 19.9% Medium-Strong: 80.1%</p> <p>Weak: 19.9% Medium-Strong: 80.1%</p> <p>Weak: 19.9% Medium-Strong: 80.1% Weak</p>	<p>$p= 0.822$ No significant differences</p>	<p>$p= 0.442$ No significant differences</p>
Hedonism	<p>Weak: 17.8% Medium-Strong: 82.2%</p> <p>Weak: 17.8% Medium-Strong: 82.2%</p> <p>Weak: 17.8% Medium-Strong: 82.2%</p>	<p>$p= 0.245$ No significant differences</p>	<p>$p= 0.168$ No significant difference</p>

Achievement	Weak: 21.9% Medium-Strong: 78.1% Weak: 21.9% Medium-Strong: 78.1% Medium-Strong: 78.1%	$p= 0.905$ No significant differences	$p= 0.239$ No significant differences
Power of Attorney	Weak: 18.2% Medium-Strong: 81.8% Weak: 18.2% Medium-Strong: 81.8% Weak: 18.2% Medium-Strong: 81.8%	$p= 0.094$ No significant difference	$p= 0.736$ No significant differences
Security	Weak: 26% Medium-Strong: 74% Weak: 26%	$p= 0.105$ No significant difference	$p= 0.014$ If there are significant differences

	Medium- Strong: 74% Weak: 26% Medium- Strong: 74% Strong: 74		
--	---	--	--

The COVID-19 pandemic has radically changed the living environment for a large part of humanity. To the extent that values reflect important life goals, changing environmental conditions should lead to at least a temporary adjustment of basic human values. Values are likely to change in response to external circumstances because their function is to channel energy and skills to deal effectively with upcoming challenges and normative forces. In addition, negative situations provoke changes to focus on safety, while positive changes draw attention to the individual's personal response. Evidence from studies of national or global crises supported these claims about Schwartz's value theory. These studies also indicated that changes in any given value are accompanied by a change in values. Therefore, the results provide a temporal snapshot of the dynamics of values, specifically to the dimensions corresponding to Tradition, Benevolence and Self-direction which in the research have presented low values in comparison to the other dimensions. The dimensions Security and Hedonism are revealed to be high, this alignment is possibly due to the uncontrollable nature of the pandemic, where efforts are considered futile, and people tend to live only for their well-being.

Terrorist attacks (Verkasalo et al., 2006) showed an increase in Security values, which returned to baseline within months in a sample that was not directly affected by the terrorist attacks, whereas the effects might be more

long-lasting in chronically affected groups (Daniel et al., 2013). Sortheix et al. (2019) indicated less long-lasting changes for Achievement and Power values and a more long-lasting effect for Security values after the global financial crisis. Research has shown high values for Security, Universalism, Achievement, Power, Hedonism, Conformity, and Stimulation.

If there are changes in values, these could affect the fulfillment of the students' goals and objectives, which generates a wide field of research to determine the impact on this population. Although the results indicate that there are no significant differences between the variables gender and socioeconomic level, other demographic study variables should be applied. Research should focus on analyzing whether the dimensions of the value construct could be affected by a negative global, local or regional event, and longitudinal studies should be conducted to determine the behavior in the values of various populations and communities. More research is needed on samples with differential risk trajectories (both infectious risk and economic risk).

Conclusions

The findings were analyzed from the perspective of the emotional processing that students have, which activate differential motivations based on the state of the person's biological system. In doing so, a biologically oriented homeostatic perspective on values is adopted, interpreting values as motivational states that adjust according to the demands and challenges of the environment. Values are relatively stable, however, they may react more quickly to demands, over time they may result in value adjustments depending on the ability of the person's system to cope with incoming situational demands. However, it may also be

plausible that more complex reciprocal feedback mechanisms exist (Schwartz et al., 2012). Cross-sectional data do not allow for a finer distinction of directional changes. Consistent with data suggesting that values change dynamically in the current pandemic environment (Daniel et al., 2021), the storyline provides a process that may help to understand psychological adjustments in an extreme event. In conclusion, values, can be affected by the impact of situational perceptions and concerns about major life events, in this case such as the Covid 19 pandemic. The data collected that are significantly affected by the pandemic highlight the social consequences specifically in the decrease of the values of Tradition, Benevolence and Self-Direction, however, the Security dimension is maintained as well as Hedonism, which as previously suggested this could be due to the fact that in the face of a catastrophic event people only see their personal integrity, When determining that there are no significant differences between gender and socioeconomic level, it can be indicated that the population has a similar behavior, which could influence their development or academic activity, however, it was determined that the security dimension does have a marked statistical difference in what corresponds to socioeconomic levels, which could determine that the economic factor influences the perception of transcendental values.

Basic goals and aspirations in life changed. These changes were rapid, but they lasted over time. These results can have substantial effects for the future of individuals and society. As we struggle with climate change, hunger and poverty, the focus of individuals on personal, rather than societal, goals may prove detrimental over time. We are curious to learn about changes in values in the countries most affected by

the pandemic and, especially, what happens over even longer periods of time.

References

- Bardi, A., Buchanan, K. E., Goodwin, R., Slabu, L., & Robinson, M. (2014). Value stability and change during self-chosen life transitions: Self-selection versus socialization effects. *Journal of Personality and Social Psychology*, *106*(1), 131 - 147. doi:<https://doi.org/10.1037/a0034818>
- Benish-Weisman, M. (2015). The interplay between values and aggression in adolescence: A longitudinal study. *Developmental Psychology*, *51*(5), 677 - 687. doi:<https://doi.org/10.1037/dev0000015>
- Burke, B. L., Kosloff, S., & Landau, M. J. (2013). Death goes to the polls: A meta-analysis of mortality salience effects on political attitudes. *Political Psychology*, *34*(2), 183 - 200. doi:<https://doi.org/10.1111/pops.12005>
- Daniel, E., Fischer, R., Bardi, A., Benish-Weisman, N., & Lee, J. A. (2021). Changes in personal values in pandemic times. *Social Psychological and Personality Science*. In press. doi:<https://doi.org/10.1177/19485506211024026>
- Daniel, E., Fortuna, K., Thrun, S. K., Cioban, S., & Knafo, A. (2013). Brief report: early adolescents' value development at war time. *Journal of Adolescence*, *36*(4), 651 - 655. doi:<https://doi.org/10.1016/j.adolescence.2013.03.009>

- Fischer, R., Bortolini, T., Pilati, R., Porto, J., & Moll, J. (2021). Values and COVID-19 worries: The importance of emotional stability traits. *Personality and Individual Differences*, 182, 111079. doi:<https://doi.org/10.1016/j.paid.2021.111079>
- Klironomos, S., Tzortzakakakis, A., Kits, A., Öhberg, C., Kollia, E., & Ahoromazdae, A. (2020). Nervous system involvement in COVID-19: Results from a retrospective consecutive neuroimaging cohort. *Radiology*, 297(3), 324 - 334. doi:[10.1148/radiol.2020202791](https://doi.org/10.1148/radiol.2020202791).
- Lechien, J. R., Chiesa-Estomba, C. M., Beckers, E., Mustin, V., & Ducarne, M. (2021). Prevalence and 6-month recovery of olfactory dysfunction: A multicentre study of 1363 COVID-19 patients. *Journal of Internal Medicine*, 290(2), 451- 461. doi:<https://doi.org/ezproxybib.pucp.edu.pe/10.1016/j.concog.2023.103464>
- Lu, Y., Li, X., Geng, N., Mei, P., & Wu, C.-C. H. (2020). Cerebral microstructural changes in COVID-19 patients - An MRI-based 3-month follow-up study. *EClinicalMedicine*, 25, 100484.
- Maslova, O. V. (2018). Value shifts in Vietnamese students studying in Russia. *Psychology In Russia*, 11(2), 14-24. doi:[10.11621/pir.2018.0202](https://doi.org/10.11621/pir.2018.0202).
- Maslova, O., Shlyakhta, D., & Yanitskiy, M. (2020). Schwartz Value Clusters in Modern University Students. *Behavioral Sciences*, 10(3), 66. doi:<https://doi.org/10.3390/bs10030066>

- Miners, S., Kehoe, P. G., & Love, S. (2020). Cognitive impact of COVID-19: Looking beyond the short term. *Alzheimer's Research & Therapy*, 1(1), 170.
- Pyszczynski, T., Lockett, M., Greenberg, J., & Solomon, S. (2020). Terror management theory and the COVID-19 pandemic. *Journal of Humanistic Psychology*. doi:<https://doi.org/10.1177/0022167820959488>.
- Ritchie, K., Chan, D., & Watermeyer, T. (2020). The cognitive consequences of the COVID-19 epidemic: collateral damage?. *Brain communications*, 2(2), fcaa069.
- Schuster , C., Pinkowski, L., & Fischer, D. (2019). Intra-individual value change in adulthood: A systematic literature review of longitudinal studies assessing Schwartz's value orientations. *Zeitschrift Fur Psychologie/Journal of Psychology*, 227(1), 42 - 52. doi:<https://doi.org/10.1027/2151-2604/a000355>
- Schwartz, S. H. (2012). An Overview of the Schwartz Theory of Basic. *Online Readings in Psychology and Culture*, 2(1). doi:<https://doi.org/10.9707/2307-0919.1116>
- Schwartz, S. H., Cieciuch, J., Vecchione, M., Davidov, E., Fischer, R., Beirlein, C., & Konty, M. (2012). Refining the theory of basic individual values. *Journal of Personality and Social Psychology*, 103(4), 663 - 668. doi:<https://doi.org/10.1037/a0029393>
- Sortheix, F. M., Parker, P. D., Lechner, C. M., & Schwartz, S. H. (2019). Changes in young Europeans' values during the global financial crisis. *Social Psychological and Personality Science*, 10(1), 15 - 25. doi:<https://doi.org/10.1177/1948550617732610>

- Taylor, S., Landry, C. A., Paluszec, M. M., Fergus, T. A., Mackay, D., & Asmundson, G. (2020). Development and initial validation of the COVID stress . *Journal of Anxiety Disorders*, 72. doi:<https://doi.org/10.1016/j.janxdis.2020.102232>.
- Thornhill, R., & Fincher, C. L. (2014). *The parasite-stress theory of values and sociality: Infectious disease, history and human values worldwide*. Springer.
- Verkasalo, M., Goodwin, R., & Bezmenova, I. (2006). Values following a major terrorist incident: Finnish adolescent and student values before and after September 11, 2001. *Journal of Applied Social Psychology*, 36(1), 144 - 160. doi:<https://doi.org/10.1111/j.0021-9029.2006.00007.x>
- Wolfin, K. A., & Bardi, A. (2018). Fitting motivational content and process: A systematic investigation of fit between value framing and self-regulation. *Journal of Personality*, 86(6), 973 - 989. doi:<https://doi.org/10.1111/jopy.12369>

The challenges of informatics in nursing practice: Integrative review.

José Ivo Oscar Contreras Briceño

PhD. in Nursing, Universidad Técnica Particular de Loja,
Ecuador.

jocontreras@utl.edu.ec

<https://orcid.org/0000-0002-9870-9944>

Introduction

Nursing professionals have a unique role in healthcare, they are the healthcare profession that is most in contact with the patient and as such collect, store and use patient data as a central function of their role. In the midst of the 21st century it is impossible to work without technology and therefore nursing informatics is not a 'specialty' but a characteristic of being a healthcare professional in the modern era, however, it must be recognized that there is a difference between being digitally capable and being credible in terms of informatics.(Cummings et al., 2020)

On the other hand, computerization and the use of new technologies is a progressive process that is increasingly present in our society and in the nursing profession. All healthcare areas are affected by this computerization process. But there are still nursing professionals who have difficulties in using them, especially those who have been in the profession for more years and who belong to the generation that "saw the technology arrive", so they have had to adapt to a new way of working to which many find it difficult to get used to. Today's nursing professional faces an enormous challenge in taking advantage of new technological resources to carry out his or her work more

efficiently, effectively and in the shortest possible time, and to be fluent in access to health information and knowledge, its management or the generation and dissemination of new knowledge.(Arandojo, 2016)

Currently, the discipline faces challenges in understanding, prioritizing and delivering critical care. Health systems are challenged by the lack of care resulting from shortages of skilled personnel and deficiencies in staff mobilization. Both challenges can be compounded or alleviated by greater integration of technology, but maximizing the benefit requires foresight and understanding. This article can help open the necessary dialogue about planning for the future and is a call to action for the nursing profession to conceptualize its position on exponential technological growth and the provision of critical care. (Archibald & Barnard, 2018)

An integrative review of how nursing professionals use technology to access data at the point of care and the challenges it presents to them generally does so specifically by accessing evidence to guide the care they provide and by accessing medical records. However, they have several concerns related to the use of technology in point-of-care settings, some of which can be resolved by investing in implementing new technologies.(Brown et al., 2020)

On the other hand, key challenges related to big data flows and data science from a nursing perspective. Benefits and challenges are considered from the components of data governance, data science infrastructure and data science pipeline and illustrated through six case examples: (a) electronic health records and symptom science, (b) omics, (c) dementia care and social care. multimedia, (d) prediction campaign and sepsis, (e) smart sensors and aging in place, and (f) dashboards and numerical and graphical literacy of nurses. In addition, two cross-cutting

themes (ethical conduct of research and data science competencies) are addressed.(Bakken & Koleck, 2019).

This is an integrative review of the literature using the most important health sciences databases, namely: PUBMED, CINAHL, MEDLINE, SCOPUS, WEB OF SCIENCE, SCIENCE DIRECT, TRIPDATABASE AND VIRTUAL HEALTH LIBRARY (World Health Organization), LILACS, EMBASE AND SCIELO, if necessary a manual search will be performed to find papers that cannot be found with the search formula. The time window for the search corresponds to January 2019 and February 2023 for primary articles.

These reviews are particularly valuable to nursing because they answer questions we have about practice, guide the review, and involve a comprehensive search of the literature. Unlike some types of reviews, in an integrative review, the quality of each of the studies is assessed and then the individual studies are interpreted and synthesized into some meaningful conclusions to answer questions and share new knowledge about the topic.(Toronto & Remington, 2020)

The search strategy will be carried out by using AND and OR operators:

- 1.- In the three languages in which the largest volume of publications on the subject are available, English, Portuguese and Spanish.
- 2.- Full text manuscripts.
- 3.- Time window: 2019 - 2023
- 4.- Texts available for free access
- 5.- Doctoral thesis
- 6.- Quantitative research
- 7.- Qualitative studies
- 8.- Mixed approach studies

The exclusion criteria will be:

- 1.- Texts with only summary

- 2.- Manuscripts whose content is not related to the research topic.
- 3.- Primary documents in another language
- 4.- Systematic reviews on the topic
- 5.- Gray literature (thesis) of bachelor, specialty and master's degrees
- 6.- Studies for years prior to 2019

The initial search formula is: (enfermería OR nursing OR Enfermagem OR Enfermagem) AND (retos OR desafíos OR desafios OR desafios) AND (informática OR computing OR IT). As refinement of scientifically valid information becomes necessary, it may require alterations in the search formula.

Other useful keywords could be: Electronic (E), blended, distance, computer-assisted, computer-based, digital, electronic, mobile, Internet, World Wide Web, intranet, information literacy, information literacy, information and communication technology (ICT), information technology (IT). The following keywords can then be added to the searches: problems, barriers, perceptions, attitudes, challenges, challenges, weaknesses, readiness and concerns. All this in the three languages mentioned.

The results obtained should be presented in the form of a paragraph, graph or table, do not use graph and table. Each of them must be done using the APA 7th Edition.

Establish new studies and research questions.

Conclusions

Conclusions are written without enumerating them should be written using scientific argumentation techniques.

References

- Arandojo, M. (2016). New technologies and new challenges for the nursing professional. *Index de Enfermería*, 25(1-2), 38-41. https://scielo.isciii.es/scielo.php?pid=S1132-12962016000100009&script=sci_arttext&tlng=en.
- Archibald, M., & Barnard, A. (2018). Futurism in nursing: Technology, robotics and the fundamentals of care. *Journal of Clinical Nursing*, 27(11-12), 2473-2480. <https://doi.org/10.1111/JOCN.14081>
- Bakken, S., & Koleck, T. A. (2019). Big Data Challenges from a Nursing Perspective. In M. Househ, A. Kushniruk, & E. Borycki (Eds.), *Lecture Notes in Bioengineering* (pp. 3-16). Springer, Cham. https://doi.org/10.1007/978-3-030-06109-8_1/COVER
- Bourgault, A., & Upvall, M. (2019). De-implementation of tradition-based practices in critical care: A qualitative study. *International Journal of Nursing Practice*, 25(2), e12723. <https://doi.org/10.1111/IJN.12723>
- Brown, J., Pope, N., Bosco, A. M., Mason, J., & Morgan, A. (2020). Issues affecting nurses' capability to use digital technology at work: An integrative review. *Journal of Clinical Nursing*, 29(15-16), 2801-2819. <https://doi.org/10.1111/JOCN.15321>.
- Cummings, E., Bichel-Findlay, J., Procter, P., Hübner, U., Honey, M., & Day, K. (2020). Nursing Informatics Education: A Global Perspective. In E. Berner (Ed.), *Informatics Education in Healthcare* (Vol. 1, pp. 153-166). Springer, Cham. https://doi.org/10.1007/978-3-030-53813-2_12

Delaney, C., Weaver, C., Sensmeier, J., & Pruinelli, L. (2022a). *Nursing and Informatics for the 21st Century-Embracing a Digital World, Book 1: Realizing Digital Health-Bold Challenges and Opportunities for Nursing*. https://books.google.com/books?hl=en&lr=&id=JmFkEAAAAAQBAJ&oi=fnd&pg=PT14&dq=nursing+informatics+challenges&ots=x6XC_JjvDS&sig=sVEIgQNo-E3WbL4JHq9U_-cK4Vg

Delaney, C., Weaver, C., Sensmeier, J., & Pruinelli, L. (2022b). *Nursing and Informatics for the 21st Century-Embracing a Digital World, -Book 2: Nursing Education and Digital Health Strategies*. <https://books.google.com/books?hl=es&lr=&id=J2FkEAAAQBAJ&oi=fnd&pg=PT13&dq=nursing+informatics+challenges&ots=XOfoOhPjuT&sig=CH-9g7wBStcKuerAUwhNFFr6O9o>.

Toronto, C., & Remington, R. (Eds.) (2020). *A Step-by-Step Guide to Conducting an Integrative Review* (1st ed.). Springer Nature Switzerland. https://scihub.se/10.1007/978-3-030-37504-1_1

Stock Market Forecasting using LSTM- MACD

Jefferson Tarcisio Beltrán Morales

PhD, Central University of Ecuador

jtbeltran@uce.edu.ec

0000-0002-0528-0019

Dayanne Odaliz Maldonado Chalá

Central University of Ecuador

domaldonado@uce.edu.ec

0000-0003-2435-1131

Mario Alexander Sánchez Tipán

Central University of Ecuador

masanchezt1@uce.edu.ec

0000-0002-2644-8669

Angie Sabina Yépez Rodríguez

Central University of Ecuador

asyepezr1@uce.edu.ec

0000-0003-3549-0014

Introduction

During the last few years, both Machine Learning and Deep Learning have made their way into the field of trading, being some of the most widely used methods to make profits when trading on the stock market (Rouf et al., 2021). Some of the algorithms used to make these predictions are KNN, SVM, Linear Regression and Random Forests. (Saranya & Anandan, 2019) However, these models may not prove to be the most optimal, so other types of algorithms have been used, such as LSTM (Hochreiter & Schmidhuber, 1997) and time series models (Li et al., 2019), which given the case of stocks in the stock market, time is one of the main factors to be analyzed. Finally, it is necessary to take into account the MACD (Aguirre et al.,

2020), an econometric indicator that has proven to have an acceptable predictive capacity within the stock market. In this sense, in order to evaluate the different models mentioned above and determine the one with the best results, it is necessary to resort to a methodology, in this case CRISP-DM (Schröer et al., 2021) (IBM Corporation, 2021) which, together with the cross-validation technique (Laura-Ochoa, 2019) allows for monitoring and analysis of the data collected, models tested and their different configurations, among other aspects that will make it possible to determine the model that best fits the data obtained.

State of the Art

In terms of previous research we can mention the work of Saranya and Anandan (Saranya & Anandan, 2019) in which the application of Machine Learning algorithms for stock market forecasts is detailed, and the importance of data preprocessing and normalization is exposed. The results obtained in stock forecasts for the companies Amazon, Google, Microsoft and Alibaba are presented; for this they make use of four models, KNN, SVM, Linear Regression and Random Forests; the one that shows a higher accuracy is Random Forests, so, the authors suggest that it would be the one that would give more yields if used to operate in the stock market.

On the other hand, in the research of Leung et al. (Leung et al., 2014), they expose an approach to market prediction with the help of Machine Learning through the use of Structural Support Vector Machines (SSVM), where they show its applicability by means of experimental results.

Likewise, Rouf et al. in 2021 (Rouf et al., 2021) explain in their article "Stock Market Prediction Using Machine Learning Techniques: A Decade Survey on Methodologies,

Recent Developments, and Future Directions", that technology has made its way into the field of trading, so it is necessary to take into account Machine Learning techniques as the new method to perform operations that generate some profit. A large number of algorithms are applied here, including Artificial Neural Networks, Deep Neural Networks and Naive Bayes, among others.

(Umer et al., 2019) indicate the importance of following a workflow to perform a predictive market model, starting with obtaining data, preprocessing it, applying its predictive model and finally evaluating the results against real data.

Also, (Mohanty et al., 2022) present their "StockBot" realized with different LSTM architectures, in which the significant changes are based on the number of layers and hyper parameters, and the use of an Encoder-Decoder model, which together allowed them to establish an algorithm for buying and selling decisions supported on stock price predictions and to the differences between these.

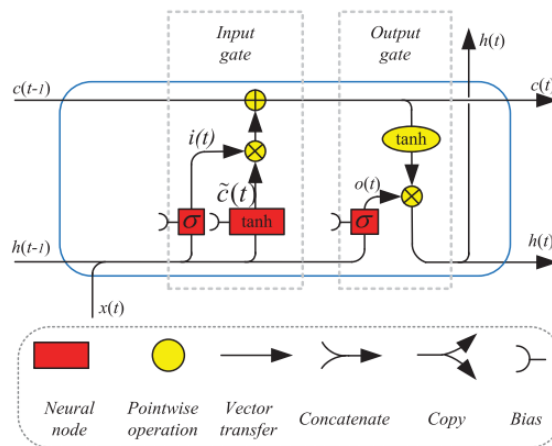
LSTM

From Recurrent Neural Networks (RNN) appear the LSTM (long short-term memory) cells proposed at the end of the 20th century (Hochreiter & Schmidhuber, 1997). (Hochreiter & Schmidhuber, 1997) which can be used with data that have sequence, such as time series (Li et al., 2019) in finance (Kim & Kang, 2019), as they have both short-term memory like RNNs and also long-term memory.

LSTM was created as a solution to drawbacks in RNN, especially time delays, for this it used CEC (Constant Error Carousels) related to time-constant error streams that allow that memory storage that characterizes it, and extends the CEC to avoid conflicts in weight updates (Staudemeyer & Morris, 2019).

The classical LSTM architecture (Yu et al., 2019) is shown in Figure 1.

Figure 1. LSTM architecture



Source: (Yu et al., 2019)

MACD (Moving average convergence / divergence)

It is an econometric indicator that uses Exponential Moving Averages to evaluate its convergence or divergence. (Aguirre et al., 2020) It is made up of two curves, the MACD line and the signal line; the first is obtained with the difference between the 12 and 26 period EMA (Exponential Moving Average) price calculations; and the second with the 9 period EMA, with which it is possible to establish buy or sell signals for stocks (Appel & Dobson, 2007). (Appel & Dobson, 2007).

Therefore, the MACD line in (2) is defined as follows:

$$MACD_{linea} = EMA_{12 \text{ periodos}} - EMA_{26 \text{ periodos}} \quad (2)$$

The interpretation of the MACD line is based on its crossing above or below the zero line, in the first case it becomes a

buy signal and in the opposite case it is a sell signal (DIAO & WU, 2015).

In addition, based on the above calculations the MACD histogram can be obtained, using the difference between the MACD line and the signal line, so the bar is positive when the MACD line is above the signal line and the bar is negative, in the opposite case. The difference between these curves is the actual height of the bar of the histogram (Vaidya, 2020) With this chart it is easier to find divergences, as shown in Figure 2.

Figure 2. Buy and Sell Signals with MACD

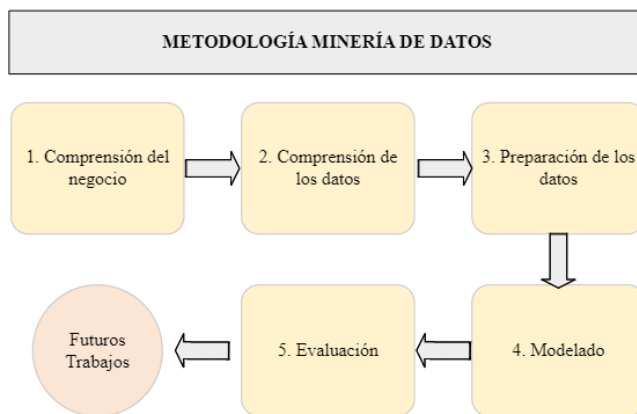


Source: Own elaboration based on (IBM Corporation, 2021)

CRISP-DM

Several methodologies can be used for the Data Mining process, one of the most used is CRISP-DM (Cross Industry Standard Process for Data Mining). (Schröder et al., 2021) Its phases adapted to a research process can be seen in Figure 3.

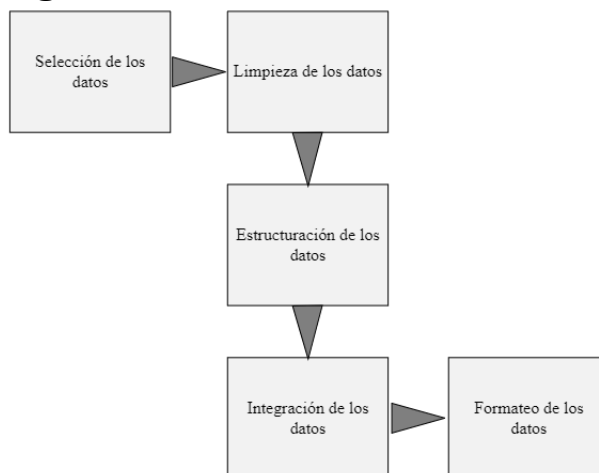
Figure 3 *Data Mining Methodology*



Source: Own elaboration based on (Schröer et al., 2021)

For the Data Preparation phase there are a series of activities, as shown in Figure 4.

Figure 4. *LSTM architecture*



Source: Own elaboration based on (IBM Corporation, 2021)

In the present research we seek to make daily predictions of the stock values of four companies in the stock market:

Google, Facebook META, Netflix and Amazon using data obtained from the Yahoo Finance API, for which the CRISP-DM methodology is used (Schröer et al., 2021) (IBM Corporation, 2021).

With this data, several Machine Learning Regression models were trained and tested using cross validation such as: Decision Trees, Random Forests and KNN in the Regressor tool.

Finally, a prediction model using RNN-LSTM was preliminarily developed in Python, Tensor Flow and Keras; and additionally with the objective of improving the results obtained in the first model, the theoretical basis of the MACD indicator is used to apply the transformation of the input variables for Artificial Neural Networks when performing operations between columns as mentioned in the article "Stock Closing Price Prediction using Machine Learning Techniques." (Vijh et al., 2020) which shows the effectiveness of these applications; therefore, an "LSTM-MACD" model was developed, which uses as input variables exponential moving averages (EMA) based on the MACD indicator and operations between them, since being EMA they focus on recent values (Shen & Shen, 2016) and price changes given after external situations can be better predicted. This model proved to be the most suitable to be able to determine the market fluctuations inherent to the stock price in most of the selected companies.

Application of the methodology

2. Understanding the business

In the stock market different assets are traded such as, company shares, currencies, cryptocurrencies, etc., and it can be defined as the place where shares of publicly traded companies are traded, and investors who buy them acquire ownership of the company, but at the same time the

investments become profit or loss of the company (Raj et al., 2023).

Likewise, the main objective of operating in the stock market either through a broker or a stockbroker is to generate profits in the short or medium term.

Therefore, this research focuses on finding a predictive model capable of determining the fluctuation in the stock price of different companies based on their historical data, so as to make it possible to generate income through stock market operations.

The historical data is obtained through the Yahoo Finance API and allows the training of various predictive models and the generation of predictions of new data.

2. Understanding the data

This phase begins with initial data collection using the Yahoo Finance API between January 01, 2020 through February 28, 2022 for Machine Learning models, and a second set of data from January 01, 2015 through February 28, 2022 for use in Deep Learning models.

The data sets present seven variables:

- Date: Date on which the share value was recorded (yyyy-mm-dd).
- Open: Opening value of the stock on a certain date (Date).
- Low: Lowest value reached by the share.
- High: Highest value reached by the stock.
- Close: Closing value of the stock on a certain date (Date). It is the variable to predict.
- Adj Close: Closing value of the stock after corporate actions of the company.
- Volume: Number of shares traded on a certain date (Date).

Two sets of data are used due to the way each model learns and operates, since as a result of the COVID-19 pandemic

the stock values vary drastically between the years 2020 and 2022, however, using data from previous years improves the accuracy of certain models based on Recurrent Neural Networks, so it was taken into account for the second set of data from the year 2015.

Once the data has been collected, it is necessary to review the quality of the data, taking into account empty fields, missing attributes, inconsistent data due to typing errors, among others.

As the last part of this phase, an exploration of the data was carried out, with which it was possible to determine a close relationship between the closing value of the shares with the rest of the variables, and a more detailed analysis using some basic statistics demonstrated the feasibility of predicting closing values and training each model with specific time periods.

On the other hand, for the LSTM-MACD models, the following input variables were used for the neural network:

- Date: Date on which the share value was recorded (yyyy-mm-dd).
- EMA [26]: 26-period exponential moving average.
- EMA [12]: 12-period exponential moving average.
- MACD - Line: Difference between EMA [26] and EMA [12].
- Signal: Signal line value of the MACD indicator.
- HIST: Difference between MACD - Line and Signal.

The variable to predict is "Close" (Close value of the stock). EMA, MACD - Line, Signal and HIST are calculated based on the variable "Close".

3. Data preparation

The main focus here is on the data and its proper treatment in order to guarantee good results in each of the prediction models.

Following the indications in Figure 4, data selection is the first step of the phase, for this purpose, data from the

following companies were chosen: Amazon, Google, Facebook META and Netflix between January 1, 2020 and February 28, 2022, and from January 1, 2015 to February 28, 2022. For the data to be used in the different models, they will be divided into training and test sets.

It is worth mentioning that the data provided by the Yahoo Finance API does not contain empty fields, and the cases of atypical data are directly related to the global situation experienced by the COVID-19 pandemic, so it was not necessary to perform an exhaustive cleaning of these. Likewise, no data restructuring was required.

For the creation of basic statistics it was necessary to create new columns that store arithmetic mean, standard deviation, and quartiles calculations for each value obtained from the companies' shares, excluding the volume variable.

Similarly, since data were obtained from a single source, it was not necessary to perform an integration analysis.

On the other hand, it was essential to normalize the data using two methods "min-max" and "max", to be used with the Machine Learning models.

4. Modeling

For the use of data-driven modeling techniques, since all the fields in the tables are numeric, except for the date, the values in this column were converted to date type.

Since the variable to be predicted is numerical "Close", it was decided to use the following Regression Machine Learning models: Decision Trees, Random Forests and KNN with the help of the RegressoR tool.

Since time is one of the main variables of the model and to compare them with Deep Learning models, in addition to the models mentioned in the previous point, it was considered to use Recurrent Neural Networks (RNN) with the Long Term Memory Model (LSTM) using Python,

Tensor Flow and Keras. To try to improve the stock prediction results, LSTM was implemented together with the econometric indicator MACD.

The test plan developed consists of a first phase in which the data is divided into training (70%) and test (30%) sets, the latter serving to validate the accuracy of the models generated.

It is further determined that RMSE (root mean squared error) and MSE (mean squared error) will be used to evaluate and compare the models (Kamble & Deshmukh, 2017), whose formulas are as follows:

$$MSE = \frac{1}{N} \sum_{i=1}^N (y_i - \tilde{y}_i)^2 \quad (3)$$

$$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N (y_i - \tilde{y}_i)^2} \quad (4)$$

In (3) and (4), N represents the number of observations, y_i the actual value, and \tilde{y}_i the value obtained with the prediction.

In MSE and RMSE the difference between the actual and predicted values are considered errors, that is, $e_i = y_i - \tilde{y}_i$, $i = 1, \dots, N$ and the aim is to minimize them. (Kamble & Deshmukh, 2017).

Thus, for the construction of the models, changes are made in the parameters of each one of them in order to obtain the best result using cross-validation. For the Machine Learning models, the data set of the years 2020-2022 is used; and for RNN-LSTM and LSTM-MACD, the data set used was between 2015 and 2022.

The final specific configurations used in each Machine Learning model for the Amazon company.

Table 1. *Specific configuration of the Machine Learning models (Amazon).*

Model	Specific Configuration
<i>Decision Trees</i>	Minimum to split a node: 20 Maximum depth: 16
<i>Random Forests</i>	Number of trees: 20 Number of variables: 2
<i>KNN</i>	K value: 19 Kernel: Optimal Data Scaling: yes Distance q: 2

The RNN-LSTM configurations can be seen in Figures 5 and 6, while for LSTM-MACD they are presented in Figures 7 and 8.

Figure 5. LSTM configuration: Amazon - Facebook META

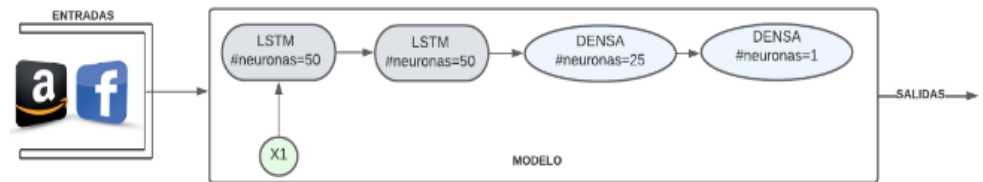


Figure 6. LSTM Configuration: Google - Netflix

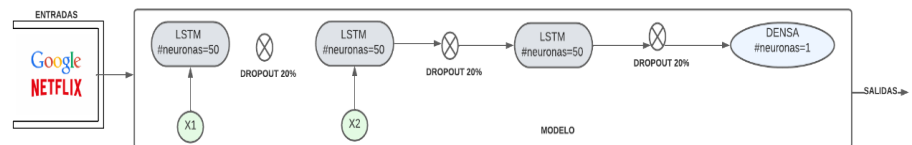


Figure 7. LSTM-MACD configuration: Amazon - Facebook META

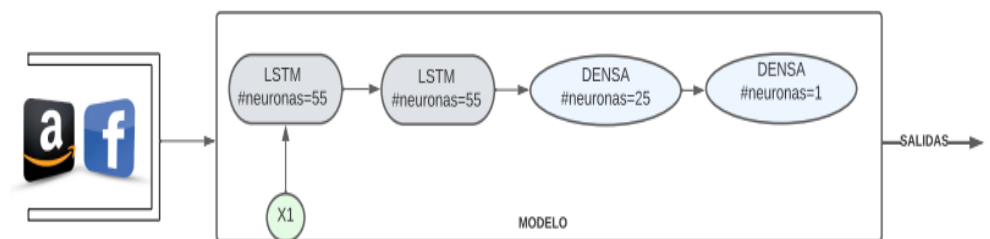
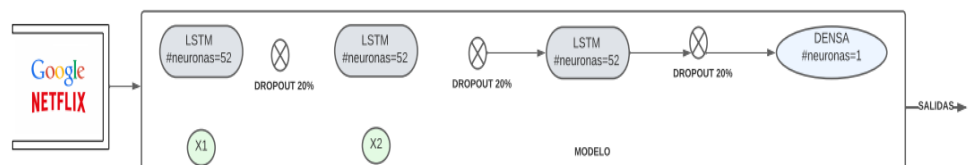


Figure 8. LSTM-MACD Configuration: Google - Netflix



5. Evaluation

The evaluation phase of CRISP-DM is detailed in the Results and Discussion section.

6. Future Work (Implementation)

This phase is described below in the Future Work section.

Once the models were developed and executed, tests were performed on the data collected in order to verify the accuracy of the predictions, using the lowest RMSE obtained for each model for comparison.

Table 4.

The lowest RMSE obtained in the different models.

RMSE				
Model	AMAZON	Facebook k META	GOOGLE	NETFLIX
<i>Decision Trees</i>	30.21	28.41	28.08	28.69
<i>Random Forests</i>	18.00	11.57	8.56	16.08
<i>KNN</i>	21.03	16.6	11.88	18
<i>Recurrent Neural Networks (RNN- LSTM)</i>	14.35	12.14	96.98	37.22

<i>LSTM- MACD</i>	5.22	11.05	5.94	34.92
-----------------------	------	-------	------	-------

For the Machine Learning models, Random Forests obtained the best result in the four companies. With the use of recurrent neural networks RNN-LSTM it was possible to improve the RSME only in the case of Amazon, in Facebook META was similar to Random Forests.

With the introduction of MACD in RNN-LSTM (LSTM-MACD) it was possible to reduce the RSME in three companies (Amazon 5.22, Facebook META 5.94 and Google 11.05), but not in Netflix where the RSME increased (32.94) with respect to Random Forests (16.08).

Figures 9 to 12 present in visual form the actual stock values of the analyzed companies and the predictions using LSTM-MACD.

Figure 9. Results obtained with LSTM-MACD for Amazon

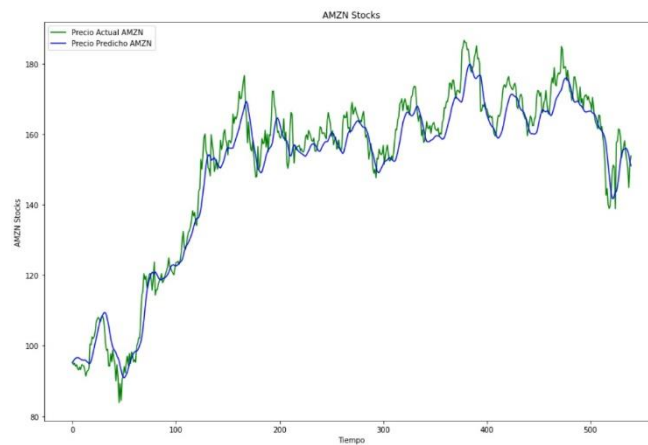


Figure 10. Results obtained with LSTM-MACD for Google

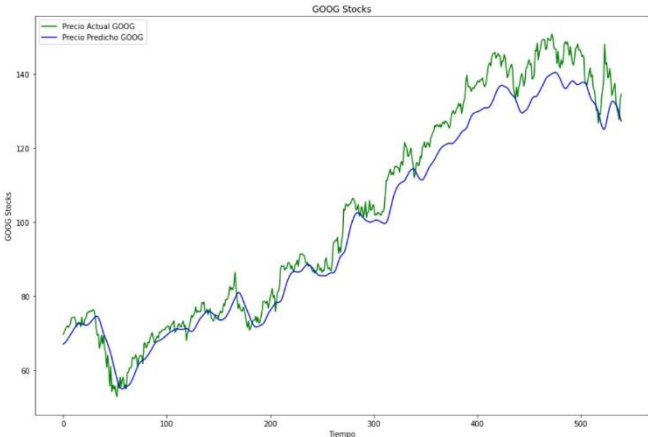


Figure 11. Results obtained with LSTM-MACD for Netflix.

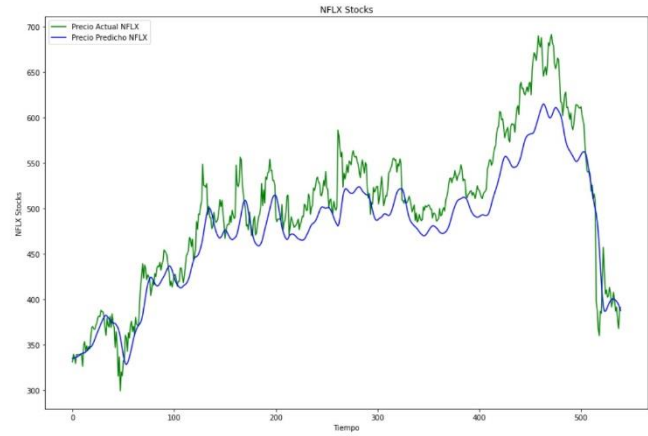
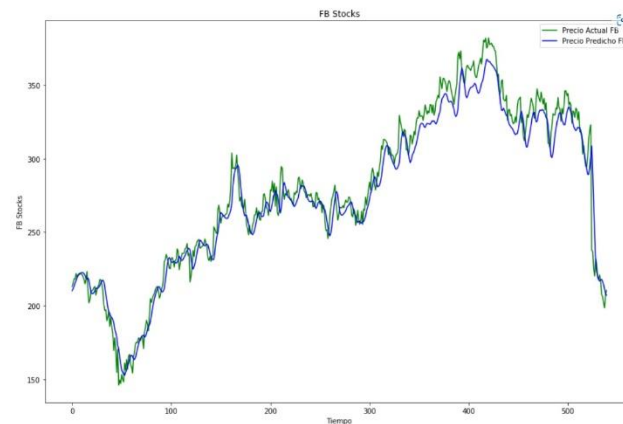


Figure 12. Results obtained with LSTM-MACD for Facebook META



Conclusions

In the present research, several predictive models were evaluated in order to find the one that is able to adequately determine the future values of Amazon, Facebook META, Google and Netflix stocks.

Some Machine Learning Regression models that are part of the Regressor tool were used, in particular Decision Trees, Random Forests and KNN; Recurrent Neural Networks were also considered, in particular LSTM; and finally, looking for an improvement of the predictions, a model was developed that combines LSTM and the econometric indicator MACD (Moving Average Convergence/Divergence) that uses as input variables moving averages and operations between them.

The models performed in Regressor showed good results for the four companies, being Random Forests the one with the lowest RMSE, however, the need to use in the models several variables related to the closing value of the stock during the day makes it difficult to predict future values, so

developing a model with LSTM neural networks together with MACD became the solution to this problem.

RNN-LSTM gave a lower RMSE for Amazon (14.35) compared to Random Forests (RMSE 18.00).

LSTM-MACD proved to be able to make good daily predictions of stock values, having the lowest RMSE for Amazon (5.22), Facebook META (5.94) and Google (11.05). In contrast, for Netflix the best model was Random Forests (RMSE 16.08).

The LSTM-MACD model consists of a recurrent LSTM neural network with 4 and 7 layers of neurons for the Amazon-Meta and Google-Netflix company pairs respectively, and each of these layers consists of a different number of neurons and particular configurations per company, which, due to similar data trend, seasonalities and cycles, match pairwise in the neural network structures, which is a particular case of the present study.

LSTM-MACD uses exponential moving averages that focus on the weighting of the most recent data, when price variations directly influence the predictions, where the values of the last few days become more important than previous historical values.

Finally, the LSTM-MACD predictive model for three of the four companies analyzed obtained the lowest RMSE compared to various Machine Learning and Deep Learning models, demonstrating its usefulness as a support for predicting stock prices in the stock market. It is not possible to generalize these results, as each company and its data must be analyzed on a case-by-case basis using various predictive models.

Once obtained a LSTM-MACD model that adequately predicts the closing prices of the shares of companies in the stock market, and also have the variables to calculate an indicator for a possible purchase or sale of shares with the

help of the MACD, as future work is proposed: the development of a web application that makes use of this model, presenting predictions in a friendly way to users. Also, we could think of generating a model based on this research, which takes the prediction of the new value of a stock and automatically generates a buy or sell signal in the stock market.

References

- Aguirre, A. A., Medina, R. A., & Méndez, N. D. (2020). Machine learning applied in the stock market through the Moving Average Convergence Divergence (MACD) indicator. *Investment Management and Financial Innovations*, 17(4), 44-60. [https://doi.org/http://dx.doi.org/10.21511/imfi.17\(4\).2020.05](https://doi.org/http://dx.doi.org/10.21511/imfi.17(4).2020.05).
- Appel, G., & Dobson, E. (2007). *Understanding MACD (Moving Average Convergence/Divergence)*. Greenville: Traders Press. <https://signalforall.com/articles-download/understanding-macd-article.pdf>
- DIAO, X., & WU, M. (2015). Technical analysis of three stock oscillators testing MACD, RSI and KDJ rules in SH & SZ stock markets. *2015 4th International Conference on Computer Science and Network Technology (ICCSNT 2015)*. <https://doi.org/10.1109/iccsnt.2015.7490760>. <https://doi.org/10.1109/iccsnt.2015.7490760>
- Hochreiter, S., & Schmidhuber, J. (1997). Long Short-Term Memory. *Neural Computation*, 9, 1735-1780. <https://doi.org/10.1162/neco.1997.9.8.1735>.

- IBM Corporation (August 17, 2021). *Data Preparation*. (IBM) Retrieved March 15, 2022, from <https://www.ibm.com/docs/en/spss-modeler/SaaS?topic=guide-data-preparation>
- Kamble, V., & Deshmukh, S. (November 24, 2017). Comparison Between Accuracy and MSE, RMSE by Using Proposed Method with Imputation Technique. *Oriental Journal of Computer Science and Technology* SEMANTIC SCHOLAR. <https://doi.org/http://dx.doi.org/10.13005/ojcs/10.04.11>
- Kim, S., & Kang, M. (March 1, 2019). FINANCIAL SERIES PREDICTION USING ATTENTION LSTM. A PREPRINT . <https://doi.org/https://doi.org/10.48550/arXiv.1902.10877>
- Laura-Ochoa, L. (2019). Evaluation of Classification Algorithms using Cross Validation. *17th LACCEI International Multi-Conference for Engineering, Education, and Technology*. <https://doi.org/10.18687/LACCEI2019.1.1.471>
- Leung, C. K.-S., MacKinnon, R. K., & Wang, Y. (July 2014). A machine learning approach for stock price prediction. *IDEAS '14: Proceedings of the 18th International Database Engineering & Applications Symposium*, 274-277. <https://doi.org/https://doi.org/10.1145/2628194.2628211>.
- Li, Y., Zhu, Z., Kong, D., Han, H., & Zhao, Y. (2019). EA-LSTM: Evolutionary attention-based LSTM for time

series prediction. *Knowledge-Based Systems*, 181.
<https://doi.org/10.1016/j.knosys.2019.05.028>.

Mohanty, S., Vijay, A., & Gopakumar, N. (July 15, 2022). StockBot: Using LSTMs to Predict Stock Prices. *Journal of Banking and Financial Technology*, 1-14.
<https://arxiv.org/pdf/2207.06605v1.pdf>.
<https://arxiv.org/pdf/2207.06605v1.pdf>

Raj, P., Ashu Mehta, & Singh, B. (2023). Stock Market Prediction Using Deep Learning Algorithm: An Overview. *Lecture Notes in Networks and Systems*, 471, 327 - 336. https://doi.org/10.1007/978-981-19-2535-1_25.

Rouf, N., Malik, M. B., Arif, T., Sharma, S., Singh, S., Aich, S., & Kim, H.-C. (2021). Stock Market Prediction Using Machine Learning Techniques: A Decade Survey on Methodologies, Recent Developments, and Future Directions. *Electronics* 2021, 10(21).
<https://doi.org/https://doi.org/10.3390/electronics10212717>.
<https://doi.org/https://doi.org/10.3390/electronics10212717>

Saranya, A., & Anandan, R. (2019). Stock Market Prediction using Machine Learning Algorithms. . *International Journal of Recent Technology and Engineering*, 8(2S4), 280-283.
<https://doi.org/https://doi.org/10.35940/ijrte.b1052.0782s419>.

Schröer, C., Kruse, F., & Gómez, J. M. (2021). A Systematic Literature Review on Applying CRISP-DM Process Model. (M. M. M. Cruz-Cunha, R. Martinho, R. Rijo, N. Mateus-Coelho, D. Domingos, & E. Peres, Edits.)

Procedia Computer Science, 181, 526-534.
<https://doi.org/https://doi.org/10.1016/j.procs.2021.01.199>

Shen, X., & Shen, T. (2016). Knock Limit Controller based on Exponential Moving Average of Knock Intensity. *IFAC-PapersOnLine*, 49(11), 691-695.
<https://doi.org/https://doi.org/10.1016/j.ifacol.2016.08.100>

Staudemeyer, R. C., & Morris, E. R. (September 23, 2019). - Understanding LSTM - a tutorial into Long Short-Term Memory a tutorial into Long Short-Term Memory. <https://arxiv.org/pdf/1909.09586.pdf>

Umer, M., Awais, M., & Muzammul, M. (2019). Stock Market Prediction Using Machine Learning(ML)Algorithms. *ADCAIJ: Advances in Distributed Computing and Artificial Intelligence Journal*, 8(4), 97-116.
<https://doi.org/https://doi.org/10.14201/ADCAIJ20198497116>.
<https://doi.org/https://doi.org/10.14201/ADCAIJ20198497116>

Vaidya, R. (2020). Moving Average Convergence-Divergence (MACD) Trading Rule: An Application in Nepalese Stock Market(NEPSE). *Quantitative Economics and Management Studies (QEMS)*, 1(6).
<https://doi.org/https://doi.org/10.35877/454RI.qems197>.
<https://doi.org/https://doi.org/10.35877/454RI.qems197>

Vijh, M., Chandola, D., Tikkiwal, V. A., & Kumar, A. (2020). Stock Closing Price Prediction using Machine

Learning Techniques. *Procedia Computer Science*,
167, 599-606.
<https://doi.org/https://doi.org/10.1016/j.procs.2020.03.326>.

Yu, Y., Si, X., & Zhang, J. (2019). A Review of Recurrent
Neural Networks: LSTM Cells and Network
Architectures. *Neural Computation*, 1235-1270.
https://doi.org/10.1162/neco_a_01199.

Interactive Classroom: a methodological strategy in mathematics education

Carlos Luis Sánchez-Pacheco

DOCTOR IN EDUCATION, Universidad César Vallejo

carlossanchez21@hotmail.com

<https://orcid.org/0000-0003-4831-5813>

Introduction

Despite being seen as a right of all and seen as a duty of the State, access to public education in Ecuador is still something that goes through a series of challenges. These challenges are linked to the scenario of inequality faced by the population, which has become even more acute since 2020 with the advent of the health crisis caused by COVID'-19, widening the gap between the poor and the poorest classes in the country.

It is in this scenario that a new teaching modality also arises for the educational system, hereinafter called Distance Learning. It should be noted that the main pillar of this modality is the use of Information and Communication Technologies, which indirectly promote the rapprochement and, at the same time, the distancing and social isolation of people, contributing to the mitigation of the impacts caused by the health crisis. However, the scenario of social inequality aggravated by the pandemic is an impeditive element in terms of access to education, since a large part of the population cannot access technologies, much less the Internet.

To be a teacher of the 21st century is to understand that the role in society is one of great responsibility and failures will be perpetuated in the daily and later life of the student-subject.

In the current years, complex problems of daily school life are being faced, so this professional must be prepared to exercise the teaching activity and, at the same time, play the

role of opinion leader, promoting the formation of subjects with a critical and reflective character. In addition, the teacher must be willing to adapt to uncertain and emerging situations in the pedagogical dynamics. Such as modifications in the planning of their activities, use of pedagogical techniques and resources that facilitate student learning, as well as the adoption and creation of mediation strategies that come to solve situations that may be embarrassing.

Mathematics here is not only a discipline, but also an area of knowledge. The teaching of Mathematics, as well as other disciplines in the area of exact sciences, is often a challenge for the teacher in terms of developing teaching methodologies that are able to promote student autonomy, as well as a better appropriation of the content available in the classroom. Thus, the search for tools that teach the content and solve difficulties brought from other series is to achieve extraordinary goals.

Technologies reduce overwork by facilitating human life. Thus, mathematics teachers cannot remain inert in the face of technological advances, being necessary the search for knowledge to incorporate them into their pedagogical proposals, since the current form is not very valid. According to (PREDIGER, BERWANGER, & MÖRS, 2013) the student arrives at school already with a representation of Mathematics, since it is from the interaction with the environment and social influence that he/she builds a course on the area of knowledge. This may explain the lack of interest of a considerable part of the students, but we reflect that this may also be the result of the lack of stimulation and the methodology adopted by the teacher. Finally, it is necessary to seek and know the resources to have the expected effect.

Importance of the technological scenario in education

Active methodologies bring many benefits and evolution in the teaching-learning process of students, since we make them an active being in their training, developing their autonomy and protagonism. In order for the student to develop this capacity to actively participate in his or her education, situations must be created that make such actions possible. In this sense, the student should be encouraged from an early age to practice actions of cooperation and reflection on their education.

When talking about this mix of the use of active methodologies that allow the development of the student as an active being in his or her formation, we are directly confronted with the teaching-learning method in Mathematics, which still integrates the traditional *modus operandi* of the educational system. In fact, Mathematics in its essence is a discipline that demands time and practice, but more interaction and critical reflection by the student on what he studies is necessary. In this sense, to break with this traditional pattern, it is necessary to work mathematics in a meaningful way for the student's daily life, giving a real meaning to the proposed activities. We learn more and better when there is meaning in what we do, i.e., a logic that guides our paths and resolutions (MORÁN & BACICH, 2018, p. 80)..

Another point when talking about education today is to perceive technological advances and their consequences. In the last decades we have initiated a great revolution in the media mediated by the Internet. In this way, all the dynamics of people, companies and businesses have changed, causing significant changes. Education, as part of this environment, was directly impacted in this process, acquiring new scenarios, new methodologies and technological tools aimed at meeting the new realities and

social demands. Although many educational institutions do not have access to these technological products due to social inequality, numerous platforms and software have emerged that add directly to the lives of teachers, students and other members of the school community. In this regard, DZIUBAN, GRAHAM, & MOSKAL (2018) reinforce that: These tools enable the personalization of learning and provide stimuli that drive students in their discoveries. Managers can monitor student and teacher performance, while parents can view their children's performance at any time, and can also intervene before formal assessments, not just after. (DZIUBAN, GRAHAM, & MOSKAL, 2018)..

Therefore, teachers and other professionals involved in education face a great challenge: to use all these resources and technological tools in our teaching as a way of adding autonomy and critical thinking to the student's educational process, while contributing to the inclusion and dissemination of the benefits that the digital era can bring to their performance.

Technologies play a fundamental role in education by providing both the teacher and the student with information that contributes to the construction of knowledge in an exponential way. In this entertainment, that student who is not connected, that is, does not have access to the Internet, has his right of access to education partially deprived in the distance learning modality, since he loses the opportunity to acquire materials with a greater wealth of information. Resulting also in a subject who does not have or has a compromised digital literacy, which can directly affect his reality, since the current labor market requires mastery of technologies and, at the same time, a versatile professional profile in terms of analysis and information search (MORÁN & BACICH, 2018)..

In Education 4.0, which has emerged with the impact of technology, teachers must have the perception and

flexibility to assume the roles mentioned above. As well as seeking to adapt their classroom dynamics to this new learning environment, proposing mediating strategies to achieve student learning. (RAMIREZ, RIVERA, & HERNANDEZ, 2020)..

In this sense, the teacher needs to get out of the comfort zone and open up to new positions, since there is no prefabricated model and people in the 21st century are always up to date. It is necessary to elaborate goals and objectives aligned to the historical and social context of the students. Thus, working individuality and collectivity at the same time. (MENDIZABAL & ESCALANTE, 2021)..

The teacher adopts a new attitude, although still playing the role of specialist with different knowledge, it is also necessary to assume different roles such as: consultant, learning facilitator, collaborative advisor, classroom manager, leader. Thus, it assumes the role of pedagogical mediator, making the student have autonomy and be the main responsible for the construction of knowledge. (ALVES & FONSECA, 2022)

In this perspective, educational institutions must rethink their curriculum based on the current reality. As well as, seeking to increase strategies that use accessible tools and platforms in the classroom. Thus, the training of students should be linked to the ability to deal critically and creatively with technology. Therefore, the correct use of technologies as a learning method is one of the functions of the modern school. (TORRES & COBO, 2017).

Due to the correct use of platforms and digital media, the teacher needs to prevail with the same systematization used in their practices. It is necessary to delimit and choose the step by step, including the fundamental tasks for students to acquire the desired knowledge. Teachers need to find, not only one or another motivating task to make the classroom environment less tense, but also consider the set of tasks

proposed in the unit, which naturally includes their diversity, time of realization and use of statements and materials.

The teacher must seek lifelong learning, since the individual is built from the objects and activities that surround him. Thus, teachers 4.0 are required to have the competence to navigate through different multimedia and educational tools, and to know how to handle them. Therefore, we can understand that this technological change has impacted positively and negatively on society, starting from the need for a professional with a critical and reflective sense that mediates the citizens of society for the proper use and according to the need.

Technologies can be allies in the construction and acquisition of student competencies. According to (PERRENOUD, 2000) when students' education is supported by technology, it favors the development of judgment, critical thinking, memorization, imagination and communication skills, research spirit, among others. Thus, we can see that the use of technologies in the classroom facilitates the teacher's work and makes it clearer, richer and more precise.

There are several educational platforms and tools that can be used to enhance the teaching and learning process of students. However, how to use them is one of the challenges of the market. It is necessary for pedagogical practice to be innovative, and it is up to teachers to seek the appropriate training to build new knowledge. Thus, the incorporation of novelties will be effectively encompassed in the teaching network.

Understanding the current teaching-learning process and the accessible tools, strategies were designed to develop student autonomy and contribute to the development of active learners in the educational process. In addition, something that would allow the development of the student

to the technological environment and using these tools to their advantage contributing to their learning.

The qualitative research was developed in a public educational institution, located in the south of the city of Guayaquil, involving 02 (two) courses of the 3rd High School, with a total of 90 students. In this institution the distance learning developed in this period of pandemic was carried out synchronously through the Google Meet platform where classes were simultaneous during two days a week. In addition, students also developed asynchronous activities through Google Classroom and Google Forms.

Therefore, the work with the interactive classroom was developed from the current contents of the school year studied by the classes. To start the process, an interactive PDF was developed, where through this material, an environment similar to that of the classroom was built in an attractive and playful way. For this purpose, emojis, figures and bright colors were used. Thus, in this environment we provided the materials to be studied by the students, through links attached to these figures of the material. In this sense, the students had access to two materials on the topic in question in PDF version, in addition to two supporting videos. The fifth link guided them to the attachment activity carried out in Google Forms. With the material in hand, the last ten minutes of a class were dedicated to present this experiment to the students, commenting on how they could explore the material and perform the requested tasks.

Subsequently, the material was made available in the Google Classroom of the classes and groups of classes so that the students had free access to them until the next class to carry out the proposal.

Finally, we came to the intervention class where we finalized the process of creating the Interactive Classroom. In this class we began by asking the students about their

considerations about the activity and then we started the class. With that we started solving examples of calculus of determinants, since it was a topic of difficulty for the students during the whole process. Then we began to solve the remaining exercises to practice. For this process we prepared an animated PowerPoint presentation, again using several figures in emojis, trying to keep the students' attention during the course of the class. During this stage we asked questions to the students and commented on the content in question, always prioritizing a cooperative and participatory class.

This small introduction to a new teaching-learning model brings good results, especially in terms of developing students' autonomy and, above all, providing them with something new and attractive, generating an enjoyable and not so monotonous class. In this sense, the activity can be an important starting point to develop in the student these important concepts: autonomy and interaction during the teaching-learning process.

As an evaluation process, we chose to use a one-minute comparative writing technique, which resulted in a series of responses, identifying difficulties and progress in the application. It is worth mentioning the message left by a student in the chat: today I learned about the main and secondary diagonals and the areas of the triangle and most importantly how to do the calculations correctly. The class was fun, the teachers are very funny. Within this story, we can see how important that moment when teachers interact and do relaxed activities. So, diving a little, we see that the student in three lines highlights the diversity of content developed in the class and it is possible to conclude that there was, indeed, interaction.

When analyzing a second record, we note the use of the class, the student emphasizes: "I really liked it! It was very interesting to learn with this way of teaching". Which leads

to a question, why many teachers do not use the tools, in the digital environment, free and accessible to all in their classes? The answers can be summarized in two thoughts left as the authors' opinion: the teacher does not seek or has not had access to the necessary training and/or is not willing to deviate from the usual methodology.

In a third and last record, the student highlights a very intriguing point: "Go ahead, my curiosity goes further to find the solution". Curiosity" is one of the competencies for the teacher to instigate his students, because it is from there that the student interacts with knowledge, strengthening the use of active methodologies in the learning process.

With the application of the activities we realized that most of the students liked the proposal and tried to participate in the best way possible. Whenever there is contact with something new, a moment of familiarization is necessary. For some, more time is needed, as we work with a great diversity. This was one of the consequences of the application in the research field, a certain group of students presented difficulties in interacting with the interactive classroom and also with Google Forms. We did not expect these difficulties, since we were dealing with third year high school classes.

One of the points to improve would be the way to apply the activity. As already mentioned, many students had difficulties accessing and attaching resolutions through Google Forms. In this sense, for a better result, considering the possibilities and technical capabilities of the devices used by the students, develop the activity through Google Classroom. In addition, an option to reevaluate would be the face-to-face discussion in the synchronous class, since it is unlikely to foresee the doubts that the students had throughout the activity. Therefore, constructing a pre-made slide, even if animated, may not be sufficient. In fact, this was one of the things we noticed in the lesson planning, and

we decided to use OpenBoard to support these particular problems.

Analyzing the whole process, we believe that it was a meaningful activity, considering that more than half of the students returned the activity and we had a satisfactory participation in the synchronous class through the chat. In addition, we emphasized the importance of building animated classes with colorful slides using figures. This is important because students have fun and are curious to see the next slides. Keeping their attention and leading them to interact and during the class.

Conclusions

Through this activity, we had many reflections and learnings about our teaching practice. In this sense, we initially perceived the challenges and possibilities of proposing something new in the classroom, even if it is at a distance. As already argued throughout the text, innovation is necessary and the teacher must be attentive and study the best ways to contribute to this process and its current demand. In addition, although timidly and quickly, we realized the benefits of applying a methodological concept that deviates from the formal standard during classes. A first sign of this is the participation and interaction of students in the process of their learning, developing their autonomy and using digital technologies to their advantage. With the application of the interactive classroom in the high school classes referred to, we verified and appreciated the options that this tool can provide in the teaching-learning process. Thus, we conclude that, with this application, a starting point was given and that the work developed can be improved and adapted to new perspectives. In other words, as teachers we must always contribute to education and, above all, understand and always try to apply the ideas of active methodologies. The success of education in our

country depends directly on our ability to reflect, evaluate and always be ready to propose something for the teaching-learning process.

References

- ALVES, A., & FONSECA, Y. (2022). Pedagogical and technological mediation: concepts and reflections on teaching in digital culture. *Revista Educação Em Questão*, 60(64). doi:<https://doi.org/10.21680/1981-1802.2022v60n63ID28275>
- MENDIZABAL, G., & ESCALANTE, A. (2021). The challenge of education 4.0: labor competencies for emerging work by covid-19. *Revista Iberoamericana de las Ciencias Sociales y Humanísticas Vol. 10, Núm. 19*. doi:<https://doi.org/10.23913/ricsh.v10i19.242>
- MORÁN, J., & BACICH, L. (2018). *Metodologias ativas para uma educação inovadora: uma abordagem*. Penso.
- PERRENOUD, P. (2000). *Dez novas competências para ensinar*. Artmed.
- PREDIGER, J., BERWANGER, L., & MÖRS, M. F. (2013). RELATIONSHIP BETWEEN STUDENTS AND MATHEMATICS: REFLECTIONS ON STUDENTS' DISINTEREST IN LEARNING THIS SUBJECT. *Revista Destaques Acadêmicos, [S.l.], v. 1, n. 4*. Retrieved from <http://univates.br/revistas/index.php/destaques/article/view/39>
- RAMIREZ, M. d., RIVERA, C., & HERNANDEZ, J. (2020). Education 4.0: Approaching a new way of learning

with online tools. *Cognosis Journal ISSN 2588-0578*
5(2):1-12. doi:10.33936/cognosis.v5i2.1997.

TORRES, P., & COBO, J. (2017). Educational technology
and its role in achieving the purposes of education.
Educere, vol. 21, no. 68, pp. 31-40. Retrieved from
<https://www.redalyc.org/pdf/356/35652744004.pdf>

RGB free colorimeter for sensing and sorting of pigmented spheres

With the advance of technology in recent years, various electronic systems have been designed to help automate industrial processes in different fields, such as production, manufacturing, maintenance, etc. The classification of objects is part of a production process, in this case the color of the object is the main parameter that is taken into account to perform this process. [1].

The development of this project is accompanied by a previous study of published articles concerning the use of color sensors for object classification, in this case a TCS3472 sensor has been considered, which provides perceived wavelength values of light according to the RGB model.

A spherical design has been defined as the subject of study for the classification which will be replicated in 4 bodies of a different color each (blue, red, green, yellow), determined the model and color of the object we proceed to establish the mathematical model to be used for color detection based on the saturation of this and the luminosity reflected on the body.

By being able to classify objects based on their coloration, one of the possible applications for this classification system is in the manufacture of fruit sorting and packaging.

A more advanced application of the system the detection of objects by shape as developed in Japan in that study it was established that in most supermarkets, the cashier has to distinguish several dozens of products without barcode, such as vegetables, deli, bread, etc. It is a heavy task to

remember all those goods, because the lineup of goods partially changes every day. Therefore, automated recognition A system is required to reduce the cashier's workload or to realize convenient self-service checkout lanes. (Morimoto, 2018)

Development

In 2020, a group of researchers from the National University of Colombia developed and evaluated a prototype for measuring the color of fresh vegetables, using DHT11 sensors for temperature and TCS230-3200 for color. Through tests carried out it was deduced that the color measurement with the prototype is dynamic, because it avoids the use of a lighting system, since the color sensor has integrated LED devices. After the analysis of the results it was concluded that the prototype developed by integrating components such as sensors and data acquisition card and free software, allows to evaluate the color in a different way; 2) the average error recorded by the prototype was 15.57 %, a lower value than that recorded by the commercial colorimeter which was 27.45 %. [3]

Similarly Hermoza Llanos (2018) in his research conducted in Sacha Inchi producing companies in Lima, determines as main objective the design of a selection system for peeled Sacha Inchi fruits by color. All materials in contact with the seeds were considered as non-contaminating, the final output flow is 200 Kg/h distinguishing between dark brown and almond colored seeds. The materials used were a TCS3472 RGB color sensor, vibrating table, LCD screen.

A research conducted in 2018 in Italy to determine the impact of light pollution on a vehicular driver used the RGB sensor, type TCS34725 as a luminance meter as it allows the possibility to adjust the data acquisition rate, between very high or low rates the latter range of obtaining is necessary

for situations where there is little traffic or partially uninhabited areas in order to reduce the amount of data. [4]

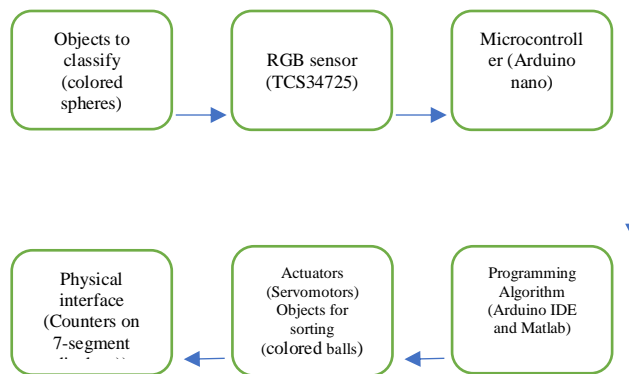
Tests carried out showed that the structure of the system is suitable for modifications towards an image processing system capable of controlling the quality of the seeds to be processed. It is concluded that the cost, dimensions and final processing capacity of the system, make it competent compared to other options currently available in the market, in addition to increasing productivity in the seed selection process, since it translates into shorter production times and therefore higher commercial profits. [5]

According to these two authors, the electronic color interpretation system to be developed is feasible and has tools that are within reach such as, for example, the RGB sensor TCS3472, ATMEGA series microcontrollers, etc. The communication between these devices and the visualization through a physical graphic interface can be done since, in the analyzed investigations, the architecture used and the programming algorithms used can be observed, the latter are made both in Python and Matlab, which contributes even more to the development of the project.

The classifier system consists of elements such as an RGB sensor, a servomotor, 7-segment displays to visualize the number of hits of the classifier, programming algorithms to meet the main objective which is to classify objects according to color. The RGB sensor is the main element of the system, since it can determine the color of the object, this is not possible without the help of programming algorithms. Through the use of algorithms it is possible to process the data acquired by the sensor and send functions to the actuators to perform the classification procedure, these actuators are the servomotors that direct the object to a specific place for a color. As a visual interface there are 7-

segment displays where the count of each classified object will be shown. The following image shows the architecture of the exposed process.

Figure 1. Block diagram of operation



- Specification of objects to be classified

The bodies selected for classification are spheres whose composition is wood with a diameter of 2cm and a weight of 70gr, each one of them coated with acrylic paint with the respective color (Blue, Green, Yellow, Red).

The importance of the object to be classified is due to the range of colors that it will have, since, according to this data, the sensor will proceed to detect it to later process the data and be able to classify it.

- Color

The color of a surface is described by a combination of three primary colors: red, green and blue. In a colored image, each pixel is represented by a certain value of red, green and blue components. In the RGB color space, the pixel $p(i)$ is defined by an ordered triplet of red, green and blue coordinates $(r(i), g(i), b(i))$, representing the red, green and

blue light intensities respectively. The intensity value varies from 0 to 255. [6]

Table 1. Color analysis

Color	Length wave	Colors analogs	Length wave	Color type
Blue	436-495 nm	Blue Turquoise Blue Vioaceous	489.04 nm 380 - 500nm	Monochromatic
Red	620-700 nm	Red Orange	600 - 500 nm	Monochromatic
Green	495-570 nm	Green Blue Yellow Greenish	555 nm 574 nm	Monochromatic
Yellow	566-589 nm	Orange	592-620 nm	Monochromatic

Prepared by: The Researchers

- RGB sensor

The RGB sensor allows distinguishing colors by extracting information from the light using three coupled sensors that separate the incident light into its red, green and blue components. In the case of the TCS3472 sensor, it can be

used with an Arduino microcontroller using I2C communication.

The TCS3472 device provides a digital return of red, green, blue (RGB) and clear light detection values. A blocking infrared filter, integrated on-chip and located on the color detection photodiodes, minimizes the IR spectrum component of the incoming light, allowing color measurements to be made accurately. The high sensitivity, wide dynamic range and IR blocking filter make the TCS3472 an ideal color sensor solution for use in the field.

varying lighting conditions and through attenuating materials. [7]

The classifier system includes a TCS3472 color sensor which provides a digital output of the perceived values of red, green, blue (RGB) and clear or unfiltered light. An on-chip infrared filter, located above the photodiodes, minimizes the infrared spectral component of the incoming light and allows the color components to be measured accurately.

- Electronic card for data processing

The data taken by the RGB sensor are sent to the processing card, where through the Arduino IDE and Matlab, the data will be processed to calibrate the sensor, control the speed of the servomotor and count the classified objects. It is worth mentioning that the speed at which it will work must be established and the necessary libraries must be installed to avoid problems in the execution of the program.

- Programming algorithms

These algorithms are created through a flow chart shown in the methodology section. The importance of the algorithms is due to the fact that, the classification process will be performed correctly and through tests it will be possible to reduce the margin of error in case it exists.

- Actuators

The actuators, in this case the servomotors, will be in charge of routing the route to where the sorted object should arrive according to its color. Both the programming and the location of these are of utmost importance.

- Physical interface

Through the use of 7-segment displays, the number of objects that have been classified can be visualized, these are located with labels to identify which color corresponds to a certain quantity.

Mathematical model

The parameters taken into account to describe the color are:

- L: brightness
- a: Red/green coordinates where +a indicates red and -a indicates green.
- b: Coordinates yellow/blue in which +b indicates yellow and -b indicates blue.
- c: represents the chroma key.
- h: corresponds to the hue defined as an angle (in degrees) on the color wheel.

Once the color data is obtained, it is compared with other samples to evaluate their differences. [8]. If these differences are called ΔL , Δa , y Δb for the axes L, a and b respectively, the total distance between two colors is given by Δ whose formula is:

$$\Delta = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2} \quad (1)$$

With the data acquired from the RGB sensors, it is divided for 255 in order to have values in the range of 0 to 1 as shown below.

$$R' = \frac{R}{255} \quad (2)$$

$$G' = \frac{G}{255} \quad (3)$$

$$B' = \frac{B}{255} \quad (4)$$

With this data, the pitch is calculated with the following formula:

$$H = \begin{cases} 0^{\circ} & \Delta = 0 \\ 60^{\circ} * \left(\frac{G' - B'}{\Delta} \text{ mod } 6 \right), C_{max} = R' \\ 60^{\circ} * \left(\frac{B' - R'}{\Delta} + 2 \right), C_{max} = G' \\ 60^{\circ} * \left(\frac{R' - G'}{\Delta} + 4 \right), C_{max} = B' \end{cases} \quad (5)$$

The brightness is calculated depending on the luminosity:

$$S = \begin{cases} 0, & \Delta = 0 \\ \frac{\Delta}{1 - |2L - 1|}, & \Delta <> 0 \end{cases} \quad (6)$$

Where:

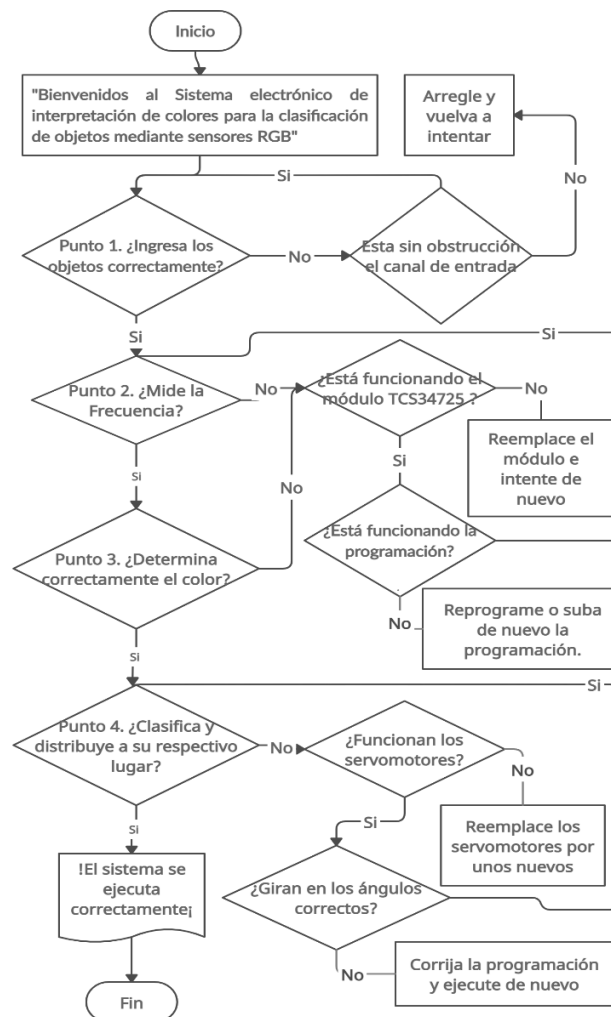
- S: saturation.
- Δ total color differential
- L: Luminosity.

For the calculation of the percentage error, a standard statistical formula is used in which the actual value and the approximate value are used:

$$e = \frac{|V_{REAL} - V_{apox}|}{V_{REAL}} * 100\% \quad (7)$$

Development of the system

- Principle of operation



The sphere enters through the upper part of the structure through a circular duct of 2.3cm in diameter, until it reaches the sensor TSC34725 which is responsible for measuring the frequency of the visible spectrum, determining the color of the same, if there is a problem such as external light leakage into the cavity the system will not work properly throwing values not included in the programming, so the user must re-enter the object to be classified and verify that there is no filtration of ambient light inside the mechanism.

If the measurement made by the sensor is within the contemplated parameters, the sphere passes to the classification stage, which is performed by a servomotor programmed to move in four different positions depending on the value provided by the sensor, each one oriented to the containers where the object will be deposited according to its color, reaching the detector sensor Me-0634, which allows the system to be automatic, although it also has a manual mode.

Since the spheres are the right size, there is no concern about clogging, although it could happen in case the servo runs through the propeller prematurely, then it will be necessary to intervene.

The second and third point focuses on the RGB sensor TSC34725, which is responsible for measuring the frequency of the visible spectrum, determining the color of the sphere, having variations in the measurement by external variables such as light and temperature, which were reduced to the minimum possible to avoid sudden changes.

Therefore, if it were to fail already controlling these parameters, it would be necessary to change the complete module.

Finally, this point four focuses on the mechanical part of the system, which includes the servomotors, may have failures either programming, physical and electrical, these should be corrected first by programming, if this process does not work should be verified the status and operation of the servomotors and if they present faults should be replaced by new ones.

Physical architecture

Table 2. Main components of the **system**

Hardware	Reason for selection
Sensor TCS34725	It has a filter for IR signals that can be activated or not.
ATMega 328P	High performance, low power consumption and optimized for C compilers.
HiTec Servomotor	Maximum load support of 4Kg
7-segment display	Cost, simplicity, efficiency.
Potentiometer 50kΩ	Allows to adjust the current flow.

Prepared by: Steven Salazar

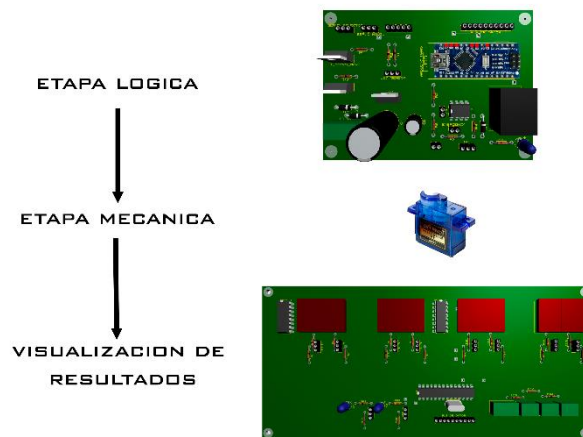


Fig. 2 General stages of the operating cycle

- Algorithm for system configuration

The programming of the sensor, the processing of the data obtained by it and the configuration of the selector mechanism is performed on a programmable Arduino Nano board using the `Adafruit_TCS34725` library for the interpretation of the recorded values.

First you must include the necessary libraries depending on each module and sensor to be used, this can be done from the IDE library.

Then we proceed to declare the variables for the counting of red, yellow and green balls, additionally we create a buffer where the ball count will be stored to send, by serial communication, to the display.

Set the variables in which the hit count of sorted spheres will be stored, and a buffer to display the hits on the displays.

```
int countR=0;

int countN=0;

int accountG=0;

int accountA=0;

byte buf[4];
```

The pins to which the modules are to be connected are declared, which consist of LEDs for the start and end of the process, as well as the button that allows the system to start.

```
const int led_start=3;

const int ledSensor=4;

const int led_pare=5;

const int buttonStart=6;

const int enced;

serovo=13;
```

This stage is called void setup, the code that is executed once, usually set to set general operating parameters, such as starting modules and preconfigurations. There may be more stages of the same type, usually called functions.

The pins for the servomotors are assigned, in this case the pins (7 and 8) for PWM outputs will be used. Subsequently the Arduino serial communication is declared, in this case we work at the speed of 9600 bits per second (baud) established for the microcontroller.

Determine the pins where the servomotor will be connected, as well as the data transmission speed, the standard is 9600 baud.

```
topServo.attach(7);  
  
bottomServo.attach(8);  
  
Serial.begin(9600);
```

In the "void setup" the programming is established that does not depend on bubbles (repetitions), but that will be executed only once, a clear example is when the operation range is defined for each frequency (color), from there it must be calculated for all the frequencies we will use (red, green, blue and yellow), besides that it will store in a buffer parameter (buff) the number that will be registered.

If one of the conditions is not met, the counter will return its previous value, i.e. unchanged, because it may represent values with variation due to external changes such as ambient brightness.

In case of errors, the hexadecimal code is printed on the serial monitor, in addition to helping to verify that it is working correctly.

In this part the tolerance ranges of the data obtained from the sensor that the algorithm accepts are established, as you can see if one of the conditions is not met the counter will return the last correct value, if the data received is outside the parameters the value received is printed on the serial monitor of IDE Arduino.

```
if((r < 2.15) & (r > 1.8) & (g < 0.75)&(g >
0.45)){
    color = 1; // Red
    buf[0]=1+countR++;
    cont=0;
}
if((g < 1.4) & (g > 1) & (b < 0.6)&(b > 0.35)){
    color = 2; // Yellow
    buf[1]=1+countN++;
    cont=0;
```



```

}

if((r < 1.15) && (g > 1.20) && (b < 0.8)){

    color = 3; // Green

    buf[2]=1+countG++;

    cont=0;

}

if ((r < 1) && (g < 1.2) && (b > 1)){

    color = 4; // Blue

    buf[3]=1+countB++;

    cont=0;

}

else{

    cont++;

    if(cont==5){

        /*buf[0]=accountR++;

        buf[1]=countN++;

        buf[2]=G++ account;

        buf[3]=countB++;*/

        output=0;

        cont=0;

```

```
}  
  
}  
  
Serial.write(0xff);  
  
for(int i=0;i<sizeof(buf);i++){  
  
    Serial.write(buf[i]);  
  
    delay(2);  
  
}  
  
return color;  
  
}
```

Finally, we have a very important stage for the automation of the electronic system, since here we create the functions that are executed in loops depending on the data obtained from the sensors. We start by making the analog and digital readings of the RGB sensor and the power button respectively. An anti-bounce function is created so that the state of the button is saved applying a delay of 20 milliseconds, this allows that when the button is pressed only one state is saved and not the other states that occur at the time of short-circuiting positive and negative with the button.

After the previous function, an 'if' conditional is performed where it is indicated if the button status is 1 or if the infrared LED detects a ball, the main function called "MAIN_SYSTEM" will be executed, otherwise the function "OFF" will be executed.

When using a push button, an anti-bounce function must be implemented in the code, since the residual currents generated when pressing the push button can send erroneous values to the card, this function provides a 20ms delay that allows saving only one value at the moment of pressing the push button.

```
void loop() {  
  
  ReadBall=analogRead(DetecBall);  
  status=digitalRead(buttonStart);  
  
  //ANTI-REBOUND FUNCTION  
  if(status==HIGH &&  
  statePrevious==LOW){  
    output=1-output;  
    delay(20);  
  }  
  statePrevious=status;  
  if(output==1||ReadBall<7){  
    systemPrincipal();  
  }else{
```

```

shutdown();

}

}

```

Table 3. Arduino libraries

Arduino	
Code for acquiring sensor readings	Description
ReadBall=analogRead(DetecBall);	Take readings from the sensor connected to analog pin A1.
Code to move the servos	Description
digitalWrite(encedico_serovo, HIGH);	Controls the section that transports the sphere to one of the containers.
Code for storing the data captured by the sensor	Description

<pre>tcs.getRawData(&red, &green, &blue, &clearcol);</pre>	Stores the RGB spectrum data in the assigned variables for further processing.
---	--

Prepared by: The Researchers

Table 4. HTML color analysis

HTML	#7828
RGB (r,g,b) B	(120, 40, 140)
CMYK(c,m,y,k)C	(70, 100, 0)
HSV (h, s, v)	(288°, 71%, 55%)

Prepared by: The Researchers

- Violet: between 420 and 400 nm wavelength.
- Attenuated violet: between 400 and 380 nm, it constitutes a band with a double connotation, because on the one hand it is considered as part of the visible violet light and on the other hand it is part of the ultraviolet radiation (UV).
- Visible ultraviolet light: between 380 and 310nm. Although by definition UV radiation is not visible, a part of this radiation is called UVA or near ultraviolet.

- Design of the structure

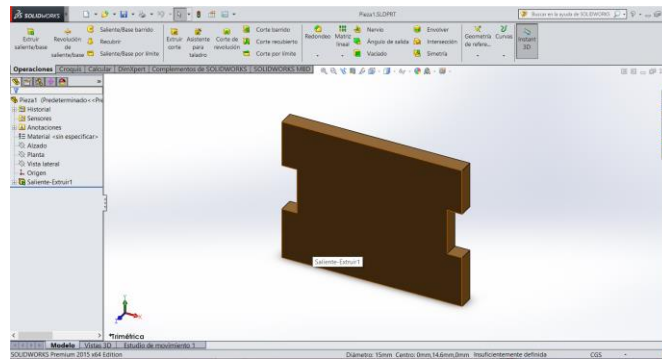


Fig. 3 Figure of the front part

Composed of two rectangular-shaped side pieces with small cuts on their sides for coupling with the front and rear piece.

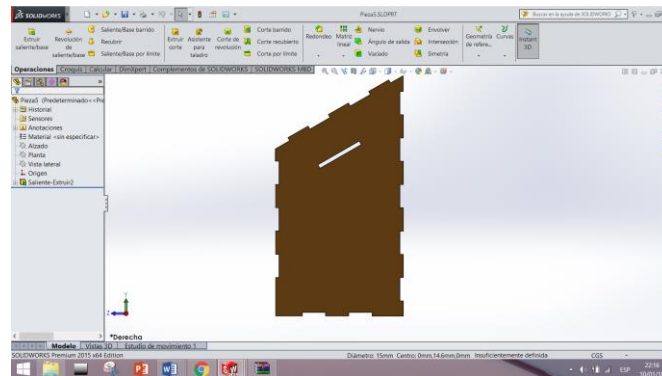


Fig. 4 Side part

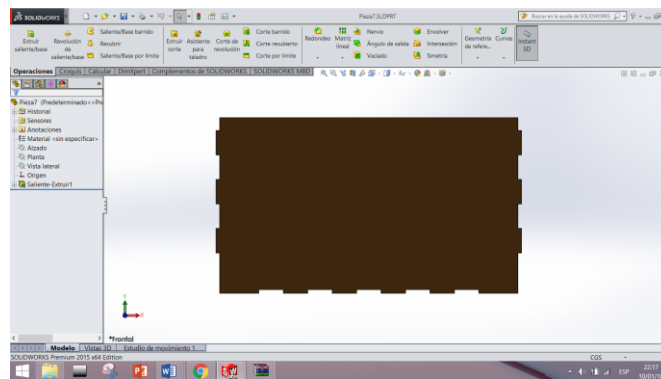


Fig. 5 Rear part

By joining each of the parts together, the structure would look as follows.

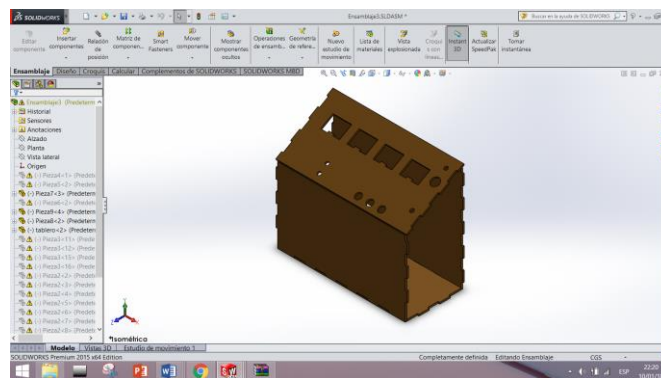


Fig. 6 Complete structure.

The assembly is completed by joining the parts and their respective connectivity of each of the different electronic elements.

Table 5. Front panel elements and their symbology

N°	Element and function in the system
1	7-segment display: counters
2	Green Led: Indicates that it is working
3	Red Led: Indicates that it is stopped
4	Button: Starts the system
5	Button: Pauses the system
6	Button: Resets the system
7	Potentiometer: Accelerates or slows down speed
8	Button: Emergency
9	Red Led: ON = emergency; OFF = normal

Prepared by: The Researchers.

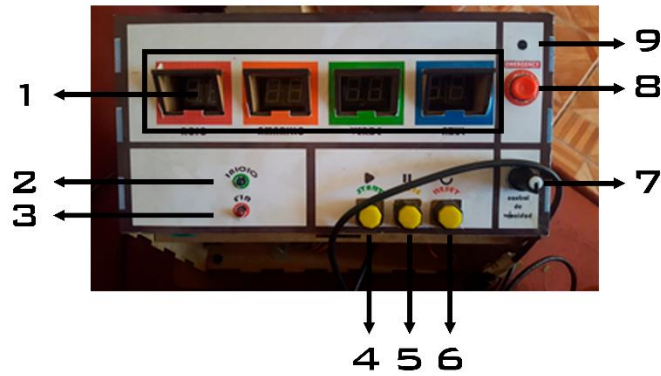


Fig. 7 Front panel of the display panel

A total of 1089 tests were performed for each sphere separated in ranges of 99 consecutive repetitions for each one, taking into account that the effectiveness of the sensor is given by the saturation and luminance of the object, the configuration of this was divided into three stages with percentages of tone in the saturation and luminance of 50%, 75%, 100% with the following data obtained:

- Test 1 luminance and saturation at 50%.

Table 6. Performance tests with 1089 samples

First Test					
Sample (Actual value)	Colors	Classified spheres correctly	Satur ation	Bright ness	Percen t error

1089	Blue	1016	50%	50%	0,06%
1089	Green	1035	50%	50%	0,049%
1089	Yellow	1023	50%	50%	0,060%
1089	Red	1009	50%	50%	0,073%
Total		4083			0,2424%

Prepared by: The Researchers.

With 50% saturation and brightness, a total of 273 faults were obtained, divided into 73 for the blue color with an error percentage of 0.06%, 54 for the green color with an error of 0.064%, 66 for the yellow color with an error percentage of 0.066% and 80 faults for the red color with an error percentage of 0.073%.

- Test 2 luminance and saturation at 75%.

Table 7. Performance tests with 1089 samples

Second Test					
Sample (Actual value)	Colors	Classified spheres correctly	Satu ration	Lumi ness	Percent error
1089	Blue	1031	75%	75%	0,053%
1089	Green	1024	75%	75%	0,059%
1089	Yellow	1036	75%	75%	0,048%
1089	Red	1031	75%	75%	0,053%
Total		4119			0,213%

Prepared by: The Researchers.

With luminosity and saturation at 75%, a total of 4119 hits and 237 misses were obtained, divided into 58 for the blue color with an error percentage of 0.053%, 65 for the green color with an error of 0.059%, 53 for the yellow color with a percentage error of 0.048% and 61 misses for the red color with an error percentage of 0.053%.

- Test 3 luminance and saturation at 100%.

Table 8. Performance tests with 1,089 samples

Third Test					
Sample (Actual value)	Colors	Spheres classified (Approx. value)	Satu ration	Lumi ness	Percent error
1089	Blue	1071	100%	100%	0,016%
1089	Green	1054	100%	100%	0,032%
1089	Yellow	1066	100%	100%	0,021%
1089	Red	1067	100%	100%	0,020%
Total					0,089%

Prepared by: The Researchers.

By varying the brightness and saturation to 100%, a total of 98 faults are obtained, divided into 18 for the blue color with a percentage error of 0.016%, 35 for the green color with an error of 0.032%, 23 for the yellow color with a percentage error of 0.021% and 22 faults for the red color with an error percentage of 0.020%.

The design contemplates a sequential scheme where there is a point of entry of the spheres, then it is directed with an actuator to the *TCS3472* sensor, this is responsible for determining based on algorithms a correct decision, in turn the result determines the position of the servo in the

following degrees (red 58°, yellow 92°, green 134° and blue 175°), at the end the sphere descends to its respective place.

The spheres comply with regular proportions and in accordance with the design of the structure, since there are no inconveniences in its path, giving an optimal work flow for the operation tests, in addition to the fact that there is a stop in the ejection area, so that it does not hit the surface of the base and consequently the paint of the spheres is not worn.

In test sequence 153 the sorter jammed, requiring the emergency button to be pressed to bring the prototype to a complete stop. This behavior was repeated every 130 to 160 runs of the mechanism.

When running the 752 test, the classifier suffered the jamming of a green sphere and it was necessary to press the emergency button to stop the mechanism, however, it remained stuck in its cavity, restarting the system constantly, making it necessary to disconnect the prototype's power supply to unjam the button.

Conclusions

Although the prototype works 96% adequately, since it has only two displays for each color to keep track of the hit count, it does not allow more than 99 positive tests to be displayed continuously for each one before having to restart the system.

When the emergency button got stuck and the system was continuously restarted, it was determined that the cavity that houses it is narrower on the inner edge due to a fault in the construction of the container, making it necessary to replace it with a switch that provides more safety in its

operation because the mechanism does not interact with the structure that contains it.

The use of the TCS34725 sensor, which in addition to containing an infrared filter to avoid the principle of saturation in the colors also has a white LED, which supports the principle of luminosity, which contributed to the fact that by bouncing the light from it on the sphere, the real wavelength value of the color used on the sphere can be obtained.

The tests performed were able to determine that the higher the percentage of hue, saturation and luminosity, the greater the number of spheres classified. With a percentage of 100% in each of the above parameters, the error could be reduced from 6.26% to 2.27% with respect to the average error among all colors.

The saturation of the spherical object was an important factor in the classification. The blue color is greatly affected by this parameter, since at first it had an error incidence equal to 6.70 % with saturation equal to 50 %, which could be reduced to 1.74 % with 100 % saturation.

References

- [1] J. D. Filote Razo, "RGB sensor to detect color changes in fruit skin," *Acta Universitaria*, p. 7, 2016.
- [2] Morimoto, "An Object Recognition Method using RGB-D Sensor," from *Second IAPR Asian Conference on Pattern Recognition*, Himeji, Japan, 2018.

- [3] S. Sarria-Dussán, A. M. Garzón-García, and R. E. Melo-Sevilla, "Development and evaluation of a prototype for color measurement in fresh vegetables," *Technology Information*, pp. 253-260, 2020.
- [4] L. C. I. G. G. Z. C.D. Galatanu, "Measuring the driver exposure to the light pollution," from *IEEE International Conference on Environment and Electrical Engineering and 2018 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe)*, Palermo, Italy, 2018.
- [5] E. A. Hermoza Llanos, Artist, *Design of a peeled sacha inchi seed sorting machine, by color with a capacity of 200 kg/h.* [Art]. Pontificia Universidad Católica del Perú, 2018.
- [6] A. S. A. A. Kanade, "Development of Machine Vision based system for classification of Guava fruits on the basis of CIE1931 chromaticity coordinates," from *Symposium on Physics and Technology of Sensors*, Pune, India, 2015.
- [7] TAOS, "COLOR LIGHT-TO-DIGITAL CONVERTER". United States 2012.
- [8] J. Ruíz Martínez, Física Y Química. Profesores de Enseñanza Secundaria, Murcia: MAD-Eduforma, 2002.

- [9] Y. Ohno, "CIE fundamentals for color measurements," *Society for Imaging Science and Technology*, vol. 2000, pp. 540--545, 2000.
- [10] A. Serrano Tierz and M. P. Biel Ibáñez, *Aesthetics of the industrial product and its graphic representation*, Zaragoza: Prensas de la Universidad de Zaragoza, 2013.

Machine Vision for Pattern Detection and Recognition in Surveillance Environments

Freddy Robalino; Gabriel López

*Universidad Técnica de Ambato, School of Systems,
Electronics and Industrial Engineering
Ambato, Ecuador, e-mail: frobalino@uta.edu.ec*

Introduction

Technology remains in constant development in various areas of society, particularly in relation to computational issues. One of the aspects that has been taking greater trend in terms of its use, has been the so-called artificial vision, which arises as a question within the scientific community, to raise the possibility of teaching computers to perform tasks commonly performed by humans; such as: analyze visual information from the environment [1]. Therefore, the objective of this discipline is to generate new intelligent systems, with the ability to make autonomous decisions about different activities in daily life and in the industrial field. At a global level, machine vision has a myriad of applications, among which stand out: automation of industrial processes, content selection, monitoring and control systems, as well as the localization of objects or people. In addition to that, this discipline has been considered as a topic that encourages research activity in the scientific community in various disciplines [2].

In Latin America and particularly in Ecuador, machine vision is mostly used in quality control and industrial process control applications, few systems are oriented to surveillance, since there is a wide use of closed circuit television (CCTV), which are supervised by one or several

guards in a single room for several hours at a time. For this reason, the probability of occurrence of dangerous situations is high, since they do not provide an adequate level of control and image processing [3].

By linking technology with security systems in organizations, the use of techniques and knowledge is promoted to find a solution to a real problem, such as insecurity, which in many cases causes economic losses to the victims and, in the worst cases, affects their integrity.

For this reason, the proposed system seeks the location and detection of individuals in uncontrolled or difficult to access environments; automatically, through pattern recognition. For this purpose, it is based on the use of digital image processing algorithms, which are obtained by surveillance cameras in real time.

Presentation of the problem or objective

Currently, video surveillance security systems based on analog cameras are generally connected to a group of monitors, which in turn have a considerable dependence on operators, with the main drawback being the rate of visual attention, which does not exceed 45 minutes, since the guard must observe several situations at the same time for several hours, it is exhausting and the probability of an inopportune event is very high, causing a loss of efficiency in long-term monitoring [4].

Ecuador is advancing in technological development in many areas, however, security systems with Artificial Vision are little or nothing designed or implemented, because the country still operates security systems with CCTV.

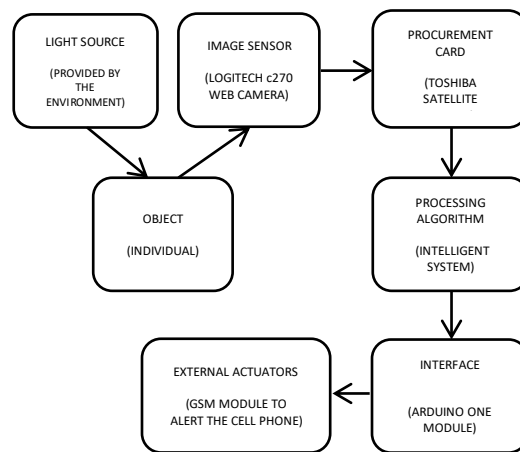
That is why the intelligent system, being surveillance oriented, has several characteristics such as intelligence,

which uses pattern recognition of people, and when it detects them, sends an alert to the cell phone by means of a call or message. The rules of action that interpret the images acquired within the system are two, on the one hand there is the systematization, which is the correlation between the parts of the system that allow optimal performance. On the other hand, there is the robustness, which within the research is characterized by having an extraction insensitive to capture and illumination noise.

Intelligent System Architecture

The proposed system, being of an intelligent type, aims to integrate elements of the environment with communication networks, and in this way, achieve information processing that helps to have an effective control over specific situations such as the detection of individuals by their outline. For this purpose, the intelligent recognition system is divided into different sub-processes that communicate with each other. The first step of this system is based on the fact that in order to detect an object, it will act continuously capturing the frame rate; that is, the rate of frames per second, and through this it establishes whether or not there is the presence of individuals. However, to make the above more understandable, it is possible to develop this process in a stable way, through the architecture shown in the following figure.

Figure 1. Proposed Intelligent System Architecture



To explain how the architecture works, the stages leading to pattern recognition and automatic alerting are described.

Light source

Its function within the system is to enable contour extraction of individuals. For best system performance, the light source must be uniform and independent of the environment in which it is implemented. This allows the acquisition of data suitable for unfavorable conditions such as low light and noise situations that surveillance systems face when exposed to open or confined environments, as well as the constant movement of people.

Image Sensor (Camera)

The use of a high quality camera is essential for the correct performance of the system, for the reason that it is responsible for providing more information about the environment. Ganiyu (2020) states that the function of the camera sensor is to convert the visible scene formed by the lens into an electrical signal suitable for further processing (p.62). Therefore, if it delivers images with too much noise,

i.e., with variations in brightness, color, among others; the recognition process will be prone to errors [5].

A factor that directly influences this is the type of camera, since it suggests the quality of the images received for monitoring or recording. In this project the Logitech C270 camera is used, its characteristics are described in the following table.

Table 9 Logitech C270 webcam parameters

Parameter	Description
Lighting conditions	Automatic illumination correction
Field of view	Diagonal field of view (dFoV) of 55°.
Maximum Resolution	1280 x 720p/30 fps in wide screen
Type of Approach	Fixed focus
Compatibility	Compatible with popular platforms, including Skype and Zoom.
Microphone	Built-in microphone with software noise reduction.

Snapshot resolution.	3 megapixels
Anchor Structure	Universal clip for LCD, CRT or laptop monitors
Communication port	USB 1.1 / 2.0 port
Loading speed	1 Mbps or higher
Sensor	CCD - Charge Coupled Device

Prepared by: Gabriel López

Source: Logitech International S.A. [6].

Although there are several parameters to optimize the performance of the image sensor, the resolution has the greatest influence as it has a direct impact on the quality of the image, which refers to the number of pixels used to construct the image. Therefore, the higher the resolution, the more details the camera will capture. In the system, the camera used has a high definition (HD) resolution of 1280x720.

Acquisition System (Graphic Card)

In this case, the acquisition system is performed by means of a computer graphics card. Basically, at this stage the card captures the video images entered by input devices (camera) and converts them to a digital signal for further processing; in addition, filters are applied to eliminate motion blur, noise; in order to improve the extraction of

information from the acquired images. An important aspect to take into account is that the transmission speed and the capture of shots from the graphics card must be high, as well as the transfer speed from its memory to the computer memory, so that there are no delays and the surveillance system works in real time. [7]

Digital Image Processing (DIP)

An important aspect of the PDI is that the images with which it works do not come only from the visible light census, that is, from the region of the electromagnetic spectrum in which the human eye is able to perceive colors; but also the images can come from the census of any area of the spectrum; therefore, it is necessary to use a camera with high sensitivity and capable of capturing images with low incident light [8].

Interface

During this process the communication between the system software, which is in charge of detecting the patterns and the Arduino ATmega16U2 module, which together with the GSM SIM 908 module, have the objective of immediately delivering the automatic alert.

External Actuators

Finally, when detecting the presence of an individual, the alert order is sent to the external actuator, so that it makes the call and sends a text message. In this case, the cell phone alert method is used because it is more effective as it is a remote surveillance system and its response is immediate. It should be noted that this requires a GSM SIM 908 module, whose function is to make a call or send an SMS when detecting a possible intruder.

The methodology used for this research work has an experimental approach since operational tests are carried out. As for the operation mode of the system, it is represented in the block diagram shown below.

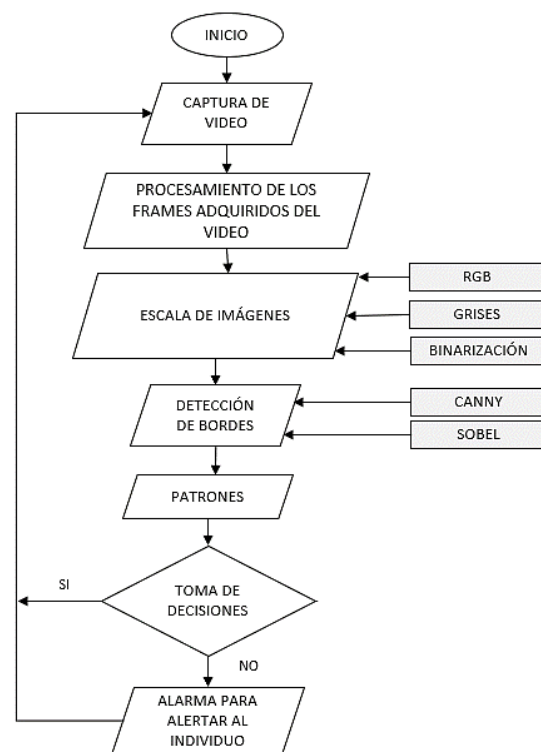


Figure 2. Methodology used in the proposed Intelligent System

A. Pattern recognition

The intelligent system is based on the recognition of the contour of people, this is not a rigid and dynamic object with a great diversity in its bone structure, due to multiple factors that the human body possesses such as: lighting

(contrast and shadow) and other body characteristics (body extremities). [2]

The required system characteristics for pattern recognition are shown in the following table.

Table 2. System characteristics for pattern recognition

Features	Description
To be robust	Noise-insensitive extraction
Discriminants (classification)	Distinguish objects of different classes
Chain codes	Represents by an incremental code the boundary
Noise sensitivity	The border is undersampled
Rotational invariance	Determines a starting point that can be detected on the rotated object
Translation invariance	It is immediate
Invariance to scaling	Depends on border subsampling

Deformation invariance	In general, there is no
Discriminating capacity	Requires efficient sequence classification methods

Prepared by: Gabriel López

The stages of the pattern recognition process are described in the following section.

II. Pattern Recognition Process

The pattern recognition architecture for the intelligent system consists of three main phases: artificial vision, pre-processing and image processing, which are detailed below:

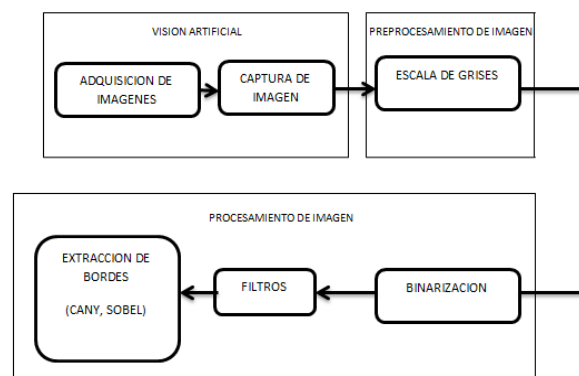


Figure 3. Architecture of the pattern recognition system.

Machine Vision Phase

- Images can be acquired from both real-time and previously recorded uncontrolled videos, which are closely linked to the concept of illumination.
- Images are acquired at an interval of 2 frames per second (fps), which allows the system to obtain greater accuracy in the detection of individuals.

Image preprocessing

- The gray scaling considered the intensity values present in each pixel, which ranged from 0 to 255, with 255 assigned as the lightest level and 0 as the darkest level. These values varied depending on the time of day. This configuration facilitates the processing by working with only two color scales.

Image processing

- In order to reduce the information of the images, a binarization process was performed, converting the images from grayscale to black and white, thus, the image information is reduced to two possible values, 1 for white and 0 for black; with this reduction, the segmentation of images into particle regions and background regions is facilitated.
- The filtering stage is used to remove unwanted information from the resulting binary image, the maximum filter is used to widen and thin the light and dark areas respectively; on the other hand, the minimum filter performs the opposite of the maximum function; and the medium filter performs the function of homogenizing the image pixels, this is only necessary when there is the presence of random noise.

- The Background subtraction phase consists in the comparison of each of the video frames of an image sequence with the initial frame or another one chosen at convenience, so that, in the resulting video, the elements that remain constant are black, and those that have changed are white or vice versa. This model is based on region detection.

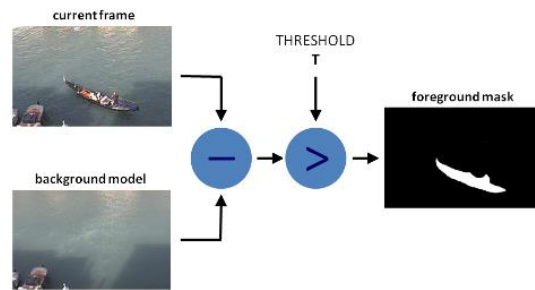


Figure 4. Background Subtraction

Algorithms Used

The tools used are MATLAB and OpenCv, as these together have the ability to manipulate matrices containing information about the acquired image, making them ideal for digital image processing, which is what is needed for this project.

The use of these two tools makes it possible to compare the performance of licensed software versus free software.

It should be noted that, for each of the stages, both tools have specific commands.

For video capture, hardware adapters are used to connect the devices through drivers. In this process a 2D matrix of values known as a digital image will be obtained.

For both Matlab and OpenCV you must first create a video input object, which represents the connection between the device and the software. Although they present the same principle, OpenCV has a better performance since it is possible to work with an internal or external camera and the software will automatically detect the characteristics of the connected device. In the case of Matlab, the camera to be used and the port where it is connected along with its characteristics must be declared for proper operation.

The commands used for video capture are described in Table 3:

Table 3. Video Capture Commands

Matlab	
Code to purchase video	Description
<pre>vid = videoinput('winvideo', port to which the device is connected, 'camera resolution');</pre>	Event to be executed for camera detection
Code to capture image	Description
<ul style="list-style-type: none"> • [name, path]=uigetfile('*.video format', 'select video format'); • handles.xyloObj = VideoReader(fullfile(path, name)); 	Event to be executed for video playback in any format in the first case and for real-time camera in

• axes(handles.axes2)	the second case.
In OpenCV	
Code to purchase video	Description
videoCapture Name(Flag)	Event that is executed for camera detection, if the flag is 0, the internal camera will be used and if the flag is 1, an external bed will be used.
videoCapture.open("name. Video format");	Event to play stored videos

Prepared by: Gabriel López

Source: OpenCV, Mathworks

The following commands were used for digital image processing in Matlab and OpenCV:

Table 4. Commands for digital image processing.

Matlab	
Codes used in processing	Description
<pre>name=rgb2gray(image name); level=graythresh(image name); intensity=level*255 BW=im2bw(I1,level);</pre>	<p>Event to be executed for the conversion of colors to gray.</p> <p>Event to be executed for gray to binary image conversion.</p>
OpenCV	
Codes used in processing	Description
<pre>morphologyEx(mask, binaryImg, CV_MOP_CLOSE, element);</pre>	<p>Event that converts the captured image to binarized image this function is part of the MOG declaration which is a</p>

<pre>Mat imgDifference = binaryImg.clone(); threshold(imgDifference, imgThresh, 30, 255.0, CV_THRESH_BINARY);</pre>	function used in the bakground.
--	------------------------------------

Prepared by: Gabriel López

Source: OpenCV, Mathworks

A comparison between gray scaling using Matlab and OpenCv tools is shown below.



Figure 5. Grayscaleing in Matlab



Figure 6. Grayscale in OpenCv

The background detection stage is where there is a big difference between the two tools since in Matlab the Canny edge detector is used, once the edges are detected, the convolution between the image acquired as background scene and the current image is performed to distinguish which are the moving objects; therefore, it is advisable to use images with the lowest possible noise to avoid errors.

On the other hand, in OpenCV the MOG function is used, which has a wide advantage over Matlab since it is possible to choose whether to perform an automatic learning of the background scene, in the same way the blob analysis function that groups the moving objects is performed, allowing an easier processing and a greater advantage in the filtering processes. The commands used for this stage are described below:

Table 5. Commands used in the background.

Matlab	
Codes used in the background	Description
<pre>cp1=convn(imcopy,mP1); cp2=convn(imcopy,mP2); cp3=max(cp1,cp2); cp3=uint8(cp3); imcopy=uint8(imcopy);</pre>	<p>Event in which the convolution of the stored image with the current image is performed in order to detect if there are variations between both images.</p>
OpenCV	
Codes used in the background	Description
<pre>MOG2 - >operator()(image, mask, -1);</pre>	<p>Event in which the comparison of the stored image with the current one is performed. It is worth mentioning that</p>

	this function includes binarization
--	-------------------------------------

Prepared by: Gabriel López

Source: OpenCV, Mathworks

A comparison of background detection using Matlab and OpenCv tools is shown below.



Figure 7. Background Detection in Matlab



Figure 8. Background detection in OpenCv

In the edge detection phase, in Matlab the most efficient edge functions are Sobel and Canny; on the one hand, Sobel detects edges at those points where the gradient of the image is maximum. While Canny, finds edges by looking for the local maximum of the gradient of the binary image. In OpenCV, blob analysis is used, which in conjunction with the MOG function provides the edges of moving objects, thus allowing a better performance since the analysis would focus on the blobs created in each region within the images and not on the entire image as Matlab does.ç

Table 6. Commands used for edge detection

Matlab	
Codes used in the border	Description
<code>[I3=edge(imcopy,'canny');</code>	Edge extraction with the Canny

BWs =edge(I,'sobel', threshold * fudgeFactor);	or sobel method in real time.
OpenCV	
Codes used in the border	Description
MOG2 ->operator()(image, mask, -1);	Event in which edge extraction is performed.

Prepared by: Gabriel López

Source: OpenCV, Mathworks

The following figures show a comparison of edge detection using Matlab and OpenCv tools.



Figure 9. Edge Detection in Matlab

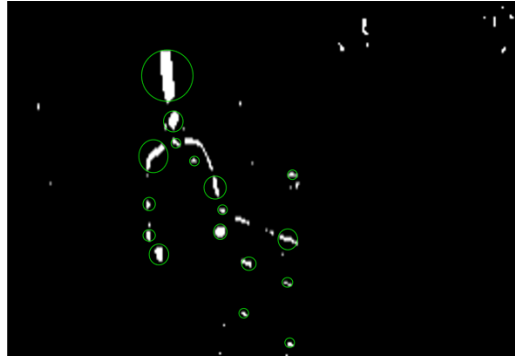


Figure 10. Edge detection in OpenCv

The intelligent surveillance system presented, once it identifies people at a certain point in the environment, it seeks to identify them again, that is to say, it follows them during their stay in the camera's field of vision.

For this, both Matlab and OpenCV take into account the center of gravity of the people; where a box was drawn around them in order to differentiate the other objects that are moving in the scene, such as animals, etc.

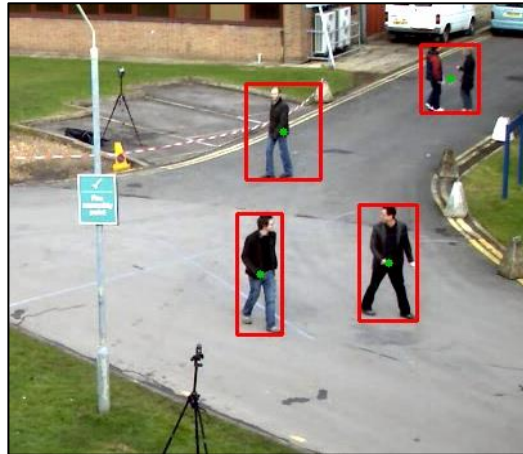


Figure 11. Follow-up of people

Intelligent System Environment

A user-friendly interface was designed to facilitate the transmission of control and system visualization information by means of buttons, labels and two-dimensional planes, the latter being used for video and image visualization.

Figure 12 shows the graphical environment of the intelligent system.

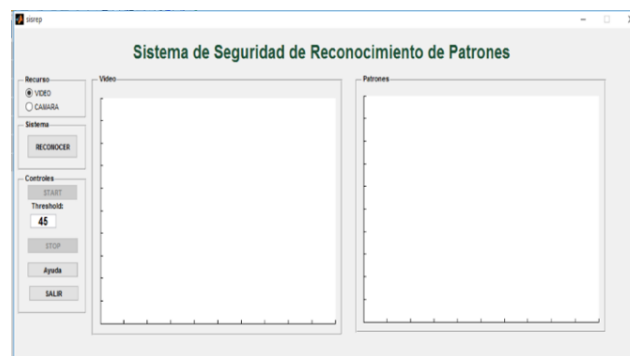


Figure 12. Graphical environment of the intelligent system.

The two constructed planes project different images, the left plane is used to visualize the detection of the body parameter of the persons, while the right plane is used to visualize the detection of the contours of the persons.

OpenCV presents better performance over Matlab according to several factors such as:

- The image scaling stages are located within the Background functions, which allows the performance and response time to be better at the time of processing, since everything is part of the same function, giving the opportunity to choose whether the learning of the background elements is automatic or by previous captures, while in Matlab each function is independent; therefore the programming code is more extensive; in addition to this, it is necessary to pay attention to each filtering stage to eliminate the noise found in the images.
- In contour detection in OpenCV, the use of the blob function allows grouping all moving objects by sections, to facilitate the analysis of the data, helping the image quality and filtering processes not to be too strict when identifying moving objects; which means that the use of high resolution cameras is not necessary for optimal performance.
- OpenCV, being a library dedicated exclusively to the development of artificial vision and image processing, has functions with greater accuracy; in addition, the management of brightness and contrast of the images can be variable in real time without causing delay in the program.

Functional tests were carried out in order to verify the efficiency and accuracy of the system in the recognition of the contour, through the taking of 10 captures. It should be noted that these

were carried out in two sessions; during the day from 8 am to 5 pm and during the night from 9 pm to 11 pm, thus ensuring that the system is active most of the time.

Below, it is possible to observe some of the captures obtained from the system in the morning and daytime, where the output image with the detection of the people tested (left picture) as well as the image where the detection of the contours of these in the processing of the video frames (right picture) using the two tools, Matlab and OpenCv, can be seen.



Figure 13. Detection of objects in the day with Matlab.



Figure 14. Object detection during the day with OpenCv.



Figure 15. Object detection at night with Matlab.



Figure 16. Object detection at night with OpenCv.

In addition to the system tests, a verification based on the system flowchart was performed in order to establish the operability percentages of the different processes that govern the recognition system. The verification based on the operability with Matlab and OpenCv tools is summarized in tables 8 and 9 respectively.

Table 8. Verification based on operability with Matlab

PATTERN RECOGNITION TESTS			
Name		Based on use	
Made by		Programmer	
Description		Verify the use and working environment of the system	
No.	Category	Expected system response	Operational profile
1	Artificial Vision	Video capture and display	88%
2		Edge and contour extraction	85%
3		Segmentation	93%
4		Pattern detection and recognition	90%
5	Wireless communication	Automatic alert system	100%

Prepared by: Gabriel López

Table 9. Verification based on operability with OpenCv

PATTERN RECOGNITION TESTS			
Name		Based on use	
Made by		Programmer	
Description		Verify the use and working environment of the system	
No.	Category	Expected system response	Operational profile
1	Artificial Vision	Video capture and display	95%
2		Edge and contour extraction	95%
3		Segmentation	95%
4		Pattern detection and recognition	98%
5	Wireless communication	Automatic alert system	100%

Prepared by: Gabriel López

The verification of the intelligent system based on operability, shows average results of 93.6% with Matlab and 96.6% with OpenCv among all the processes related to artificial vision and wireless communication that make up the system.

With the use of Arduino modules with USB port, an interruption or break in the data transfer during the process is avoided.

Additionally, regarding the automatic alert management method, the utilization of the Arduino UNO development board and GSM SIM 908 module was effective due to the fact that, once any pattern of the test individuals was detected, the alert command is delivered immediately.

Finally, in relation to the system performance, during the morning hours there were no considerable errors in the capture of the frame rates, while at night there was more noise compared to the tests performed in the morning; however, thanks to the emphasis placed on image filtering, this could be controlled and not have repercussions on erroneous results.

Conclusions

- The detection and pattern recognition of the intelligent system has been correct in all the cases tested, obtaining a success rate of 93.6% with Matlab and 96.6% with OpenCv in an approximate interval of 2 to 3 seconds of response time.
- In low light conditions, the software of the proposed system in a future version could compensate for such a situation by using the negative mode color conversion algorithm.

- The motion frame processing algorithms, in conjunction with Sobel and Canny edge extraction methods in Matlab and MOG and blob in OpenCv, cooperate for the high percentage of operability, especially those for image filtering and pixel correction, algorithms that cooperate in higher magnitude.
- The intelligent system achieves efficient pre-processing and processing of information by means of grayscale to binary transformation, thus facilitating pattern recognition on computers of nominal performance.

References

- [1] J. Sanabria and J. Archila, "Motion detection and analysis using machine vision," *Scientia Et Technica*, vol. XVI, no. 49, pp. 180-188, 2011.
- [2] R.Llobregat, "Digital processing of video images for smoke detection", M.S. thesis, Escuela Politécnica de Valencia, Valencia, Spain, 2011.
- [3] L. Sanchez, R. Fernandez, "Digital Image Processing: Fundamentals and practices with MATLAB" Ph.D. dissertation, University of Leon, Spain, 2011, pp. 10-23.
- [4] D. Ameijeiras, "Review of object detection and tracking algorithms with deep networks for intelligent video surveillance," *Revista Cubana de Ciencias Informáticas*, vol. XIV, no. 3, pp. 165-195, 2020.
- [5] A. Ganiyu. "Design and Implementation of An Improved Digital Video Surveillance System. Computer Engineering and Intelligent Systems" (IISTE), XI (2), 60-67, 2020.

[6] Logitech, "Logitech.com," 2022. [Online]. Available: <https://www.logitech.com/es-roam/products/webcams/c270-hd-webcam.960-000947.html>. [Last accessed: 28 January 2022].

[7] E.M. Acurio, "Design and construction of a didactic module of artificial vision oriented to the quality control of filling glass bottles with different types of liquid", Thesis, Electronics and Control Engineering, Escuela Politécnica Nacional, Quito, Ecuador, 2011.

[8] J.D. Cruz, "Automatic sorter of plastic screw caps for continuous production process, based on surface defects inspection", Thesis, Ing. Applied Sciences Mechatronics, Universidad Técnica del Norte, Ibarra, Ecuador, 2011.

The teaching of food biotechnology in an engineering career through a face-to-face and hybrid system in Ecuador

Díaz-Monroy, Byron

Doctor en Ciencias Veterinarias, Máster en Biotecnología.
Facultad de Ciencias Pecuarias, Escuela Superior
Politécnica de Chimborazo, Ecuador. e-mail:
bdiaz@esPOCH.edu.ec / <https://orcid.org/0000-0003-3721-7994>

Baquero-Tapia, María Fernanda

Magister en Producción animal. Facultad de Ciencias
Pecuarias, Escuela Superior Politécnica de Chimborazo,
Ecuador. e-mail: mbaquero@esPOCH.edu.ec /
<https://orcid.org/0000-0003-3331-528X>

Díaz-Arrieta, Ronald

Master universitario en Ingeniería de software y sistemas
Informáticos. Universidad Estatal de Milagro-UNEMI,
Ecuador. e-mail: rdiaza@unemi.edu.ec /
<https://orcid.org/0000-0003-4566-8437>

Introduction

This paper seeks answers to the following research questions:

1. In the Ecuadorian context, which of the two educational systems in question is the best to achieve an efficient learning of Food Biotechnology in the agroindustry engineering career?
2. What are the determining factors to achieve a high level of learning of food biotechnology in students of agroindustrial engineering in Ecuador? Does the educational system have an influence? Is it possible to improve the learning of food biotechnology by innovating the "on-line" educational system that was

created as an emergency during the COVID-19 pandemic? The mission of the agroindustrial engineering career at the Ecuadorian university is to train agroindustrial engineers with solid, creative, integral knowledge, with values and principles, identified with the local, regional, national and international reality, to direct, investigate and innovate the agroindustry; respectful of the environment, with emphasis on security, sovereignty and food and non-food safety, in accordance with the productive matrix and the National Plan of Good Living of Ecuador. To achieve this, it uses a curriculum consisting of 9 levels (PAOS), where 60 subjects are taught in 6480 hours of work grouping classroom classes, independent work, experiential learning, pre-professional practices and curricular integration project or thesis. Food Biotechnology is taught in the sixth level of the career, it is considered a professionalizing science, it has an hourly intensity of 5 hours per week with 16 weeks of work per academic period (PAO), traditionally it was taught in a face-to-face manner, but due to the COVID-19 pandemic, the modality was changed to a hybrid system (part face-to-face and part online via internet), Thanks to this unforeseen event, the teacher had to implement a series of changes and migrate all the contents and activities to a Moodle virtual platform with a virtual classroom in an Oasis system and the Teams tool for the delivery of virtual classes, including laboratory practices through video tutorials. In this context, there were two different scenarios (face-to-face and hybrid mode) with different results, so the problem to be solved with this research work is to determine which of the two systems or educational modalities offers better results to establish the knowledge of food biotechnology in the students of this engineering career. Therefore, the following objectives were proposed:

1. To evaluate the level of learning of food biotechnology in students of Agroindustrial Engineering with two

educational systems: classroom and hybrid.
2. To determine the advantages and disadvantages of each of the educational systems evaluated in the Ecuadorian environment.

3. To identify concrete actions to be implemented to improve the learning of Food Biotechnology in Agroindustrial Engineering careers in Ecuador. The execution of this work has full justification based on the following considerations:

- Biotechnology as a science and as a subject of this engineering career has great importance and technological applications to ensure the food security of human beings.
- It is necessary to determine the impact and influence of the educational system or modality on the level of learning of this science in engineering students, future engineers in agribusiness.

- It is clear that each educational modality poses both advantages and disadvantages in relation to the level of learning of Biotechnology, these should be evidenced and taken advantage of by the higher education system.

- At the end of the study, alternatives could be proposed for the improvement of the educational system in order to achieve a better level of learning of Biotechnology and other related sciences.

- Therefore, this work is a real contribution to the improvement of engineering education in the Ecuadorian university.

Biotechnology in the field of higher education

When human beings became sedentary, they developed the cultivation of plants and the care of animals for food. It was then necessary to preserve them and discovered that in some cases the food was modified and transformed into products that were not only stable, but were also pleasant to the taste

and did not make them sick. It is thought that this is how the processes to produce fermented foods began to be "domesticated", foods that came to provide an important nutritional variety to the diet, at the same time that yeast, fungi and bacteria were empirically incorporated to the task of food production, thus initiating food biotechnology (Wacher, 2014). In order to achieve sustainable development, biotechnology is presented as an effective tool that allows different solutions to problems such as loss of agricultural productivity, contamination, new pests, diseases, reduction of green areas and biodiversity, through the application of innovative technologies, at the same time creating numerous business opportunities, through the transfer of knowledge which is carried out through formal agreements between companies and universities, or through the establishment of new companies dedicated to biotechnology founded by enterprising academics (González, et al. 2010).

On the other hand, according to Pérez (2022), as a result of the social distancing caused by the COVID-19 pandemic, hybrid education has emerged, which is booming alongside new educational technologies. Hybrid classes are a new option for the educational community. This hybrid model allows for the combination of a face-to-face portion with a distance, online portion that takes place in students' homes or workplaces mediated by technologies. Hybrid education is an alternative teaching method that emerged with the advance of educational technologies, presenting a new option for learning: hybrid classes. It is a model that combines Distance Education (DE) and face-to-face meetings. Initially, its objective was to solve the problems of time and distance for those who could not incorporate study into their daily routine or were too far from the educational institution to attend classes. Gradually, however, people came to realize that hybrid education has other advantages

for both students and teachers. According to the Online Education Blog (<https://hotmart.com/es>), when we talk about hybrid classes we refer to an educational method that combines online and face-to-face education, taking advantage of the positive aspects of each and increasing the efficiency of learning. This type of teaching can be delivered in two ways:

1. **disruptive model.**
In this case, an ODL platform is used that offers video classes and allows students to access from anywhere. There may also be face-to-face meetings with professors to discuss a topic, perform a special activity or make an evaluation. But this type of meeting is occasional and infrequent.
2. **Semi face-to-face model**
Many institutions adopt this model, which preserves face-to-face classes, but with distance options. Among the blended options, the following stand out:
 - 2.1. **Synchronous hybrid model.**
Synchronous means "at the same time", so it is about combining in a single class the physical presence of some students with the online participation of others. There can be rotation between groups or remain the same throughout the course. This model has been adopted in some schools and institutions of higher education as a way out of the restriction of the number of students per classroom, or as an option to include more people.
 - 2.2. **Station rotation model**
Classes are divided into workstations, each of which has a specific function that together achieve a single objective. In the station rotation model, each student (or group) works in one space for a certain amount of time, and then moves on to another until all stations are completed throughout the process. As it is a hybrid education model, at least one of these stations must be online.
 - 2.3. **Rotational laboratory model**

In this case, the working group is divided in two, depending on the activity: theoretical or practical. After some time, they reverse their roles with the objective of reaching the same results, regardless of the order. A good example of this model is physical education classes, since knowing the theory of a game and its rules is as important as learning the techniques and having the experience of how those rules work. Thus, in one class there may be one group of students learning the theory of handball while the other is practicing it and, in the other group, there may be a group of students learning the theory of handball while the other is practicing it.

Individual rotation model

In the individual rotation model, students work individually, without having to go through all the study stations. In this way, the trajectory is personalized, according to the needs of each person. For example: if you are doing a course in electromechanics, you can opt only for the areas that are geared towards electricity.

2.5. Inverted class

The inverted class is a method widely used in universities. The student studies the subject that will be addressed, before the face-to-face classes. In this way he is more prepared when the professor exposes the ideas of the subject studied. The professor, in turn, tries to ask some assumptions of the content, observes if they are correct or not and always contrasts them with a different idea within the material that the students read. In addition, the exchange of experience with the discussion of content seen before class is excellent for the learner to develop autonomy and a different way of thinking when obtaining their knowledge. Thus, the learner can choose the best way to learn.

Advantages of hybrid education

In any of these models, it can be said that the online medium gives students autonomy and flexibility, as well as allowing

them to learn on their own and explore their capabilities outside the classroom. On the other hand, face-to-face meetings favor a more personal exchange of experiences and real-time communication. In other words, the two complement each other to enhance the teaching and learning process, in addition to broadening the audience for a given course. These are the advantages:

1. For students

1.1. Cultivating autonomy

Some people get used to studying alone and even prefer it, as they concentrate better. Hybrid education stimulates the ability to investigate and search for answers and solutions autonomously. This characteristic is excellent not only for studies but also for life, because it encourages people to take responsibility for their decisions.

1.2. Enhancing learning

It is possible for students to learn even more by having continuous access to other types of materials suggested or not by teachers. Thus, face-to-face meetings allow students to observe the subject they are studying in their own way.

1.3. Have greater flexibility

With hybrid classes, students can organize their study time in the best way, depending on their personal or family routine. Hybrid education overcomes face-to-face and time limits, since it is possible to study from anywhere and at any time.

1.4. Better use of classes

It is easy to observe that students can make better use of the classes because they do not stay only in the expository classes, but seek knowledge before. In this way, it is possible for the student to learn even more, because in addition to what the teacher presents, he/she will have continuous access to other types of materials suggested or not by the teacher. In addition, the discussion that takes place

afterwards, allows the student to try to observe in his own way the subject he is studying.

1.5. Approximation of the school reality

In addition to the two advantages presented in the previous topics, students can still organize their studies in the way that best fits their reality. That is, they manage to fit the study period into their daily life. It is not necessary only to go to a face-to-face class to hear the teacher speak and finish the learning process there. Hybrid education overcomes these limits, since it is possible to study from anywhere and at any time.

2. For the institution

2.1. Taking advantage of work time

Not only do students have advantages, but educators also gain from hybrid classes. A teacher who teaches many classes per day may not have enough time to prepare in the best possible way, or may not even be able to teach a large number of students, since the physical space is limited. By creating online classes (non-perishable), you will have more time to dedicate to other activities or to study and prepare new materials.

2.2. Cost reduction

Reducing costs is an advantage for both the institution and the students. Since it is not necessary to have a physical space every day to give classes, courses can have a lower cost, in addition to using free online tools to produce material and transmit the meetings.

Bet on hybrid classes

As you may have already realized, hybrid education is an excellent option to go beyond traditional education. Allying technology to education is a way to spread knowledge even further, in addition to incorporating institutions to the new reality of students, who are constantly in contact with the Internet. But do not think that this alternative is only for those who already work with education. Hybrid education

can be an interesting method for in-company training, for example. Online courses are increasingly in demand and address topics from various areas. The following are some experiences with the hybrid system used in the education system of several countries: When comparing academic performance in Microbiology and Parasitology, in medical students, with a quasi-experimental study in 58 students in the third semester of the career, using two educational modalities, one face-to-face and the other hybrid (face-to-face/online), it was observed that the overall result of the post-assessment showed a difference in academic performance in favor of the experimental group ($p = 0.016$), demonstrating that the use of a hybrid modality as an educational strategy favors greater learning in medical students (Rosales, et al. 2008). The face-to-face education model has been at the center of educational debates generating tensions due to the scarce incorporation of communication and information technologies, especially organizational technologies, both in the way of structuring classroom or institutional functioning, as well as in the organization of the educational system and the governance of institutions and the way in which teaching is organized (Rama, 2020).

In a study to explore the factors affecting the implementation of distance education in the pandemic context, globally, the main findings showed empirical and theoretical data such as difficulty in: Internet connectivity, access to equipment and technological and digital infrastructure and student-teacher relationships; weak digital competencies were also found; The conclusion was that the trend has been the increase in the use of information and communication technology to support educational activities, but at the same time access to these media is limited, leading to complex educational processes under the distance mode, which require expanding

the search for strategies that minimize the difficulties imposed by reality, the alternative being the hybrid mode (Carbonell, et al. 2021). It should be accepted that telematic technologies do not constitute an unquestionably effective resource for student learning, but that it is necessary to integrate them into a well-founded educational program to be applied pedagogically. Since the conjunction of all the elements related to the educational process (objectives, contents, methodologies, strategies, activities, etc.) are the indispensable conditions that allow telematics to really acquire an educational meaning, it is understood that at the heart of the educational process that takes place in the classroom is the interaction between individuals: teacher and student (Pastor, 2005). It is perceived that the training processes in the online or virtual modality have not been sufficient to respond to the challenges of higher education in the digital era, and hybrid or blended learning is constituted as an alternative for digital teacher education in higher education, being an effective modality for digital teacher education courses because the face-to-face component complements virtual learning; in addition, given the problems of connectivity and internet access the blended learning modality is an alternative for continuous teacher training (Balladares, 2018). The situation experienced by the pandemic and its consequences have led to the birth of a new hybrid teaching model that is in the process of conceptualization and experimentation. The scenario that is opening up only consolidates the trends of the importance of learning that enhances digital competencies in both teachers and students, as recognized by the European authorities (European Council, 2018). The hybrid model of education requires transformations at two levels: pedagogical and organizational (De Obesso & Nuñez, 2021), in the pedagogical part, what is proposed by

(Al-Samarraie, Teng, Alzahrani, & Alalwan, 2018; Huertas et al., 2018; Means et al., 2014; Morán, 2012) in e-learning education and the current philosophy arising from Bologna, student-centered learning, applied to the design of hybrid educational programs in their three levels of interaction (Bernard et al., 2009). At the organizational level, the institutional adaptations produced to integrate into business studies the transformations of the environment and students should be observed (Krishnamurthy, 2020), taking into account the need for training in the skills of the future for the digital society of teachers, students and the university digital transformation itself (Holford, 2019; Ladevéze N. & Núñez, 2016; OECD, 2018). The pedagogical model of hybrid learning is increasingly used in higher education, due to the fact that it promotes significant changes in learning, this conception implies the opening to effective opportunities for dialogue and collaborative construction of content, as well as the promotion of digital culture based on collaborative and cooperative activities between managers and teachers to act differently in the classroom (Mejía, et al. 2017). According to the online educational blog Ingenio.edu.pe, the advantages of education in hybrid modality are:

1. Virtual interaction among students allows generating direct participation in questions and answers that complement the learning context.
2. Links to videos or documents, virtual repositories of practices and texts, help to reinforce what has been learned in class, where the environment can be personalized with basic questions that allow a better interaction and experience with the student.
3. Allows the creation of more meaningful personalized learning environments, which enable improvements in the performance and results of young people.
4. More flexible schedules, and savings in transportation

costs and work and study materials, as well as having the best teachers regardless of their location.

5. It focuses on learning, since the time of practices, exams and evaluations can be deferred to online processes, allowing more discussions and exchange of ideas in the classroom.
6. Instant feedback once an evaluation has been presented saves productive time for the teacher, who can even customize the messages to be sent to students according to the grade obtained.
7. Of course, the savings in consumables such as paper, pens and so on. This advantage is more related to the environment and its care, but it is also part of the benefits of hybrid education.

While as disadvantages the following are cited:

1. The lack of discipline in the administration and organization of time can generate vulnerability in the educational process.
2. Students who are not very participative tend to have less understanding and qualification at the end of each process.
3. The availability of computers, laptops, smart phones, internet, signal, among others, can generate difficulty either by impossibility of use or by schedules of activities in people who share this technology.
4. It is also possible that some students do not feel motivated in this modality due to the lack of direct interaction in a classroom with their classmates.
5. Student distraction is more difficult to correct or control due to the impossibility of transmitting body or gestural messages by the teacher.
6. Teachers must be continuously updated in the innovations and tools that appear in order to be competitive in the educational environment.

A sample of four hundred students who studied the fifth level of the mentioned career, divided in 8 different academic

semester periods, during 4 consecutive years (2018, 2019, 2020 and 2021), two in classroom system and two in hybrid system (classroom and online) of an institution of higher education (IES) of Ecuador, having exercised the teaching of the subject the same teacher with a Master's degree in Biotechnology and PhD in Veterinary Sciences, being the research executed of quasi-experimental type. For the purposes of this research, the face-to-face strategy was operationally defined as the modality in which students attend the classroom to have classes in the presence of the professor and following his work instructions, and the hybrid modality (face-to-face / online) as the situation in which students attend the classroom to have collaborative work sessions and discussion guided by the instructor based on the online course, as well as the laboratory to perform the experimental practices. This implies that students must read the contents of the virtual classroom created for this purpose and carry out the activities and learning experiences programmed on the course website. On the other hand, the dependent variable was academic performance, defined as the result of measuring the knowledge acquired in the course. of the measurement of the knowledge acquired in the subject of Food Biotechnology, through the previously validated instrument, expressing its result in a numerical value ranging from 0 to 100 (Percentage).

To measure the results of academic performance in the study groups, an instrument composed of 100 items was previously constructed and validated, where multiple-choice answers predominated, considering the following five areas of knowledge that make up Food Biotechnology:

1. Biotechnology, history, current situation and perspectives
2. Principles of genetic engineering applied to biotechnology.
3. Production of food and other biotechnology products

4. Quality control in biotechnological products
5. Bioethics and its applications in biotechnology.

The validation process of the instrument used was carried out by three professors from related areas of the same career. Three rounds were carried out with the reviewers until an agreement was reached, emphasizing the clarity of the questions, coherence with the contents to be evaluated and relevance, as well as updating in terms of the advances in knowledge. In addition, the internal consistency of the previously validated evaluation instrument was calculated. The alternative hypothesis tested was that students who use the hybrid modality acquire higher academic performance compared to students who attend a classroom course. A pre-evaluation (diagnostic test) was applied to each group at the beginning of the academic period, using a questionnaire with multiple choice questions as follows:

1. Two of the sciences that integrate Biotechnology, are:
 - a. Biology and Enology
 - b. Biochemistry and Macrobiology
 - c. Microbiology and Genetics
 - d. Medicine and Cloning

Correct answer: C Point value: 1

2. In a broad sense BIOTECHNOLOGY is the use of:
 - a. Interesting chemical molecules, cells or organisms for specific processes.
 - b. Biologically obtained molecules, cells or organisms for specific processes.
 - c. Reactor-derived molecules, cells or organisms for specific processes
 - d. Genetically modified molecules, cells or organisms for specific processes.

Correct answer: B Point value: 1

The post-evaluation took place eight days after the end of the course. The courses had a duration of 16 weeks each. The first 4 groups or parallel groups received the classes in the traditional way, using the face-to-face modality with the teacher of the subject. On the other hand, the development of the hybrid modality, applied to the other 4 groups, consisted in the development of the indicated course in online sessions, for which a virtual classroom was built, nested in an institutional website under a Moodle platform (Figure 1), in which the student was provided with the theoretical information, with links and file consultation, in which the activities necessary to acquire the learning were specified and the practices were face-to-face in a physical laboratory with adequate infrastructure.



Figure 1. Screenshot of the virtual classroom format of the Food Biotechnology course. The online readings shown through the links were previously selected by the teacher according to the thematic content of the subject, which allowed the student to access the information in different formats (pdf, power point) and from other Web sites. In order for the student to be

informed of the activities scheduled for the face-to-face and online sessions, messages were sent through the work group created on the WhatsApp platform. Students who presented less than 70% attendance during the period of the research were eliminated from the study. The data obtained were analyzed using descriptive statistics and a Student's t-test ($P \leq 0.05$). During the study, a diagnostic test was performed at the beginning of each academic period within the 4 years of study, which consisted of applying to all the students who were the subject of this work, a standardized test of 100 questions on knowledge considered as basic, necessary or previous to Food Biotechnology, having obtained as a general result that there are no statistical differences between the years of evaluation, Thus for 2018 the academic performance of the students submitted to the diagnostic test was 72%, for 2019 it was 70%, these two years under the face-to-face modality, likewise for the hybrid modality, i.e. for 2020 the performance was 72% and for 2021 it was 71%, which shows that the students started from a similar knowledge base, so it is expected that there was no influence of this basic knowledge on subsequent results

Academic performance of students in Food Biotechnology evaluated by means of the diagnostic test at the beginning of each academic period of the 4 years of study under the two educational modalities (Classroom and hybrid). As can be seen in Table 1, it was found that there is a higher level of learning of the knowledge of Food Biotechnology when the education system uses the hybrid modality, in such a way that statistical differences ($P \leq 0.05$) are evidenced between the two modalities studied, thus, with the face-to-face education system a 78 ± 3.04 % of learning of the knowledge of this science is achieved, while with the hybrid system 86 ± 3.02 % was obtained.

TABLE 1. Level of learning (%) of the areas of knowledge of food biotechnology according to the education system used

AREA DEL CONOCIMIENTO	% APRENDIZAJE				
	SISTEMA PRESENCIAL	DS	SISTEMA HIBRIDO	DS	p*
Biotecnología, historia, situación actual y perspectivas	79	±2,1	90	±4,1	0,045
Principios de Ingeniería Genética aplicados a la Biotecnología	75	±1,3	83	±2,3	0,038
Producción de alimentos y otros productos biotecnológicos	81	±5,2	88	±3,2	0,023
El control de calidad en productos biotecnológicos	76	±1,2	85	±4,2	0,017
Bioética y sus aplicaciones en la biotecnología	79	±5,4	84	±1,3	0,028

PROMEDIO	78		86
----------	----	--	----

Figure 3 shows the behavior of the results obtained by evaluating the level of learning achieved within each of the components of Biotechnology considered for this study, both for the classroom system and for the hybrid modality, where it can be seen that for the first component: Biotechnology, history, current situation and perspectives, students acquire and settle knowledge in $79\pm 2.1\%$ while for the hybrid system they do so in $90\pm 4.1\%$, this shows that the latter makes possible a better learning of this biological science. For the second component: Principles of Genetic Engineering applied to Biotechnology, a similar result is obtained, i.e. learning improves from $75\pm 1.3\%$ with the classroom system to $83\pm 2.3\%$ with the hybrid system, this trend is repeated for the remaining three components of biotechnology: Production of food and other biotechnological products, quality control in biotechnological products, bioethics and its applications in biotechnology, with values of 81 ± 5.2 ; 76 ± 1.2 and $79\pm 5.4\%$ learning respectively achieved with the face-to-face educational system, while with the hybrid system they improve to 88 ± 3.2 ; 85 ± 4.2 and $84\pm 1.3\%$ in their order for the same components, finding significant differences when comparing between the two educational systems under study.

Level of learning (%) by areas of knowledge of food biotechnology according to the educational system used. As can be seen in Table 2 of results, the evaluation carried out for four consecutive years on the learning level of Food Biotechnology knowledge in students of the Agroindustry Engineering degree at an Ecuadorian public University, shows that in the first year of study (2018) a learning percentage of $75\pm 3.0\%$ is obtained, increasing slightly for the following year (2019) to a level of $81\pm 2.6\%$ under the

same modality, with an average value for the two years of its application of 78%, this is the face-to-face system, while when applying the hybrid teaching modality for Biotechnology a learning level in students of $86 \pm 2.8\%$ was obtained in the first year of its application (2020) and the same value, that is $86 \pm 2.9\%$ in the second year of its validity (2021), evidencing an increase in learning around 8% with statistical differences between the two systems.

TABLE 2. *Level of learning (%) by component of food biotechnology knowledge per year*

COMPONENTE	SISTEMAS EDUCATIVOS SEGÚN LOS AÑOS									
	SISTEMA PRESENCIAL					SISTEMA HIBRIDO				
	2018	DS	2019	DS	PROM.	2020	DS	2021	DS	PROM.
Biología, historia, situación actual y perspectivas	77	$\pm 3,6$	81	$\pm 2,7$	79	86	$\pm 1,6$	94	$\pm 3,1$	90
Principios de Ingeniería Genética aplicados a la Biología	74	$\pm 2,8$	76	$\pm 3,6$	75	85	$\pm 2,2$	81	$\pm 2,3$	83
Producción de alimentos y	76	$\pm 4,2$	86	$\pm 2,6$	81	91	$\pm 3,9$	85	$\pm 3,3$	88

otros productos biotecnológicos										
El control de calidad en productos biotecnológicos	75	±2,9	77	±1,9	76	81	±4,1	89	±2,5	85
Bioética y sus aplicaciones en la biotecnología	74	±1,5	84	±2,3	79	85	±2,4	83	±3,4	84
PROMEDIO	75		81		78	86		86		86

When analyzing the results obtained for the learning level of Food Biotechnology by type of knowledge or skill, that is, theoretical or practical, as shown in Figure 4, it was obtained in the study that with the classroom system 82% of learning is achieved for the theoretical part and 74% for the practical part, that is, skills with laboratory work, while with the hybrid system these learning levels are increased to 90% for the theoretical part and 82% for the practical skills. Let us recall that these values were obtained through the application of a test-type instrument of 100 indicators applied during 8 consecutive academic periods in the Ecuadorian higher education institution to the students of the subject under study. The study considered the evaluation of two systems for a subject of importance and wide applicability, the first pre-pandemic system known as face-to-face, which despite its great trajectory and use over time, shows limitations in the field of higher education, on the one hand, is a determinant component of educational inequality, since it imposes a centralized, unique and costly spatial location, a power

structure focused on large cities that has marked the inequalities in regional access, resulting in concentration and exclusion. On the other hand, this educational methodology relies dominantly on a learning paradigm based on rote repetition in the classroom, rather than on study based on learning resources; even the study of books is concentrated in large libraries as the center of universities (Rama, 2020). The second method evaluated was the well-known and recently applied given the circumstances of the country and the world due to the pandemic, the hybrid system, which is understood as a totally virtual modality but which differentiates between synchronous and asynchronous forms of learning, with varying degrees of use according to the learning objectives and contents. It is not a semi-presential education that combines a face-to-face teaching with a support in platforms, high diversity of interaction systems and educational work of teaching in virtual environments, mostly supported by the network and computers, cell phones or tablets, it is a dynamic that is structured both in the form of continuous education, as discontinuous, relying on multimodalities, finally it is supported by a tertiarization in the technological aspects of both connectivity (associated with synchronous forms: Zoom, Google, Team) as well as platforms with tutors, both LMS models such as Moodle, Canvas, Schoology, Blackboard, etc.), as well as platforms that support MOOCs and applications in computer laboratories of simulators or augmented reality to acquire competencies (Rama, 2021). As expected, hybrid education also has limitations, since digital disruption has created multiple social gaps and the pandemic has starkly revealed these weaknesses in digital development and the differentiated level of access and use among the various sectors and regions. This weakness in the digital development of the Latin American region

manifests itself as limitations for the realization of telework and distance education, but also in many other areas: telehealth services, tele-justice, digital commerce, digital government, digital banking, etc. In almost all cases, this derives from legal constraints, productive structures, types of infrastructure, level of training and technical skills of the various actors, limited innovative management models that give them administrative support or ideological and cultural resistance (Rama, 2020). Thus, hybrid learning or blended learning is an integrative learning modality that uses face-to-face and virtual components in a combined manner. A review of different bibliographic sources revealed experiences and results of research on the use of hybrid learning for the online professional development of university professors. Among the results, it is perceived that the training processes in the online or virtual modality have not been sufficient to respond to the challenges of higher education in the digital era, and hybrid or blended learning is constituted as an alternative of digital education of teachers in higher education (Balladares, 2018).

The main findings in the study "From distance education in pandemic to hybrid modality in post-pandemic" showed empirical and theoretical data referring to: difficulty in internet connectivity, access to equipment and technological and digital infrastructure and student-teacher relationships; weak digital competencies were also found; Thus, the trend has been the increase in the use of information and communication technology to support educational activities, but at the same time access to these media is limited, leading to complex educational processes under the distance mode, which require expanding the search for strategies that minimize the difficulties imposed by reality, the alternative being the hybrid mode (Carbonell, et al. 2021). When comparing the academic performance in

Microbiology and Parasitology, in medical students, through a quasi-experimental study in 58 students of the third semester of the career, using the two educational modalities, classroom and hybrid (classroom/online), the overall result of the post-evaluation showed a difference in academic performance in favor of the group under the hybrid modality, so it would seem that the use of this modality as an educational strategy favors greater learning in medical students (Rosales, et al. 2008). This behavior was corroborated in our study, where the hybrid system delivered better learning results in Biotechnology than the face-to-face system. Thus, the traditional educational methodology should be developed towards an innovative approach, which contemplates the changes that arise in teaching when using different methodological resources. In addition, information and communication technologies, due to their interactivity, stimulate cognitive, emotional and sensitive capacities (Fuentes, Cruz and Pastor, 2005). We have verified as teachers that the use of the Internet offers important advantages to the traditional didactic method, especially with regard to the wide and updated availability of educational material (Calatayud, Martínez, Muñoz and Cuenca, 2005), an advantage that is optimized with the commitment of the teacher in the learning process. It is recommended that learning be mediated by activities designed to improve students' understanding and the meaning of knowledge, through interaction with the same material at different times, in contexts reconfigured for different purposes and interaction among peers to share knowledge, generating reflection and active engagement of students (Cenich and Santos, 2005).

Some studies have shown that students learn better on the Web than in traditional classes (Araya, 2007; Avila and

Samar, 2004; Gallego and Martinez, 2003; Popescu and Navarro, 2005), based on the above, the teacher must motivate the student to build knowledge, using the new technological alternatives. In this mixed modality (face-to-face/online) students attend the classroom to have discussion sessions guided by the teacher, based on the course content on the web. This implies that students must read the contents of the Web site pages as well as carry out the activities and learning experiences programmed in it (Longoria, 2005). The results of this work and those of the other authors show that the hybrid modality alternative to face-to-face teaching is gaining ground, from a formal point of view, as it becomes clear that a return to the previous stage seems unfeasible, since the changes generated seem to be here to stay, although it is an evolving process (Carbonell, et al. 2021). Thus, higher education institutions must rethink the model to be used and redesign their educational structures. Wold (2013) maintains something similar, stating that hybrid education is projected into the future as a modality that contributes to the improvement of the quality of higher education, in the same way Owston, et al. (2008), indicate that this model will be a good contribution to the professional development of teachers. Concomitant to these criteria, Balladares (2018), states that in a literature review from 1999 to 2012 on research about Hybrid Learning, researchers Güzer and Caner (2014), perceive this modality as useful, pleasant, flexible and motivating for learners, although it has as a challenge to generate better learning environments through social interaction and collaborative work. It seems that these characteristics helped in our Biotechnology course to obtain better results in the learning of the students evaluated. Other researchers such as Valverde, et al. (2004) indicate that hybrid learning becomes an alternative modality for

the improvement of teaching-learning processes and constitutes a trend in the use of ICT for university teaching. Likewise, Fainholc (2008) indicates that this modality is considered ideal for the professional development of teacher training students. In this way, hybrid learning is an option of virtual educational modality integrating traditional and innovative, face-to-face and virtual, formal and non-formal, synchronous and asynchronous components, different languages, teaching approaches and learning styles (Valverde and Balladares, 2017). We already see today in a diversity of institutions, regions and countries that the knowledge society and higher education systems tend to combine a hybrid model that incorporates face-to-face and distance modalities so that in the future it will not make sense to distinguish between these two types of education (Pastor, 2005). Therefore, it is no coincidence that Morán (2012), argues that blended education, flexible education, mixed learning or widely known by its English term blended learning, or hybrid education, as a mixed category between online education and traditional education, arises in the business environment, offers an integration in the same learning process of educational elements carried out through technological means with education offered in the more traditional way (Thorne, 2003). This combination can occur in many ways: online subjects and face-to-face subjects, part of online subjects or only certain formative activities, therefore educators agree that this approach shares the opportunity to provide personalized instruction with some element of student control over the teaching-learning process, time and place (O'Byrne & Pytash, 2015), cited by De Obesso, M. and Nuñez, M. (2021). It is important to quote Obesso, M. and Nuñez, M. (2021), who in their work "The hybrid educational model: a necessary response of university education from Covid-19",

conclude and propose to analyze this model from the results obtained from the educational experiences that emerged in the years 20-21, observing the main transformations at two levels: pedagogical and organizational. In the pedagogical part, from the dimensions of analysis developed by the general literature of e-learning education (Huertas et al., 2018) and the current philosophy emerged from Bologna, student-centered learning, applied to the design of hybrid educational programs in its three levels of interaction, the main transformations will be observed in two levels: pedagogical and organizational.

(Bernard et al., 2009). At the organizational level, observe the institutional adaptations produced to integrate in business studies the transformations of the environment and students (Krishnamurthy, 2020), taking into account the need for training in the skills of the future for the digital society of teachers, students and the university digital transformation itself (Holford, 2019). The existing scientific literature continues to argue that the pedagogical model of hybrid learning is increasingly used in higher education, due to the fact that it promotes significant changes in learning, this conception implies the opening to effective opportunities for dialogue and collaborative construction of content, as well as the promotion of digital culture in terms of collaborative and cooperative activities between managers and teachers to act differently in the classroom (Mejía, et al. 2017). It can be stated then that the education of the future must enrich the potential of students and have them as protagonists in the teaching-learning process, where the teacher must guide them towards a comprehensive training, which includes the development of cognitive and socioemotional skills and the use of new technologies as a research tool for learning, communication and dissemination, so that learning is

developmental (López, et al. 2012). At this point of the analysis it is convenient to cite an experience similar to ours, which when evaluating the students of a graduate program taught under both face-to-face and hybrid modalities, through questionnaires and discussion groups, found that the hybrid model adopted (face-to-face/online) was adequate, the students' discourse shows that they were committed to the benefits of the modality, however, the typical didactic and pedagogical problems common to the teaching-learning process such as distance tutoring were maintained (Lavigne, 2006). However, it is necessary to consider the proposal of contemporary scientists, who have identified different sets of variables that should still be evaluated in the hybrid educational system: those of the socio-economic context, those of the learning environment, those of technology, those of pedagogy and those of the students (Hughes and Attwell, 2003). Similarly, in the area of hybrid pedagogical training practices for teachers in education, there is a tendency to transform the formative processes by the combination of various pedagogical trends such as cognitivism, constructivism and behaviorism with e-learning (Torres and Gutierrez, 2017). Continuing with the analysis and discussion of this interesting educational topic, it was found that indirect empirical indicators and conceptual frameworks allow assuming a persistent growth of non-face-to-face enrollment in Latin America. This process has a wide set of drivers as a derivation of economic, political, social, academic and technological logics, which have begun to outline a new element within the process of differentiation of higher education in Latin America within the framework of enrollment expansion, and which feed back, reinforcing this new component of a hybrid education in the region and the trend towards a respectable segment of the coverage of

Latin American higher education, marked by its de-presentialized character (Rama, 2007). In Ecuador, the higher education regulatory body, the Higher Education Council (CES), (2020) in the face of the Covid 19 pandemic in Ecuador incorporated in its transitional regulations an article to guarantee the continuity of students' studies; HEIs may adapt their career plans and programs to the hybrid modality, combining blended, online and distance modalities. This teaching modality will prioritize the autonomous learning of students, which requires that all courses, subjects or their equivalent contain a study guide developed by the academic staff. In order to strengthen students' autonomous learning processes, as well as the broadening, deepening and specialization of knowledge, HEIs must offer students open access to at least one virtual library and a digital support repository. In such a way that the challenges of the hybrid model is that the digital competence of teachers must be continuously updated, focusing their skills in the mastery of digital tools and methodologies for appropriate assessment (Guamán, et al. 2020). As a valid experience that corroborates the work under discussion, it is appropriate to cite Sousa, et al. (2021), who when evaluating the effectiveness of hybrid teaching with flipped classroom, in terms of student satisfaction and performance, compared to 100% online teaching in different IES (Higher Education Institutions), identified statistically significant differences in relation to academic performance where students are very satisfied with the hybrid environment and the flipped classroom methodology, with better success rates and better retention compared to fully online teaching. In recent research that is online, the results obtained are encouraging and could suggest that the application of flipped classroom in hybrid subjects generates an educational environment that

improves student performance (Hinojo, et al. 2019). Apparently and as several positive experiences of results with hybrid education have been cited in this work, it would seem to be an excellent option, since it is an ideal educational model to prepare students in a world where knowledge is not a fixed set of facts that can be easily divided into independent subjects (Viñas, 2021). Contemporary researchers recognize that remote education responded to the emergence of the pandemic and identified key success factors such as the temporalization of the teaching and learning process, synchronous teaching, the techno-pedagogical design of virtual learning environments, and university digital transformation. These results make it possible to redefine the traditional concept of hybrid education by incorporating the strengths of remote education and repositioning it as a strategic study modality for a new educational normality that progressively recovers face-to-face teaching and expands student learning (Balladares, 2021). However, one cannot leave aside the results of some research that seem to contradict in practice the advantages of hybrid education, since this type of university training originates a lack of professional identity among hybrid professionals and a notable absence of social recognition of the profession by employers as a whole, both situations could well affect the rapid insertion of graduates with hybrid training into the labor market (Damian, 2014). Finally, it should not be forgotten that an important link in the process of transformation towards quality education is the participation of the government, which, seeking the welfare of the population, establishes projects for internet accessibility, technological equipment in classrooms and provision of computer equipment to students (Ríos, 2021). Food biotechnology as a professionalizing subject in the engineering career is apparently and according to the

results of this work, better understood and applied through a hybrid system of education, so it is recommended to take into consideration these data to implement hybrid education systems for this science and other related biological sciences in university careers in Ecuador. Based on the results cited from several research works in the educational field, as well as based on our own experience in university education, the advantages of the hybrid system include the cultivation of autonomy, enhanced learning, greater flexibility of time and schedules, better use of time, reduced costs, greater interaction due to the diversity of available resources, better use and exploitation of content, design of personalized environments, the possibility of instantaneous feedback, among others. The system also has disadvantages such as the vulnerability of the educational system, the segregation of students who are not very participative, the non-existent and inequitable existence of electronic equipment for connection, the lack of motivation, the need for permanent teacher training, and greater student distraction, among others.

Given the current pandemic circumstances that continue to influence educational systems, it is necessary to redesign the structures of the curriculum, the tools to implement educational processes and adjust to the undeniable reality of a transformation, therefore, the use of the hybrid modality of education in higher education should be considered in the processes of curriculum redesign.

References

Al-Samarraie, H., Teng, B. K., Alzahrani, A. I., & Alalwan, N. (2018). Elearning continuance satisfaction in higher education: a unified perspective from instructors and students. *Studies in Higher*

- Education*, 43(11), 2003–2019.
<https://doi.org/10.1080/03075079.2017.1298088>
- Balladares, J. (2018). El aprendizaje híbrido y la educación digital del profesorado universitario. *Revista Cátedra*. 1(1), 53-69.
- Araya Rivera, C. (2007). Diseño, ejecución y evaluación de un curso bimodal en la educación superior, en *Actualidades investigativas en Educación*. Recuperado el 27 de marzo de 2008 <http://revista.inie.ucr.ac.cr/articulos/esp-2007/archivos/bimodal.pdf>
- Ávila, R. E. Samar; M. E. (2004). “Aprendizaje virtual de la Biología celular, Histología y Embriología: Uso de un Atlas Virtual y una Página Web”. En *Informédica*. Recuperado el 27 de noviembre de 2007, http://www.informaticamedica.org/IO4/papers/avila_7.pdf
- Balladares, J. (2018). El aprendizaje híbrido y la educación digital del profesorado universitario. *Revista Cátedra*. 1(1), 53-69
- Balladares, J. (2021). Percepciones en torno a una educación remota y a una educación híbrida universitaria durante la pandemia de la COVID-19: estudio de caso. *RIITE Revista Interuniversitaria de Investigación en Tecnología Educativa*, 11, 25-39. <https://doi.org/10.6018/riite.489531>

- Bernard, R; Abrami, P; Borokhovski, E; Wade, C; Tamim, R; Surkes, M. & Bethel, E. (2009). A meta-analysis of three types of interaction treatments in distance education. *Review of Educational Research*, 79(3), 1243–1289.
<https://doi.org/10.3102/0034654309333844>
- Blog educativo de la Universidad Nacional de Educación (UNAE). Consultado el 4/11/2022. Disponible en: <https://unae.edu.ec/sak-amazonia/>.
- Blog educativo en línea Hotmart.com/es. Consultado: 4/11/2022. Disponible en: [https://hotmart.com/es/blog/educacion-hibrida#:~:text=La%20educaci%C3%B3n%20h%C3%ADbrida%20es%20un,a%20Distancia\)%20y%20en%20presenciales](https://hotmart.com/es/blog/educacion-hibrida#:~:text=La%20educaci%C3%B3n%20h%C3%ADbrida%20es%20un,a%20Distancia)%20y%20en%20presenciales).
- Blog educativo en línea Ingenio.edu.pe. Consultado: 4/11/2022. Disponible en: <https://ingenio.edu.pe/blog/que-es-la-educacion-hibrida-y-cuales-son-sus-ventajas-y-desventajas/>
- Calatayud, M., Martínez Lizán, I., Muñoz, V., Cuenca, E. (2005). “Uso de internet por parte de los estudiantes de la facultad de odontología de la universidad de Barcelona”. *Educ Med*. 8 (Supl. 1) pp. 31-32.
- Carbonell, C., Rodríguez, R., Sosa, L., y Alva, M. (2021). De la educación a distancia en pandemia a la modalidad híbrida en pospandemia. *Revista Venezolana de*

Gerencia, 26(96), 1154-1171. <https://doi.org/10.52080/rvgluz.26.96.10>

Cenich, G., Santos, G. (2005). "Propuesta de aprendizaje basado en proyecto y trabajo colaborativo: experiencia de un curso en línea". *Revista Electrónica de Investigación Educativa*. 7 (2) pp. 4-5.

Consejo de Educación Superior (CES). (2020). Normativa transitoria para la educación superior. Consultado: 10/01/2023. Disponible en: https://www.epn.edu.ec/wp-content/uploads/2020/04/normativa_transitoria_rpc-se-03-no.046-2

Consejo Europeo. (2018). *Recomendación del Consejo, relativa a las competencias clave para el aprendizaje permanente Texto pertinente a efectos delEEE*.

Damián, J. (2014). La formación universitaria híbrida: retos y oportunidades. *Revista Electrónica "Actualidades Investigativas en Educación"* (14)2.

De Obesso, M. y Nuñez, M. (2021). El modelo educativo híbrido: una respuesta necesaria de la enseñanza universitaria a partir de la Covid-19. Research Gate. DOI: 10.13140/RG.2.2.34706.89289. Disponible en: <https://www.researchgate.net/publication/348755808>

Fainholc, B. (2008). Modelo tecnológico en línea de Aprendizaje electrónico mixto (o Blended learning) para el desarrollo profesional docente de estudiantes

en formación, con énfasis en el trabajo colaborativo virtual. *RED. Revista de Educación a Distancia*, 21, pp. 1-34.

Fuentes Almendras, M., Cruz Molina Garuz M., Pastor Vicente, C. (2005). “¿El entorno digital de enseñanza mejora la adquisición de conocimientos?”, en *Educ Med*. 8 (Supl. 1) p. 32.

Gallego Rodríguez, A., Martínez Caro, E. (2003). “Estilos de aprendizaje y elearning. Hacia un mayor rendimiento académico”, en *Revista de educación a distancia*, 7, pp. 1-10.

González, C., Villa, J. y Latorre, J. La biotecnología como visión de empresa. Facultad de Ciencias Agropecuarias. 2010. Vol 8:1.

Guaman, R., Villareal, A. y Cedeño, E. (2020). La educación híbrida como alternativa frente al Covid19 en el Ecuador. *Revista de Investigación Científica TSE´DE*, 3(1), 134-147.

Güzer, B. y Caner H. (2014). The past, present and future of blended learning: an in depth analysis of literature. *Procedia - Social and Behavioral Sciences*, 116, pp. 4596 – 4603

Hinojo, F., Aznar, I., Romero, J., y Mar, J. (2019). Influencia del aula invertida en el rendimiento académico. Una revisión sistemática. *Campus Virtuales*, 8(1), 9–18. Recuperado de <http://www.revistacampusvirtuales.es>

- Holford, W. (2019). The future of human creative knowledge work within the digital economy. *Futures*, 105(October 2018), 143–154. <https://doi.org/10.1016/j.futures.2018.10.002>
- Huertas, E., Biscan, I., Ejsing, C., Kerber, L., Kozłowska, L., Marcos, S., ...Seppmann, G. (2018). *Considerations for quality assurance of e-learning provision*. Retrieved from <http://www.enqa.eu/index.php/publications/papers-reports/occasionalpapers9780415630290>
- Hughes, J. y Attwell, G. (2003). A framework for the evaluation of e-learning. Recuperado el 29 de diciembre de 2021, de http://www.theknownet.com/ict_smes_seminars/papers/Hughes_Attwell.html
- Krishnamurthy, S. (2020). The future of business education: A commentary in the shadow of the Covid-19 pandemic. *Journal of Business Research*. <https://doi.org/10.1016/j.jbusres.2020.05.034>
- Ladevéze N., L., & Núñez, M. (2016). Noción de emprendimiento para una formación escolar en competencia emprendedora. *Revista Latina de Comunicación Social*, 71, 1068–1089. <https://doi.org/10.4185/RLCS-2016-1135>
- Lavigne, G., Organista, J., & Aguirre, L. (2006). Evaluación de la modalidad híbrida, presencial/en línea, por estudiantes de posgrado en educación. *Revista*

- Electrónica "Actualidades Investigativas en Educación", 6 (1). (Consultado: 13/01/2023). Recuperado de: <https://www.redalyc.org/articulo.oa?id=44760106>
- Longoria, J. F. (2005), "La Educación en Línea. México". *Colección Material Didáctico. Univ. Autónoma del Carmen*. pp. 11-12. Recuperado el 27 de noviembre de 2007, <http://www.fiu.edu/~longoria/publications/enlinea.pdf>
- López, R; Gutiérrez, M; Vázquez, S; Benet, M; Tereñes, C. y Legrá, S. (2012). La evaluación en la educación a distancia en la búsqueda de un aprendizaje desarrollador. *Medisur*: 10(2). (Consultado: 10/02/2023) Disponible en: <http://www.medisur.sld.cu/index.php/medisur/article/view/1918/6855>.
- Means, B., Bakia, M., & Murphy, R. (2014). *Learning Online: What Research Tells Us About Whether, When and How* - (Routledge, Ed.). Retrieved from <https://www.routledge.com/Learning-Online-What-Research-Tells-Us-About-Whether-When-and-How-1st/Means-Bakia-Murphy/p/book/>
- Mejía, C; Michalón, D; Michalón, R; López, R; Palmero, D; y Sánchez, S. (2017). Espacios de aprendizaje híbridos. Hacia una educación del futuro en la

Universidad de Guayaquil. INVESTIGACIÓN
PEDAGÓGICA: (15) 3. ISSN 1727-897X

Morán, L. (2012). Blended-learning. Desafío y oportunidad para la educación actual. *EduTec. Revista Electrónica de Tecnología Educativa*, (39), a188. <https://doi.org/10.21556/edutec.2012.39.371>

OCDE. (2018). *The future of education and skills Education 2030*.

Owston, R., Wideman, H., Murphy, J. y Lupshenyuk, D. (2008). Blended Teacher Professional Development: A Synthesis of Three Program Evaluations. *Internet and Higher Education*, 11, pp. 201–210. <https://doi.org/10.1016/j.iheduc.2008.07.003>

Pastor, M. (2005). Educación a distancia en el siglo XXI. *Apertura*, vol. 5, núm. 2, noviembre, 2005, pp. 60-75. Universidad de Guadalajara, México. Disponible en: <http://www.redalyc.org/articulo.oa?id=68800206>

Pérez, K. (2022). De la educación tradicional a la híbrida: Cambio e innovación. Universidad Nacional de Educación. Ecuador. Consultado: 4/11/2022. Disponible en: <https://unae.edu.ec/>

Rama, C. (2007). La despresencialización de la educación superior en América Latina: ¿tema de calidad, de cobertura, de internacionalización o de financiamiento? *Apertura*: (7) 6. ISSN 1665-6180

- Popescu, B.M., Navarro, V. (2005). “Comparación del aprendizaje en internet con la clase convencional en estudiantes de medicina, en Argentina”, en *Educ Med.* 8 (4) pp. 28-31.
- Rama, C. (2021). La nueva educación híbrida. Cuadernos de Universidades No 11. ISBN 978-607-8066-35-3. 1ª ed. México.
- Ríos, Y. (2021). *La enseñanza post pandemia: retos y tendencias de la educación híbrida*. Plus economía. (9)2. pp. 107-112
- Rosales, S., Gómez, V., Durán, S., Salinas, M. y Saldaña, S. (2008). Modalidad híbrida y presencial. Comparación de dos modalidades educativas. *Revista de la Educación Superior*. Vol. XXXVII (4), No. 148, pp. 23-29. ISSN: 0185-2760.
- Sousa, S., Peset, M., y Muñoz, J. (2021). La enseñanza híbrida mediante *flipped classroom* en la educación superior. *Revista de Educación*, 391. Enero-marzo 2021, pp. 123-147. DOI: 10.4438/1988-592X-RE-2021-391-473
- Torres, J. y Gutiérrez, M. (2017). Formación pedagógica híbrida en docentes licenciados a través de la educación a distancia y virtual. *Revista de Pedagogía*, 38 (103).
- Valverde-Berrocoso, Jesús y Balladares, J. (2017). Enfoque sociológico del uso del b-learning en la educación

digital del docente universitario. *Sophia: colección de Filosofía de la Educación*, 23(2), pp. 123-140.

Valverde-Berrocoso, J; López, E; Garrido M. y Díaz, D. (2004). Educación superior y entornos virtuales de aprendizaje: evolución de la oferta formativa on-line en las Universidades Públicas. *Revista Currículum*, 17, pp. 95-117.

Viñas, M. (2021). Retos y posibilidades de la educación híbrida en tiempos de Pandemia. *Plurentes. Artes y Letras* (12)e027. ISSN: 1853-6212

Wacher, C. (2014). La biotecnología alimentaria antigua: los alimentos fermentados. *Revista digital universitaria*. Vol. 15:8. ISSN 1607 – 6079.

Wold, K. (2013). Collaborative Inquiry: Expert Analysis of Blended Learning in Higher Education. *International Journal on E-Learning* 12 (2), pp. 221–38.

ISBN: 978-9942-33-668-2

