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Presentation of the Content

In a first article we present, *Business competitiveness in the handicraft sector. Case study of San Antonino Castillo Velasco, Oaxaca* by CRUZ-GARCIA, Leobardo Daniel, CASTILLO-LEAL, Maricela, RAMIREZ-JIMENEZ, Antonio Miguel and CRUZ-CABRERA, Blasa Celerina, with adscription at Tecnológico Nacional de México/Instituto Tecnológico de Oaxaca, in the next article we present, *Analysis of the Most Influential Social Networks in Online Shopping in Mexico* by MERINO-ROMERO, Adriana, JIMÉNEZ-GARCÍA, Martha and PÉREZ-CASTILLO, América Nohemi, with adscription at Instituto Politécnico Nacional – UPIICSA, México, in the next article we present, *Quality Control System for the Tomato Release Process produced in Greenhouse* by LÓPEZ-VIGIL Miriam Silvia, HERNÁNDEZ-FLORES Lesli Ailed, SANTOS-ALVARADO Héctor and ISLAS-TORRES Héctor, with adscription at Tecnológico Nacional de México/ Instituto Tecnológico de Tehuacán, in the last article we present, *Gender wage gap in the formal and informal sector in the COVID-19 crisis period, of the national labor market and the state of Coahuila* by ZAMARRÓN-OTZUCA, Nathalia, DE LA GARZA-CIENFUEGOS, Sandra, AGUILAR-SANCHEZ, Ana María, with adscription at Universidad Autónoma de Coahuila.

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Business competitiveness in the handicraft sector. Case study of San Antonino Castillo Velasco, Oaxaca

La competitividad empresarial en el sector artesanal. Estudio de caso de San Antonino Castillo Velasco, Oaxaca

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Abstract

The artisanal sector represents a means of subsistence for a large number of families worldwide, mainly in marginalized indigenous communities. The companies belonging to this sector produce and market products that transmit the culture and identity of their communities. Oaxaca is a state of the Mexican Republic rich in cultural diversity where the artisanal sector is extremely important for its economy, artisanal companies have had to adapt to the new conditions of a globalized market, making use of different tools and strategies that enhance their competitiveness. This article aims to describe the triggering elements of the competitiveness of the artisan sector of San Antonino Castillo Velasco, Oaxaca, Mexico, a community recognized for its production of textiles and artisan embroidery, the methodology is based on a documentary analysis of different theoretical models contrasted with an ethnographic study based on observation and unstructured interviews within its specific reality.

Competitiveness, Communities, Artisanal

Resumen

El sector artesanal representa un medio de subsistencia para una gran cantidad de familias a nivel mundial, principalmente en comunidades indígenas marginadas, las empresas pertenecientes a este sector elaboran y comercializan en el mercado productos que transmiten la cultura e identidad de sus comunidades. Oaxaca es un estado de la República Mexicana rico en diversidad cultural donde el sector artesanal es de suma relevancia para su economía, las empresas artesanales han tenido que adaptarse a las nuevas condiciones de un mercado globalizado, haciendo uso de diferentes herramientas y estrategias que potencialicen su competitividad. Este artículo tiene por objetivo describir los elementos detonantes de la competitividad del sector artesanal de San Antonino Castillo Velasco, Oaxaca, México, comunidad reconocida por su producción de textiles y bordados artesanales, la metodología se basa en un análisis documental de diferentes modelos teóricos contrastado con un estudio etnográfico basado en la observación y entrevistas no estructuradas dentro de su realidad especifica.

Competitividad, Comunidades, Artesanías

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Introduction

In a globalised world that is constantly changing, with great technological advances that have resulted in various support tools for business management, competitiveness has become an extremely indispensable element for companies to ensure their permanence and increase their positioning in highly competitive markets, not only in a local environment, but also at a global level. Regardless of the line of business, characteristics or typology of the business, it cannot be overlooked that competitiveness represents a multifactorial set of factors to promote economic growth and market participation.

There are certain relevant economic sectors in the regions that require studies to understand and analyse those factors that affect their levels of competitiveness; in Mexico and especially in Oaxaca, the handicraft sector is highly relevant. The competitiveness of the handicraft sector derives from the satisfaction of the tourist customer (national or foreign) through the adaptation of products to their needs, offered at a reasonable price and promoted through efficient communication strategies (Diaz Pichardo, *et al*., 2017).

In Mexico, according to the National Household Income Survey (ENIGH) of 2018, the number of people dedicated to the production and sale of handicrafts who depend economically on this activity amounts to 1,118,232 individuals (Fondo Nacional para el Fomento de las Artesanías, 2020 [FONART]). These data highlight the fact that the handicraft sector in the country is of utmost importance for the national economy.

The production of handicrafts symbolises a family economic activity of great relevance and importance, mainly in rural areas, since for these families it often represents the main source of income, which has sustained generations. Creating handicrafts is a process that is linked to various categories of human development: culture, economy, social development, education, even science, this activity is seen as "art" but it is also considered a "business" which must maintain and preserve standards of efficiency, quality, innovation, among many other factors to make it competitive and achieve a place in the market (Hernández, *et al.*, 2002).

In Oaxaca, according to the State Development Plan 2016-2022, one of the main strategic sectors of its economy is the handicraft business (Government of the State of Oaxaca, 2016 [GEO]), however, as mentioned in the Strategic Sectoral Plan to Boost the Economy, there is little information on this sector in a macroeconomic environment which makes it difficult to identify, characterise and quantify producers and handicraft products (GEO, 2016). It is in this state where a great diversity of communities are recognised by the large number of artisan enterprises dedicated to the production of handicrafts based on clay, textiles, wood and other elements, 95% of which are considered micro, small and medium-sized enterprises (MSMEs) family businesses (Diaz Pichardo, *et al*., 2017).

Although the production and marketing of handicrafts is one of the main economic activities in the state, it also presents a wide range of problems, starting with misinformation about the sector, low levels of production due to the time invested, difficulties in the distribution and marketing of products, complications in obtaining inputs or raw materials, among many other problems that have a direct impact on the competitiveness levels of the sector (Rojas, *et al.*, 2017).

Although handicrafts are elements recognised in Oaxaca by the state and the market as relevant economic products, in no area are efficient and substantial alternatives generated that combat the existing inequalities between the artisans of a territory, which are developed in a free market economic model. San Antonino Castillo Velasco is a municipality in Oaxaca where the commercialisation of handicrafts is one of the main economic activities, recognised for its embroidery and textiles. However, it is also a territory where inequalities are observed in terms of the competitive levels of the companies belonging to this sector.

Competitiveness and business competitiveness

When talking about competitiveness, one could think directly of companies, however, it is measured and used in the same way in other sectors and with other agents such as territories such as countries, states or regions, or even with professionals or activities.

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De la Dehesa (2009) mentions that the word competitiveness originated in the business world and has now evolved to such an extent that it is no longer only used by entrepreneurs, highlighting its use in the political world due to its relationship with the economic factors and variables involved.

National competitiveness is so important that in Mexico there is an organisation in charge of carrying out various studies on the levels of territorial competitiveness called the Mexican Institute of Competitiveness (IMCO), which generates various indices with multiple variables to determine internal and external national competitiveness.

Competitiveness is directly linked to economic growth, which is why a country can be considered competitive or not, depending on the increase in the production of its companies and the improvement in the quality of life of its society (Medeiros, *et al*., 2019).

In this way, competitiveness is directly and indirectly linked to a myriad of variables at different scales such as: growth, development, sustainability, quality of life, income, innovation, production, among many others, resulting in strategies that allow the creation of advantages of an actor over its competition.

Over time, the term competitiveness has been discussed by a large number of authors and organisations, including Michael Porter, who was the first to structure and systematise a theoretical approach to the concept, relating it to the human factor and productivity for market participation, on the other hand, authors from the Economic Commission for Latin America and the Caribbean (ECLAC) take into consideration public policies as elements that trigger competitiveness, and the Organisation for Economic Co-operation and Development (OECD) highlights the relevance of business management within what it calls structural competitiveness (Suñol, 2006).

Thus, within the theoretical baggage of competitiveness we find different terms and concepts such as territorial competitiveness, business competitiveness, structural competitiveness, to mention a few, and in turn different models, approaches and units that enable its analysis and measurement.

Business competitiveness is conceptualised as the set of business capabilities that enable the creation and implementation of competitive strategies to maintain or increase market shares and ensure certain business sustainability (Medeiros, *et al*., 2019).

Competitiveness is an indispensable element for companies in their development within the markets; those that are not interested in increasing their competitiveness will run the risk of falling behind or even disappearing, given that nowadays the range of competitors in any commercial sector is highly elevated, promoting an endless number of offers to consumers.

Hence, the terms competition and competitiveness maintain a relationship generated from the unification and breadth of markets, even at a global level, highlighting that when barriers between countries and companies are overcome, competitiveness becomes essential for survival (De la Dehesa, 2009).

Globalisation, information and communication technologies (ICTs), e-commerce, social networks, generational habits, even the global pandemic caused by the COVID-19 virus, have forced companies to establish mechanisms to stay in the market and to face not only their local competitors, but also competitors of a higher level, since today it is common to acquire products from other countries without as much complexity as in the past.

Business competitiveness depends on internal factors such as organisation and production capacity, but also on countless external factors within various environments such as political, social, technological, among others, the ability to compete will determine the creation of wealth and economic growth, promoting employment and raising the quality of life. (Rubio y Baz, 2015).

Business competitiveness becomes a multidimensional element where two important procedures converge: on the one hand, it is necessary to establish optimal processes for managing resources and taking advantage of strengths, and on the other hand, it is extremely important to know and identify what is happening abroad in order to generate growth opportunities.

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Companies become competitive when they manage to combine various factors, for example, educational level, business culture, infrastructure, level of market sophistication, environment, among others (Ibarra, González, and Demuner 2017).

Entrepreneurs must be aware of what is happening inside and outside their organisation in order to design and execute the most effective strategies to achieve and maximise the best results, and competitiveness is also related to the ability to adapt to change.

Carrasco, *et al*., (2021) mentions that business competitiveness depends on three main levels: the first is the competitiveness of the country where it is developed, involving variables such as macroeconomic stability, openness and access to markets and the complexity of regulation for companies; the second level refers to the infrastructure that is available and the third focuses on those resources and internal capabilities of companies.

Several authors agree that competitiveness depends on internal and external factors, both of which are equally important for consideration in the design and strategic planning to maintain an active participation in the markets.

Competitiveness models

As mentioned above, there have been several authors and organisations who have discussed competitiveness theoretically, proposing approaches, systems and concepts that are important for its understanding. In this section, different models are analysed in order to understand their similarities and differences.

The first model is the one proposed by the competitiveness pioneer Michael Porter, which focuses on understanding that business results depend, to a large extent, on two main factors: the characteristics of the environment in which they develop and the ability of each business to adapt to this environment and manage it efficiently (Pérez and Polis 2011).

In order to talk about competitiveness, it is important that entrepreneurs develop a deep internal and external analysis that allows them to determine their strengths and weaknesses for the operation and the opportunities and threats that enable growth and development.

Porter's Expanded Competitiveness Model" or also called "Porter's Five Forces", is a management tool applicable to any industry that allows the development of an external analysis through a study of the industry or sector to which the business activity belongs (Pérez and Polis 2011).

This model seeks to investigate the role of companies in the industry in which they operate by analysing the relationships between various actors that interrelate to achieve certain objectives in the market. Undoubtedly, Porter is an important benchmark for competitiveness and his work contributes to any economic sector, through his scheme he aims to clarify five elements that must be considered for the generation of the so-called "competitive advantage".

To visualise Porter's model graphically, see the following figure:

Figure 1 Porter's Five Forces Model
Source: Adapted from Porter's Five Forces Competitiveness Model, (Pérez and Polis, 2011)

Porter's Five Forces" is a model that allows determining the current position of companies in order to select the most appropriate strategies.

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These five forces mainly define prices, costs and investment requirements. Through its analysis it is deduced that rivalry between competitors is influenced by four elements: threat of entry of new competitors, threat of possible substitute products, bargaining power with suppliers, bargaining power of customers that combined lead to the fifth force, which is the rivalry between existing competitors (Perez and Polis 2011).

This model disaggregates each of the forces and elements into variables to be considered in order to foster a more comprehensive analysis for businesses and thus determine their position in the market.

In 1999 Vargas presented Bueno Campos' proposal on the competitive forces of the market, regrouping Porter's model together with the introduction of two more forces that were possibly omitted in the model that precedes it, in such a way that it generates three categories: current competition, potential competition and bargaining power of the agents (Benítez-Codas, 2012).

The aforementioned model is more extensive and complex on the basis of Porter's Five Forces, its purpose is to facilitate a SWOT analysis for those organisations or sectors where it is taken up and applied.:

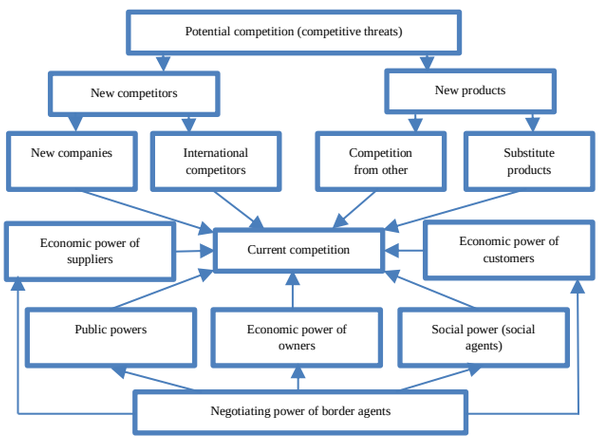

Figure 2 Bueno Campos' 10 Forces Model
Source: Adapted from Evolution of the concept of competitiveness, (Benítez-Codas, 2012, p.77)

The so-called "boundary agents" represent both economic and social actors that are part of the competitive environment of a company and that can exert power or influence the ability to compete, which is why the process of negotiation with them is necessary (Benítez-Codas, 2012).

In this model, public relations are highlighted and it is recognised that some external agents can have an impact on business growth and, above all, support the competitive capacity of companies. It is interesting to understand the author's vision through his categorisation and how the elements of his model are interconnected at a point in the current and real competition of companies.

In 1993, during a period of stable growth with markets dominated by large companies as a result of re-engineering and mergers, small players begin to appear and compete for lucrative segments, which leads Treacy and Wiersema to study these phenomena through a theory that concludes with the existence of "value disciplines" (Benítez-Codas, 2012).

For these authors, competitiveness is linked to another concept, "value", which was also taken by Porter, since his theory focused on adding value to products and customers through competitive strategies.

Value in business provides tools and strategies to position itself in the markets and expand its growth, in this sense the concept of innovation begins to be linked to competitiveness.

Treacy and Wiersema's (1993) model is based on three dimensions: customer intimacy, operational excellence and product leadership. See Figure 3.

Figure 3 Model based on the Treacy and Wiersema theory of value disciplines
Source: Adapted from Evolution of the concept of competitiveness, (Benítez-Codas, 2012, p.79)

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Operational excellence or also called "the formula" consists of the fusion of quality, price and ease of procurement achieving full customer satisfaction at a fair and acceptable cost by optimising resources (Neira-Guevara, 2022).

As mentioned above, competitiveness is directly linked to productivity, which entails optimisation of production processes and adequate use of resources, which is why the authors call it "the formula", as it is through it that a customer-company relationship will be fostered through the sale of its products and its competitive positioning.

The next element called product leadership is also known as "talent" which seeks to place the company in the best market position against its competitors by making use of innovation, problem solving and initiative for new and improved products (Neira-Guevara, 2022).

Leadership implies influencing, directing, guiding, in this sense everything is applicable from the company that seeks its competitive strategy towards its competitors, avoiding as much as possible to be the follower of the new initiatives or products launched by other organisations and taking the direction to be the one that marks the starting points.

The last element represents knowing the customer, also known as "the solution" to fully meet the expectations and needs of consumers, in order to build long-term loyalty (Neira-Guevara, 2022).

Customers represent to a large extent the survival of a company, since without them companies cannot position or sell their products and therefore would not be able to obtain income.

This model brings together three factors that, although they may seem contrary when viewed as a whole, promote competitive companies that optimise resources, promote quality and relevance to their customers through innovative products and services (Neira-Guevara, 2022).

The last model to be analysed is based on the blue ocean strategy proposed by W. Chan Kim and Renée Mauborgne (2005) who mention that for business management it is necessary to understand that its universe is made up of two different types of spaces where it can develop: red and blue oceans. See figure below:

Figure 4 Model based on the blue oceans theory
Source: Adapted from Evolution of the concept of competitiveness, (Benítez-Codas, 2012, p.80)

In the year 2000, market saturation was once again perceived and it is because of this that Kim and Mauborgne analysed the "Cirque du Soleil" and formulated the blue oceans theory, which in contrast to Porter, who focuses on the creation of competitiveness strategies with traditional operations, this theory seeks the incursion of new markets through the innovation of products and services, generating value for customers (Benítez-Codas, 2012).

The theory of blue oceans seeks and pursues constant innovation as part of the operation, abandoning saturated markets where there is even unfair competition and opening new niches where new products or services are positioned to meet the needs in a different way.

The red oceans symbolise the sectors that currently exist, i.e. the already known markets, in them the limits are clearly identified and the rules to encourage competitiveness are understood, in these oceans companies seek to achieve a position of advantage over their rivals to increase their share of the existing demand, as soon as more competitors appear in the same market, the profits and growth of the companies decrease (Kim and Mauborgne, 2005).

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This known space is the one in which companies normally operate, a space devoid of innovation where they compete for what they know and only seek to outperform the competition in a constant struggle for consumers, often implementing strategies based on prices.

On the other hand, blue oceans are those spaces where sectors that do not exist are developed, they are unknown markets where competition is not abundant or even non-existent, in these oceans demand is created and not fought for, which is why they potentially become spaces that promote the rapid and profitable growth of companies (Kim and Mauborgne, 2005).

Blue oceans are spaces for innovation in products, services, procedures and business models that clearly mark a strong differentiation and make it impossible for competitors to compete, opening up new markets and new possibilities for consumers.

There are two ways to create blue oceans: the first, which only rarely occurs, is when enterprises can create the opening of a new market from the outset, and the second is the creation from a red ocean by clearly identifying weaknesses and opportunities, but above all by devising new ways of providing satisfaction to users (Kim and Mauborgne, 2005).

It is important for the opening of blue oceans to consider four principles: opening up new consumer spaces, focusing on ideation and not on numbers, looking beyond demand and existing markets, and ensuring commercial viability (Benítez-Codas, 2012).

As can be seen, the theory of the red and blue oceans is fundamentally based on the existence of innovation to promote business competitiveness, i.e. when the degree of innovation is high enough to open new markets, companies are placed in blue oceans that enhance their development; on the other hand, when there are low levels of innovation, they compete on the basis of what is known in a constant struggle for survival.

In comparison with Michael Porter's diversification strategy and that of Treacy and Wiersema, the blue ocean strategy involves an innovation approach that could become an alternative for small and medium-sized enterprises (Benítez-Codas, 2012).

Each model considers different elements based on the contextualisation of the authors and the reality they studied, proposing different approaches to understanding competitiveness. It is worth highlighting that the point of coincidence of the models studied is sustainability and positioning in a market.

Unit of analysis

San Antonino Castillo Velasco is a municipality in the Valles Centrales region of the state of Oaxaca, belonging to the district of Ocotlán, located approximately thirty-five kilometres from the capital city of Oaxaca de Juárez (Honorable Ayuntamiento Constitucional de San Antonino Castillo Velasco [HACSACV], 2022). See Figure 5.

Figure 5 Macro location of the municipality of San Antonino Castillo Velasco, Oaxaca, Mexico
Source: Adapted from the Municipal Plan for Sustainable Development of San Antonino Castillo Velasco 2022-2024, (HACSACV, 2022, p.26)

In the municipality of San Antonino Castillo Velasco different economic activities are developed, among which agriculture, the production and commercialisation of textile handicrafts and embroidery, and the service sector stand out. According to the Population and Housing Census 2020 of the National Institute of Statistics and Geography (INEGI), 71.9% of the municipal population is employed or has an independent economic activity (HACSACV, 2022).

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It is of utmost importance to highlight that in comparison with the state, which reports 60.4 % of the Economically Active Population (EAP) (INEGI, 2022), the municipality has a higher indicator of 72.3 % of the EAP (HACSACV, 2022), positioning itself above the state average with 11.9 percentage points.

Taking as a reference the data from INEGI's National Statistical Directory of Economic Units 2019, 452 commercial establishments were identified in San Antonino Castillo Velasco with 106 different economic activities, of which fifteen are dedicated to the activity of clothing, embroidery and weaving of textile products, representing 3.31 % of the total (HACSACV, 2022).

However, according to the census carried out by the Artisans' Committee of the municipality, there are approximately 160 textile artisans and around 30 workshops, which shows that the national censuses do not reflect the correct information regarding these aspects.

For many years, mainly the women of the community, have promoted for generations the art of a unique style of embroidery in the state, producing mainly blouses that are currently internationally recognised, this being their typical product that gives them identity (HACSACV, 2022). See Figure 6.

Figure 6 Blouse with embroidery by San Antonino Castillo Velasco
Source: Adapted from the Municipal Plan for Sustainable Development of San Antonino Castillo Velasco 2022-2024, (HACSACV, 2022, p.115)

Method

The approach of this research is qualitative and ethnographic, using the techniques of participant observation and unstructured interviews derived from constant visits to the community, under the premise of obtaining natural and fluid information without any type of alteration or deviation, which allowed us to identify the information necessary to understand the elements that trigger competitiveness in the artisanal sector of San Antonino Castillo Velasco, Oaxaca.

Through documentary research, support was provided on the dimensions, categories and promoting elements of business competitiveness, comparing and discussing different theoretical models and thus contrasting theory and practice in the community under study.

The research is descriptive-explanatory in nature as it seeks to identify the elements that promote the different levels of competitiveness of the artisan sector in San Antonino Castillo Velasco, Oaxaca, Mexico.

It is non-experimental in nature, since by observing the reality in its own context, the categories of the study are not manipulated in any way, and specifically has a cross-sectional design, since the data collection was carried out at a specific moment in time.

Results

After making several diagnostic visits to the municipality, it was observed that the handicraft businesses are very varied in terms of their presentation, size and other physical characteristics that could affect the approach of customers and therefore their level of competitiveness.

From those that only have a printed or painted advertisement, to those that allow the visualisation of some of the products, to a few very colourful and large ones in the main streets of the community. In interviews with municipal authorities, it was mentioned that there are some artisans who sell their products on public streets and that some of them go to the "Baratillo" on Fridays to offer their handicrafts, regardless of whether or not they have a physical establishment.

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The following figures show certain physical differences between the artisan enterprises in San Antonino Castillo Velasco, Oaxaca.

Figure 7 Artisanal enterprise
Source: Own photograph taken during the diagnostic visit on 11 April 2023

Figura 8 Craft enterprise "Atenas".
Source: Own photograph taken during the diagnostic visit on 11 April 2023

Figura 9 Vicky" Handicrafts
Source: Artesanías "Vicky" Bordados De San Antonino Castillo Velasco (2021)

The inequalities between the businesses belonging to the handicraft sector can be visualised graphically in the previous figures, inferring an impact on the customer intimacy dimension of Treacy and Wiersema's (1993) theoretical model of competitiveness.

These disparities reflect variations in brand management, corporate image and identity, and marketing; while in some businesses the customer can see the products from the outside, in others they cannot even imagine the creativity of the crafts on offer.

The interviews conducted with some outstanding artisans in the community revealed elements such as: training for the development of competencies (knowledge, skills and attitudes) in business administration and marketing; the use of social networks and digital sales platforms; the design, management and registration of a brand; participation in fairs and events outside the locality; the application for support from government bodies such as FONART and innovation for product diversification are elements that trigger the so-called competitive advantages according to Michael Porter.

These elements have enabled some companies in the handicraft sector in San Antonino Castillo Velasco Oaxaca to enter not only local but also international markets, exporting their products to countries such as the United States and Japan, increasing their sales, positioning themselves in social networks by using content marketing, increasing their levels of competitiveness compared to other companies in the same sector that do not use these tools and strategies, in contrast to the theoretical dimension of product leadership in Treacy and Wiersema's model (1993).

Some artisans mention that it was as a result of the pandemic that the community experienced a decrease in the number of tourists (who are their main clients), which gave them an impulse to promote their products through social networks, although some businesses maintain constancy and high levels of response in their networks, while others only consider these elements as part of a "fad".

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Undoubtedly, knowledge and its application has led some handicraft businesses to increase their competitiveness to face globalisation, they recognise that it is necessary to generate changes in their processes and products to maintain a place in the market. Innovation is an issue to be highlighted by the artisans, who mention that it is through innovation that they adapt their products to the needs of an increasingly demanding client and with different expectations, validating the blue oceans model, derived from the fact that few artisan businesses in the locality have opened new markets by promoting innovative products. See Figure 10.

Figure 10 Key rings with embroidery from San Antonino Castillo Velasco, Oaxaca, Mexico
Source: Aguja de Plata (2021)

On the other hand, they have identified that production times are decisive for their sales volume and income generation, as some individual garments or products take 6 to 12 months to produce per unit, which is why part of the artisan sector in San Antonino Castillo Velasco, Oaxaca, have decided to work collaboratively, making use of the division of labour, optimising resources, reducing time and increasing their productivity, which in turn has a direct impact on increasing their competitiveness, highlighting the operational excellence of the model of the three disciplines of value.

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Conclusions

The handicraft sector of San Antonino Castillo Velasco Oaxaca, presents inequalities in the form of management of its constituent companies, with repercussions in different levels and manifestations of its competitiveness.

Theoretical and practical contrasts show that internal factors such as business strategy, resource management and the use of communication have a direct impact on competitiveness, as does the analysis of external environments such as the political environment, which provides government funding programmes for the sector, or the technological environment, which provides different tools for business use and which represent opportunities for growth and expansion.

An indisputable element of transcendence within the results of this research was innovation as a mechanism to open markets, to update to the trends and needs of clients and to the understanding of globalisation processes by the handicraft sector of San Antonino Castillo Velasco, Oaxaca.

With regard to the four theoretical models reviewed in this research, the most outstanding with respect to the data obtained are the relationship between practice and the value disciplines model by Treacy and Wiersema (1993) and the blue ocean theory model by Kim and Mauborgne (2005).

It is recommended to carry out more in-depth analysis projects on the Treacy and Wiersema (1993) model, due to the particularities it presents in its dimensions and which may be friendlier to the treatment of businesses belonging to the artisanal sector in order to understand in depth their form of operation, the strategies they implement and their business-customer relationship.

In the same way and equally important, it is suggested to analyse innovation practices and their repercussions on competitiveness and other factors of handicraft businesses, starting from the updating of products that are the result of unique and unrepeatable creative processes.

Finally, it should be noted that the qualitative analysis shows that the handicraft businesses in San Antonino Castillo Velasco, Oaxaca, maintain unequal levels of competitiveness due to various internal and external factors.

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Analysis of the Most Influential Social Networks in Online Shopping in Mexico

Análisis de las Redes Sociales más Influyentes en las Compras en Línea en México

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Abstract

The present study addresses the relationship between the use of social media and consumer purchasing decisions, with the purpose of providing valuable information for entrepreneurs to effectively allocate their resources on relevant social platforms. The focus is based on the Mexican context, with the primary objective of identifying the most influential social networks in purchasing decisions and assessing whether the variable of age plays a significant role in this process. The methodology employed combines a literature review using the Web of Science database with a quantitative analysis of data collected from the National Survey on Availability and Use of Information Technologies in Households (ENDUTIH) conducted by the National Institute of Statistics and Geography (INEGI) for the year 2022. The findings reveal that the social media platforms with the greatest influence on online purchases in Mexico are Instagram, Facebook, WhatsApp, and Twitter. Surprisingly, the study did not find significant evidence supporting the influence of age on online purchasing decisions. These results have significant implications for online marketing and advertising strategies within the Mexican context.

Social networks, Online Shopping, Marketing

Resumen

El presente estudio aborda la relación entre el uso de redes sociales y las decisiones de compra de los consumidores, con el propósito de proporcionar información valiosa para que los empresarios direccionen de manera efectiva sus recursos en las plataformas sociales pertinentes. El enfoque se centra en el contexto mexicano, con el objetivo principal de identificar las redes sociales de mayor influencia en las decisiones de compra y de evaluar si la variable de edad desempeña un papel significativo en este proceso. La metodología utilizada combina una revisión documental en la base de datos de Web of Science con un análisis cuantitativo de los datos recopilados a partir de la Encuesta Nacional sobre Disponibilidad y Uso de Tecnologías de la Información en los Hogares (ENDUTIH) del Instituto Nacional de Estadística y Geografía (INEGI) correspondiente al año 2022. Los hallazgos revelan que las redes sociales con mayor influencia en las compras en línea en México son Instagram, Facebook, WhatsApp y Twitter. Sorprendentemente, el estudio no encontró evidencia significativa que respalde la influencia de la edad en las decisiones de compra en línea. Estos resultados tienen implicaciones importantes para las estrategias de marketing y publicidad en línea en el contexto mexicano.

Redes sociales, Compras en Línea, Marketing

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Introduction

The widespread use of social networks has seen a marked increase in recent years. According to a study conducted in 2020, which was based on a sample of university students in Spain, the amount of time that young people spent daily on social networks in the period between 2016 and 2019 was analysed. The results of this study revealed a noticeable increase in the amount of time young people spent on social networks, and applications of great relevance in this trend were identified, among which WhatsApp, Instagram, YouTube and Twitter stood out (Giraldo-Luque & Fernández-Rovira, 2020). The significant increase in the number of hours people spend on social networks raises the need to investigate how these platforms can influence purchasing decisions, which, in turn, has implications for the strategies and resources that companies allocate to these platforms.

The relationship between purchase intention and the use of social media has generated growing interest among researchers. A relevant example of this trend is found in a study conducted in Nigeria in 2022, which found that social networks play a significant role in influencing online purchase behaviour (Nasidi *et al.*, 2022). Understanding the degree to which a specific social network generates engagement that prompts potential buyers to purchase products becomes essential to effectively target resources based on the influence these platforms exert on purchasing decisions.

In an additional study conducted in a developing country, specifically Saudi Arabia, to reveal the impact of social media marketing activities, it was found that social media marketing activities have a significant influence on customer behaviour. This impact is most prominent when engaging content is presented that resonates with consumers, with a particular emphasis on product personalisation (Bushara *et al*., 2023). Thus highlighting the power of digital marketing through social media for businesses, such as in the case of this study which is the restaurant industry, emphasising the importance of studying this topic.

In particular, social media platforms such as Facebook, YouTube, Twitter, Instagram and WhatsApp have become essential tools for companies' marketing and communication strategies.

These platforms provide an enabling space to increase brand awareness, foster consumer preference and strengthen customer relationships (Lin, 2021). Through the creation of engaging and relevant content, companies can reach mass and diversified audiences, generating brand recognition and recall, (Ibrahim, 2021). Ultimately, the strategic use of these social networks can contribute to business success by influencing consumers' purchasing decisions and strengthening the brand's image and reputation in the marketplace.

In order to determine the main social networks that can influence the purchase decision process, several studies have yielded significant results in different international contexts. In a study conducted in Italy and Slovakia, it was highlighted that the most relevant social networks for this purpose are Facebook, Messenger, Instagram and Twitter (Ali Taha *et al*., 2021). A relevant aspect highlighted in this study is that these social networks have oriented their design towards generating commercial opportunities by having tools specifically designed for advertising and commerce. This orientation towards commerce suggests a high potential to influence users' purchasing decisions.

On the other hand, in the UK, the social networks that have established themselves as the most widely used to reach consumers include Facebook, Twitter, YouTube, Instagram and Pinterest. Among these platforms, Facebook emerges as the most popular, closely followed by Instagram, according to an article published in 2021 (Cao *et al*., 2021). This information highlights the relevance of these social networks in communicating with consumers in the UK context, and highlights the importance of considering their impact on marketing and sales strategies.

The findings of these studies, which cover both the Italian and Slovakian context as well as the UK context, provide significant insight into social networks that can play a prominent role in purchasing decisions, and highlight the importance of understanding how these platforms can influence consumer behaviour in different regions of the world.

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Another relevant study highlights the importance of the user experience when using social media platforms, as this experience can generate a sense of enjoyment. Moreover, these platforms enable the creation of more detailed interactions with products and make it easier for shoppers who have already used a product to add their feedback (Barta *et al*., 2023). This observation underlines how user experience on social media can influence their perception of products and ultimately their purchasing decisions.

A study conducted in Bangladesh, focusing on the impact of social media on online shopping behaviour, found that factors such as celebrity endorsements, promotional tools and online reviews have a positive and significant effect on online shopping behaviour (Miah *et al*., 2022). This finding is highly relevant, as it highlights that it is not enough to simply have a presence on social media; it is equally important to manage them properly in order to positively impact potential buyers and leverage the potential that these platforms offer in the buying process.

In relation to the influence that social networks can have on repurchase intention, a study has identified that, in the context of young individuals, these platforms contribute to an increase in online repurchase intention through a phenomenon referred to as "eWOM" (electronic word of mouth). This term refers to interactions comprising opinions, comments, recommendations and experiences expressed by customers on websites and/or social media profiles associated with brands (Müller-Pérez *et al*., 2023). This suggests that business owners should pay special attention to this type of content on their social media platforms in order to retain customer loyalty.

In light of the above, the central question of this study arises: which social networks play a key role in online shopping in the Mexican context? To address this question, the National Survey on the Availability and Use of Information Technologies in Households (ENDUTIH) for the year 2022, developed by the National Institute of Statistics and Geography (INEGI), was used (INEGI, 2023). This survey stands as a valuable source of data that allows us to explore the dynamics between social networks and online purchasing decisions in the specific context of Mexico.

With the above, the main objective is to identify the main social networks that influence online purchasing decisions in Mexico.

Description of subsequent sections:

– Method: This section details the hypotheses formulated based on the research carried out on the Web of Science platform. It also presents the linear regression model used in the analysis and provides a description of the variables used in the study.

– Results: This part of the study presents the results derived from the linear regression analysis, includes a graphical representation by means of a heat plot, and reports on the hypotheses that were corroborated and the one that was refuted in the process.

– Conclusions: This section is devoted to the development of conclusions based on the results obtained in the previous section. It focuses specifically on the social networks identified as the main influences on online shopping.

Method

To carry out the quantitative analysis, the database generated by the National Institute of Statistics and Geography (INEGI) was used, which was based on the National Survey on the Availability and Use of Information Technologies in Households (ENDUTIH) for the year 2022 (INEGI, 2023). In a first step, data cleaning was carried out using SQL language, with the aim of creating a cleaned database that would serve as a basis for subsequent evaluations. In total, 58,540 records were counted at the end of this cleaning phase.

For the qualitative analysis and to generate the hypotheses, a literature review was carried out in Web of Science and the following hypotheses were developed:

Hypothesis 1 (H1): Age Significantly Impacts Online Item Purchasing. This research proposes Hypothesis 1 (H1) in order to examine whether age has a significant impact on online purchasing decisions.

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This hypothesis is supported by evidence provided by a previous study conducted in Hungary, where a significant relationship between age and purchases through the Facebook platform was observed. Specifically, this study identified a striking difference in purchasing patterns between younger consumers and those in the 50+ age group (Fekete-Farkas *et al*., 2021).

Hypothesis 2 (H2): Facebook Exerts a Significant Impact on Online Shopping for Items This hypothesis focuses on whether the Facebook platform exerts a significant impact on online item purchase decisions. The rationale for this hypothesis is based on a study conducted in hotels in Turkey, which examined the relationship between brand loyalty and social media activities, specifically Facebook pages. The aforementioned study yielded results that highlight Facebook as a platform with a substantial influence on purchase intention. Furthermore, it was identified that this influence is significantly linked to the number of page followers and other factors associated with brand loyalty (Ibrahim, 2021).

Hypothesis 3 (H3): Twitter Exerts a Significant Impact on Online Shopping for Items. We seek to assess whether the Twitter platform exerts a significant impact on online item purchase decisions. This hypothesis is supported by Twitter's notorious relevance as one of the most widely used and popular microblogs worldwide, what differentiates Twitter and underpins this hypothesis is its focus on encouraging advance purchases and special offer promotions (Juntunen *et al.,* 2020); which could be conducive to influencing online purchasing decisions.

Hypothesis 4 (H4): Instagram Exerts a Significant Impact on Online Shopping of Items Aims to investigate whether the Instagram platform significantly influences online product purchase decisions. This hypothesis finds support in a research paper conducted in South Africa, which identified a positive and significant relationship between Instagram users' salient behaviour and their intention to purchase luxury goods. This inclination is associated with the need to show their position in the social hierarchy or to achieve a higher social status (Madzunya *et al*., 2021).

Hypothesis 5 (H5): WhatsApp Exerts a Significant Impact on Online Shopping of Items It aims to find out whether the WhatsApp platform possesses a significant influence on online product purchase decisions. This hypothesis is underpinned by the widely held belief that, due to its widespread popularity and pervasive use, WhatsApp has the potential to exert a prominent impact on the online item purchase process (Ebrahimi *et al*., 2021; Miah *et al*., 2022).

Hypothesis 6 (H6): YouTube, Pinterest, Messenger and TikTok Have an Insignificant Impact on Online Item Purchases This hypothesis is based on the absence of these platforms in the most widely recognised and discussed set of social networks in the academic literature and selected for this study, (Al Hamli & Sobaih, 2023; Ali Taha *et al*., 2021; Nasidi ***et al***., 2022).

Figure 1 shows the relationship of the dependent variable "Online shopping", and the independent variables, the use of the analysed social networks.

Figure 1 Relationship between the dependent variable and the independent variables
Own Elaboration with data from the model

A binary linear regression analysis was then carried out using Gretl software to generalise the data into a single model. In this analysis, online shopping was designated as the dependent variable, which asks about online shopping in the last 12 months. In addition, respondents' age and their use of different social networks were used as independent variables, shown in Figure 1.

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The theoretical equation of the simple logit model is represented as:

$Ho{:}\beta i{=}0$

$H_1{:}\beta_i{\neq}0$

$$P(X) = \underset{1}{\mathrm{P}}(\mathrm{Y} = 1/X_1, X_2, \ldots..X_9 = \frac{}{1+e^{-(\beta_0+\beta_1 X_1+\cdots+\beta_9 X_9)}}$$

The variables are described in Table 1 below

Variable	Descripción
Online shopping (Y)	Defines whether the respondent has purchased items online in the last twelve months (during the year 2022). It is the dependent variable and is of binary type, with values of made online purchases = 1 and did not make online purchases = 0.
Age (X_1)	Defines the age of the respondent, in whole numbers. It is an independent variable.
Facebook (X_2)	Defines whether the respondent uses Facebook. It is an independent variable and of binary type with values of Yes uses Facebook = 1 and No uses Facebook. = 0
Twitter (X_3)	Defines whether the respondent uses Twitter. It is an independent variable and of binary type with values of Yes uses Twitter = 1 and No uses Twitter. = 0
Instagram (X_4)	Defines whether the respondent uses Instagram. It is an independent variable and of binary type with values of Yes uses Instagram = 1 and No uses Instagram. = 0
WhatsApp (X_5)	Defines whether the respondent uses WhatsApp. It is an independent variable and of binary type with values of If using WhatsApp = 1 and Not using WhatsApp. = 0
YouTube (X_6)	Defines whether the respondent uses YouTube. It is an independent variable and of binary type with values of Yes uses YouTube = 1 and No uses YouTube. = 0
Pinterest (X_7)	Defines whether the respondent uses Pinterest. It is an independent variable and of binary type with values of Yes uses Pinterest = 1 and No uses Pinterest. = 0
Messenger (X_8)	Defines whether the respondent uses Messenger. It is an independent variable and of binary type with values of If using Messenger = 1 and Do not use Messenger. = 0
TikTok (X_9)	Defines whether the respondent uses TikTok. It is an independent variable and of binary type with values of Yes uses TikTok = 1 and No uses TikTok. = 0

Table 1 Description of the variables used in the linear regression
Source: Own Elaboration with data from the model

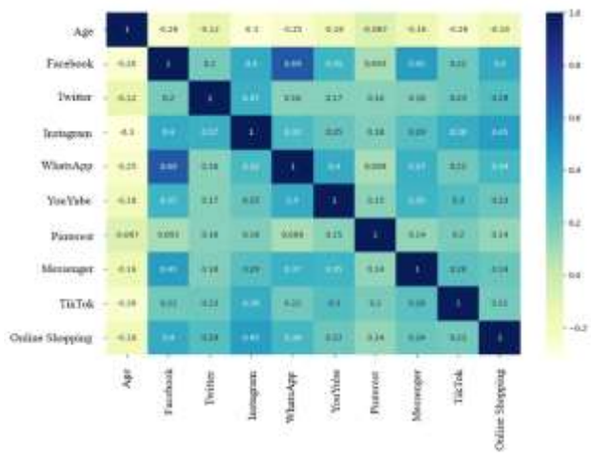
Results

The results of the linear regression are shown in Table 2.

Variable	Coef. (B)	Standard error	Z	p- value	
Constant	-3.497	0.044	-78.49	0.000	***
Age	-0.001	0.001	-1.58	0.113	
Facebook	1.457	0.043	33.96	8.91e-253	***
Twitter	1.012	0.043	23.44	1.51e-121	***
Instagram	1.344	0.028	48.85	0.000	***
WhatsApp	0.964	0.046	21.10	8.7e-099	***
YouTube	0.219	0.025	8.65	5.7e-018	***
Pinterest	0.555	0.081	6.83	8.7e-012	***
Messenger	-0.017	0.026	-0.67	0.5003	
TikTok	-0.004	0.035	-0.12	0.904	
Log-Likelihood -24135.28					
Goodness of fit of the model					
Chi-square = 17291.6					
Significant at 5%, ***					

Table 2 Predictive Logit Model, Dependent variable: Online shopping
Source: Own Elaboration with data from the model

It is relevant to mention that, in addition to the regression analysis, a heat graph was elaborated using the Python programming language, using the same variables that were the object of study in the linear regression. This heat graph allowed us to visualise the correlation between the variables and provided a graphical representation of the interaction between them, Graph 1.



Graph Heat plot of the variables used
Source: Own elaboration with data from the model

In the heat graph analysis we sought to identify the variable that most influences respondents' online purchases in 2022 according to information from the ENDUTIH survey (INEGI, 2023).

In this context, the strong variable was whether the respondent has made online purchases in the last year. Within this variable, the following sub-variables were highlighted with their respective most significant values:

– Instagram with a value of 0.45.
– Facebook with a value of 0.40
– WhatsApp with a value of 0.34
– Twitter with a value of 0.29

These values indicate the degree of influence of each of these platforms on the online purchases made by respondents.

In addition to the above analysis, the relationship between the age of the respondents and their online shopping habits was assessed. Surprisingly, age was found to have a limited influence in this context, as can be seen in the graph, as it presents the lowest values in terms of influence on online shopping.

The results of the linear regression analysis indicated that the following independent variables have a significant weight on online shopping, according to their coefficients in the corresponding column:

– Facebook with a coefficient of 1.46.
– Instagram with a coefficient of 1.34.
– Twitter with a coefficient of 1.01.
– WhatsApp with a coefficient of 0.96.

It is important to note that the p-value associated with these variables was less than 0.05, indicating that they are statistically significant in the online shopping analysis. On the other hand, the age variable did not show statistical significance in this analysis.

With the data obtained, the following results were obtained in accordance with the hypotheses proposed:

Hypothesis 1 (H1): Age Significantly Impacts Online Item Purchasing.

Hypothesis H1 is rejected. Despite the initial belief that age could influence online purchases (Fekete-Farkas *et al.*, 2021), data analysis reveals that age has a negligible impact on online purchase decisions.

This result contradicts expectations and suggests that other factors, such as social networks, may have a much more significant influence on online shopping behaviour.

Hypothesis 2 (H2): Facebook Exerts a Significant Impact on Online Item Purchases

Hypothesis H2 is confirmed. The results of the logistic regression analysis indicate that Facebook exerts a significant impact on online purchasing decisions, with a coefficient of 1.46. This supports the idea that Facebook plays a relevant role in respondents' online shopping behaviour.

Hypothesis 3 (H3): Twitter Exerts a Significant Impact on Online Item Purchases

Hypothesis H3 is confirmed. The results suggest that Twitter has a significant impact on online shopping, with a coefficient of 1.01. This supports the hypothesis that Twitter influences online shopping decisions, especially due to its focus on encouraging advance purchases and special offers(Juntunen et al., 2020).

Hypothesis 4 (H4): Instagram Has a Significant Impact on Online Shopping of Goods

Hypothesis H4 is confirmed. The analysis supports the idea that Instagram exerts a significant impact on online purchase decisions, with a coefficient of 1.34. This suggests that Instagram influences respondents' online shopping behaviour, especially in the context of luxury products (Nguyen et al., 2022).

Hypothesis 5 (H5): WhatsApp Exerts a Significant Impact on Online Shopping of Items

Hypothesis H5 is confirmed. The results indicate that WhatsApp has a significant impact on online shopping, with a coefficient of 0.96. This supports the idea that WhatsApp influences online shopping decisions due to its widespread popularity and widespread use (Ebrahimi *et al*., 2021; Miah *et al*., 2022).

Hypothesis 6 (H6): YouTube, Pinterest, Messenger and TikTok Have an Insignificant Impact on Online Shopping for Items

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Hypothesis H6 is confirmed. YouTube, Pinterest, Messenger and TikTok platforms have a negligible impact on online shopping, according to the results of the analysis. This suggests that these social networks have limited influence on respondents' online shopping decisions compared to the previously mentioned platforms.

Conclusions

The analyses conducted within the framework of this research, which include heat graph and logistic regression analysis, provide substantial evidence on the main social networks that influence respondents' online shopping behaviour in 2022, according to data obtained from the ENDUTIH survey (INEGI, 2023). Important findings related to the influence of age on online purchasing decisions also emerge.

Firstly, it has been identified that the most prominent social networks in their influence on online shopping are Instagram, Facebook, Twitter and WhatsApp. These platforms have been shown to have a significant impact on online purchasing decisions, as evidenced by the coefficients obtained through logistic regression analysis. Specifically, it is highlighted that the independent variables Facebook, Instagram, Twitter and WhatsApp have a significant weight on online shopping, with coefficients indicating their positive influence on respondents' online shopping behaviour.

In contrast, the hypothesis that age plays a significant role in online shopping has been rejected. Although this factor was initially analysed as a potentially influential variable, the results of the analysis indicate that its impact on online shopping is insignificant compared to the effect of the social networks mentioned above.

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Quality Control System for the Tomato Release Process produced in Greenhouse

Sistema de Control de Calidad para el Proceso de Liberación de Jitomate producido en Invernadero

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Abstract

Quality control is considered a primary feature to determine the commercial value of the tomato (*Lycopersicon escultelum*) and the acceptability of the product by the customer, this based on standards and parameters that guarantee a high level of quality of the tomato accepted in the process of releasing it and affirm customer confidence. This project was carried out in an agro-producing and marketing company of tomato produced in a greenhouse in the Region of Tehuacán, Puebla, Mexico, and proposes a quality control system in the tomato release process through an analysis and study of the physical and chemical attributes of the fruit that is entered into the company, to subsequently assign a quality according to the behavior of the fruit, The quality of the tomato is based mainly on the uniformity of the shape and the absence of growth and handling defects present in the fruit. Size, although not a factor that defines the degree of quality, usually has an important influence on the expectations of its commercial quality.

Tomato, Greenhouse, Quality Control

Resumen

El control de la calidad se considera una característica primordial para determinar el valor comercial del jitomate o tomate (*Lycopersicon escultelum*) y la aceptabilidad del producto por parte del cliente, esto basado en estándares y parámetros que garanticen un alto nivel de calidad del jitomate aceptado en el proceso de liberación del mismo y afirme la confianza del cliente. El presente proyecto se realizó en una empresa agroproductora y comercializadora de jitomate producido en invernadero de la Región de Tehuacán, Puebla, México, y propone un sistema de control de la calidad en el proceso de liberación del jitomate mediante un análisis y estudio de los atributos físicos y químicos del fruto que es ingresado en la empresa, para posteriormente asignarle una calidad de acuerdo al comportamiento de la fruta, La calidad del tomate se basa principalmente en la uniformidad de la forma y en la ausencia de defectos de crecimiento y de manejo presentes en la fruta. El tamaño, aunque no es un factor que defina el grado de calidad, suele influir de manera importante en las expectativas de su calidad comercial.

Jitomate, Invernadero, Control de Calidad

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Introduction

The tomato (*Lycopersicon escultelum*) is a fruit belonging to the Solanaceae family, its origin dates back to the Low Andes, however, it was cultivated and domesticated by the Aztecs in Mexico.

The tomato (red tomato) has a thick, pubescent, long stem. It has a deep, pivoting root system with little branching. The main stem is formed by secondary stems composed of epidermis with glandular hairs, bark, vascular cylinder and medullary tissue, so the plant is not self-supporting and the use of tutors is necessary for its support. The flowers are grouped in racemose inflorescence or racemose cymes (SADER, 2023).

Fruits such as Saladette tomatoes are physiologically defined as climacteric fruits due to the presence of increased respiration and ethylene synthesis at the onset of eating maturity. As part of their natural ripening process, climacteric fruits continue to ripen after harvesting.

Tomato is one of the most consumed vegetables worldwide, of which there are many types of varieties, each of which satisfies a particular demand. Among the varieties we can find the following:

– **Saladette or Roma type tomato**

It is characterised by its oval shape and abundant pulp. It can be cultivated in the open air and under protected conditions, in the open air varieties with determinate growth are cultivated, while under protected conditions indeterminate varieties are chosen.

– **Ball or Round Tomato**

It is a large, round tomato with a lot of pulp. It reaches diameters between 5.4 and 9 cm. Internationally, it is a tomato in high demand. It can be presented in bunches of four or five fruits, although the latter is more complex to produce.

– **Cherri or Cherry tomato**

It is characterised by a high sugar content and the fruit diameters fluctuate between 2 to 3.5 cm. It is generally harvested one by one and in clusters (TOV Cherry). The fruits are red or yellow in colour.

– **Cocktail tomato**

It is a variety considered gourmet and its main destination is salads. It is characterised by being round or pear-shaped, with a diameter between 3,5 and 4,5 cm.

– **Grape tomato or Uvalina**

The grape tomato has the shape and size of a large grape. The taste is similar to that of the cherry tomato, but with its own unique nuances. It is usually harvested in bunches and is approximately 1" long by 3/4" wide. The grape tomato is a hybrid, with a good leaf cover and a sweet flavour.

– **Heirloom Tomato**

Also known as "Heirloom Tomato". It is an ancestral variety characterised by its vine-like appearance and diversity of colours and sizes. It is very sensitive to diseases and has a short life once harvested. In Spain there is a subtype of this variety known as Raf tomato. Its fruit is multilocular, fleshy, ribbed and small-seeded, with a marked green neck that distinguishes it, very fleshy and with a high dry matter percentage (it does not release liquid when cut) (I. Agrónomo 2022).

Main quality parameters for tomatoes

The environmental efficiency of agricultural production and the relationship between the type of management and the monetary value of achieving environmental efficiency are important parameters for assessing the competitiveness of farms (Turkten, H. and Ceyhan, Van, 2023) as is the case in greenhouse tomato production.

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With regard to fruit quality, one should not only think of fruit with a homogeneous appearance, without damage, with a long shelf life, one should look for the quality that consumers demand in fruit, i.e. those quality factors that they perceive through their senses, those that make up the organoleptic quality such as flavour (sugar content, acid content), firmness, colour (external and internal) and aroma (FAO, 2023).

Tomato cultivation in greenhouse structures is becoming increasingly common as a crop production system. However, environmental conditions inside a greenhouse favour the development of microbial diseases (Ally, N.M., Neetoo, H., Ranghoo-Sanmukhiya, V.M., and Coutinho T. A., 2023) so good cultivation practices should prevail.

The quality level of tomato is evaluated by external aspects and technical factors, in which the ripening stage of the fruit is paramount to achieve good fruit quality.

– **Tomato colour**

Colour is a sensory attribute that can be appreciated through the physical sense of sight. The shade of the tomato influences the customer's perception of quality, because customers associate a nice and bright intense colour with a high quality tomato, showing a preference for those fruits in which the appearance is attractive. Lycopene is a carotenoid with a simple structure with an aliphatic chain consisting of forty carbon atoms, lycopene is the pigment that gives tomatoes their characteristic colour. Colour is particularly important for tomatoes destined for industry, and the red must be a deep, uniform red free of defects such as cracks or bumps. Colour measurement serves as a quality control tool, as it determines maturity and post-harvest life, and is the determining factor in terms of customer acceptability (FAO, 2023).

– **Firmness**

Firmness is one of the physicochemical parameters that best relates to the degree of ripeness of the fruit, it is a parameter indicative of the quality of tomatoes that is related to the structure of the cell wall and the state of maturity, its determination is essential for storage and acceptability.

The firmness is the perception of the fruit to the touch, it depends on the turgidity, cohesion, shape and size of the cells that form the cell wall, the ripeness stage, the type and variety of tomato classified from Very Firm (fruits that do not yield to considerable pressure), Firm (fruits that yield only gently to considerable pressure), Soft (fruits that yield to moderate pressure), up to Very Soft (fruits that yield very easily to gentle pressure).

The fruit loses firmness due to physical and chemical changes that are associated with the degradation of the cell wall and the solubilisation of pectins by the enzymes pectinase, polygalacturonase and pectalolyses. The softening or loss of firmness of the fruit is caused by the cumulative effect of a series of modifications that occur in the polymer networks that constitute the primary cell wall. Fruit softening is a complex process that involves three subsequent steps: 1) cell wall relaxation mediated by expansins; 2) depolymerisation of hemicelluloses; and 3) depolymerisation of polyuronides by polygalacturonase or other enzymes; this is why there is a loss of firmness and changes in texture quality (Díaz F.R, Juárez L., Ruiz K. 2014).

Modifications in cell wall polymers during softening are complicated and are considered to involve a coordinated and interdependent action of a range of cell wall modifying enzymes and proteins such as polygalacturonase, pectinmethylesterase, β-galactosidase, xyloglucan endotransglycosylase and expansins (Díaz F.R., Juárez L., Ruiz K. 2014).

Firmness changes as fruits ripen and become softer, its measurement is used as a sensory quality parameter to measure texture. Regarding the measurement of fruit strength, there are different measurement techniques, based on mechanical properties such as penetration, compression, puncture, deformation, controlled impact, etc. (Grupo SPE3, S.L. 2022).

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– **Size/weight**

Although size is not a factor that defines the quality grade of fruits, it can have an important influence on the expectations of their commercial quality. This is due to the fact that depending on the weight of the fruit, the size or calibre of the fruit determines the different qualities: excellent fruit, medium quality fruit, low quality fruit. The size of the tomato varies and according to the weight, the size of the fruit is determined (FAO, 2023).

– **Proper development and maturity**

During development, the fruit incorporates photoassimilates, minerals and water. The most important factor determining the final size of the fruit is the incorporation of water. There is a gain of different nutrients over time, but the most significant gain for fruit size is the gain in water. Water content marks the difference in size between different fruits of the same plant (Lobos M. and Fierro M., 2019).

– **Absence of defects**

Good appearance is the most important component for customer acceptance. Shape is one of the most easily perceptible subcomponents. In some cases, shape is an indicator of maturity and therefore of taste. This parameter is essential to determine a good quality in fruits because defects are often rejected as a consequence of customer perception, which relates a good appearance with an optimal quality, showing preference for those fruits in which the appearance is good (FAO, 2023).

– **TSS or Brix content**

The sweetness of the fruit is the result of the content of Total Soluble Sugars (TSS) such as sucrose, sorbitol, glucose and fructose. More than one type of sugar may be present in the fruit. TSS content is an important quality parameter, as sweetness has an impact on taste and therefore on the consumer's purchasing decision. It is used as a quality parameter for all fruits, climacteric and non-climacteric. In climacteric fruits, starch is converted into sugars during ripening due to ethylene (C_2H_4). In this case, TSS indicate maturity.

TSS are used as maturity indicators for non-climacteric fruits that do not ripen further after harvest. In these fruits there is no starch reserve; sugars accumulate as a result of ripening and are the major component of DM. In stone fruits such as plums, peaches and nectarines, DM and TSS are closely correlated. In these cases, DM can be used as an index of maturity. TSS is measured as °Brix, where 1°Brix is equal to 1 g sucrose equivalents per 100 g solution.

After harvest, TSS is also used as a quality parameter for fruit grading and pricing. The TSS content allows to monitor the quality of stored fruit for sales decisions.

The conventional method for measuring TSS uses a refractometer and is destructive, laborious and time-consuming. Non-destructive measurement with near infrared spectroscopy (NIRS) instruments allows for the repeated estimates needed in precision horticulture (Grupo SPE3, S.L. 2022).

– **pH**

The most subjective method to determine the degree of ripeness of the fruit is its pH, a numerical index used to express the degree of acidity or alkalinity of a solution. The determination of the pH is determined by taking samples of the tomato juice and is measured using a previously calibrated potentiometer capable of reproducing pH values. For a perfectly ripe tomato the optimum pH is approximately below 4.6, the pH in a tomato should be between 4.0 and 4.5. Tomatoes tend to become less acidic as they ripen, so they are harvested until they are slightly ripe, in order to reach the right maturity (Díaz F.R, Juárez L., Ruiz K. 2014).

– **Defects**

Defects in tomatoes are one of the main causes of a decrease in the quality level of tomatoes. They are an alteration caused by factors inherent to the development of the fruit, they can be mechanical, climatic or by external agents, which compromise the appearance or quality of the tomato.

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– **Damage due to manipulation**

This type of defect is caused when tomatoes are not harvested on the plant with a smooth rotary movement, and due to inadequate handling can cause defects or a decrease in the quality level of the tomato (Clarifruit, 2021).

– **Dehydration**

When the tomato plant receives insufficient or too much irrigation, it may develop yellow leaves or have a wilted appearance. This can cause damage to the fruit, such as wrinkled skin caused by dehydration, or cracked skin caused by overwatering (Clarifruit, 2021).

– **Pests**

Due to infestation by various insects and worms, which can cause damage to tomato plants, damage can occur from the roots to the fruit (Clarifruit, 2021).

– **Skin defects**

Tomatoes can show a multitude of skin defects, such as cracks, scars, healed wounds, pale colour, green edges, brown spot, green shoulder, etc. These types of defects affect the appearance of the tomato and therefore affect the quality of the fruit (Clarifruit, 2021).

– **Bruising**

Bruising can occur from harvesting to post-harvest handling, however, during the highest stage of ripening the fruit is more susceptible to this type of defects, because the riper the fruit is, the lower the quality decreases due to the loss of its qualities (Clarifruit, 2021).

– **Open wounds**

This type of defect may occur during the growing process or due to improper handling of the fruit, which may cause cracks or wounds in the fruit causing water loss or black mould (Clarifruit 2021).

– **Rot**

Rot can come from various sources, such as lack of calcium balance in the tomato tissue causing a certain area of the tomato to turn dark brown or leathery leading to mould (Clarifruit 2021).

The applicable standard for the handling of tomatoes for marketing is NMX-FF-031-1997SCFI NON-INDUSTRIALISED FOODSTUFFS FOR HUMAN CONSUMPTION-FRESH VEGETABLES-TOMATO. This standard establishes the minimum quality specifications to be met by tomatoes of the Solanaceae family, in all their varieties, to be consumed fresh and marketed after preparation and packaging.

Quality control is crucial to ensure that finished products meet the requirements and standards specified in a manufacturing or production context. A key area where quality control is essential is sorting and separating goods on a conveyor belt (Kamanli, A.F., 2023), such as that used in the tomato release process.

This paper presents a proposal for a quality control system in the tomato release process for a primary vegetable production unit in the Tehuacán region dedicated to the cultivation and marketing of tomatoes in greenhouses. Given that tomato is a fruit susceptible to changes in its morphology due to different factors, after a good harvest management, it is necessary to continue with a correct handling of the fruits to avoid physical damage due to impact, compression, cuts, bruises, storage temperature, among others, This affects the acceptance of the product and its positioning in the marketing chain, for which the quality control in the process of releasing the tomato takes special relevance, where it is assigned according to the characteristics and behaviour of the fruit, the final quality of the product with which it will be marketed.

Methodology

The research is of type Applied Technological for having the purpose of generating a proposal that improves its System of Quality Control in its current process of liberation of the Tomato, for which the following methodology was applied:

- Study of the release process applied in the company
- Selection of the main tomato producers that participate in the company to apply the evaluation of the Quality Control System for the process of releasing the fruit.
- Selection of the predominant tomato varieties of the selected producers.
- Identification of the parameters to determine the quality of the tomato used in the company.
- Development of the Quality Control System proposal for the tomato release process.

Analysis of results

The company under study is a producer and marketer of tomato produced in greenhouses that works with 21 producers in the region, of which the 3 producers with the greatest impact on the marketer were selected by the volume of product entered. Vibranio and Pai Pai were identified as the main varieties marketed.

The tomato quality parameters used in the company to assign the quality are the determination of firmness, the maturity index (by determining the colour), the presence of defects. It is important for the company under study to have a method that allows them to standardize the evaluation and allocation of the quality of the fruit to be marketed regardless of the different producers involved in the marketing section of the fruit, for which it is required to monitor the behaviour of the fruit by studying control samples at entry, at 8 days and 15 days, evaluating the types of defects and the predominant sizes that each producer presents.

Identification of defects

Among the main defects identified in the fruit entering the marketing and that are most likely to affect the quality of tomatoes throughout the supply chain are those described in Table 1.

Nomenclature to identify the main defects of tomatoes			
CS	**DC**	**DH**	**GS**
Dry Chalice	Damage in Coronilla	Frost damage	Sun Stroke
GO O MA	**IH**	**MC**	**LL**
Knock or Bruising	Incidence of fungus	Brown Stain	Sore
PA	**PD**	**VE**	**MV**
Clowning	Damaged Tip	Green	Greenish Spot
PG	**RT**	**MO**	**PC**
Grey Wall	Russeting minimal (cracking)	Dark Spot	Brown spots

Table 1 Nomenclature of the main defects in tomatoes

Quality Control System for the Tomato Release Process

In order to develop the proposal for a Quality Control System for the tomato release process, we started from what was initially used successfully in the company, making some modifications to complement the evaluation method.

- **Raw material evaluation**

The evaluation of the raw material begins with a series of primary inspections carried out on the fruit when it enters the marketing company, where the physical characteristics of the fruit are evaluated and the defects, sizes and significant shades of the producers are identified in order to later evaluate the yield and percentage of defects.

The tomato evaluation method is based on the standard NMX-FF-031-1997-SCFI Non-Industrialised Food Products for Human Consumption - Fresh Vegetables - Tomato - (lycopersicun esculentum mill.) - Specifications, as well as on the internal knowledge that is managed in the company.

For the identification and classification of tomato shades, Table 2 is used

Tone image:							
Description:	Green	Broken	Striped	Salmon	Orange	Red Orange	Red
Criteria	100% green tomato, which may vary from light to dark	Green to light yellow, pink or red tipped by more than 10%.	Light yellow green, pink, red or a combination of 10-30 %.	Between 30%-60% of the surface shows light pink colour	Higher concentration of red tones	Between 60-90% appears pink or red	More than 90% of the tomato surface with pink/red colours

Table 2 Shades for Saladette

– **Firmness**

For the determination of the firmness, the perception of the fruit to the touch is used, i.e. according to the touch, the firmness level of the fruit is classified according to table 3.

number	Observation
1	Very firm
2	Firm
3	Soft
4	Very gentle

Table 3 Classification of firmness levels

– **Weight and sizes**

The size of the tomato varies in direct relation to its weight, for its determination the weight/size ratio shown in Table 4 is used.

Sizes of the Saladette		
Size	**Key**	**Weight grams**
Marble	C	20-40
Third	T	45-70
Small	S	70-85
Medium	M	85-96
Long	L	96-120
Extra long	XL	120-145
Jumbo	J	140-200

Table 4 Sizes of the Saladette

Figure 1 Sizes of Saladette Tomatoes

– **Quality traffic light**

This system allows to classify and assign the quality for which each product that enters the company is destined, thus facilitating the release of raw material and determining the packaging process that each producer's fruit must have. It is updated every week, which allows to have a record of the history of the behaviour of the fruit. An example of the use of the quality traffic light is shown in Table 5.

Quality traffic light							
High presentations							
Excelnt	Producer	Variety	Zone	Specification	All Destinations	Destination MP1	Destination MP2
	Producer A	Vibranium	1	Packing in Tone 1.5	X		
	Producer B		2				
Media	Medium-sized presentations						
	Producer C	Vibranio	3	Packing in Tone 2		X	X
	Producer D		4				
National	Rescued						
	Producer E	Vibranio	5	Clowning closure from 5 to 7			
	Producer F		6				
Signature	General changes						

Table 5 Quality traffic light

Figure 1 Collection of control samples from the producer under study

The control samples taken from the producer's batch are placed in trays, which are labelled for identification, and the samples are then identified by separating the defects from the good samples. Figures 1 and 2 show an example of taking a control sample from a producer under study and its identification, respectively.

Figure 2 Identification of control sample

Complementary evaluations

– **Determination of the length of the tomato in the control samples.**

For the determination of this parameter, a vernier was used to measure the length and width of the fruit, taking into consideration the defects and the good tomatoes, which were measured twice, on the day of entry and on day 8, to evaluate the differences that exist between one day and the other.

– **Determination of pH**

For the determination of pH, two pH readings are taken, the first corresponds to the initial reading, for which a representative homogenised sample of 6 fruits is prepared, for which the skin of the tomato is removed and the placenta (where the seed is located) is removed. Subsequently, 10 g of tomato pulp is weighed and liquefied with the pulp with 20 mL of distilled water and the mixture obtained is filtered with filter paper or sky blanket. Once the filtrate has been obtained, the pH reading is taken with measuring strips or a potentiometer. The second measurement corresponds to the evaluation of the pH of the fruit after 8 days of its entry.

– **Determination of the Brix degrees**

To determine the Brix degrees, two readings are made, the first corresponds to the initial reading, in which 6 random samples taken directly from the producer's lots are selected, the Brix degrees are determined to the samples, then after 8 days after their entry, the second reading is taken to the control samples that were taken for study and observation.

Conclusions

Within the Mexican agricultural sector, tomato cultivation has an important place among the vegetables grown under greenhouse conditions, which offer advantages of control against adverse weather conditions and the presence of pests and/or diseases that limit their production and productivity compared to open-air growing conditions.

The investment in greenhouses is justified by the increase in yields, the obtaining of higher quality fruit and the possibility of obtaining several harvests per year.

For marketing, a key step is the Quality Control System for the release process of tomatoes produced in greenhouses, which allows evaluating the characteristics of Shades, Firmness, Size/Weight, Development and Maturity, Absence of Defects (dry calyx, crown damage, frost damage, etc.), damage to crown, frost damage, sun damage, bruising, fungus incidence, brown spot, sores, clowning, tip damage, green, green spot, greenish spot, grey wall, cracking, dark spot and brown spots), TSS or Brix content and pH.

Having a good organisation and Quality Control in the Agro-production and Marketing Company of tomatoes produced in greenhouses in the region of Tehuacán, Puebla, allows the product to be released with quality standards for export and national markets. The company must continue with its good agricultural practices and food safety and security programmes, which contribute to the final quality of the fruit.

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Gender wage gap in the formal and informal sector in the COVID-19 crisis period, of the national labor market and the state of Coahuila

Brecha salarial por género en el sector formal e informal en el periodo de crisis COVID-19, del mercado laboral nacional y del estado de Coahuila

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Abstract

One of the Sustainable Development Goals of the 2015-2030 agenda establishes guaranteeing equal remuneration between women and men for work of equal value. This objective is taken up in the 2018-2024 nation project for Mexico. In the project, the Federal Government aims to eliminate inequality gaps between women and men, as well as the obstacles that women face in all areas. The objective of this research is to estimate the Gender Wage Gap in the formal and informal sector of the labor market of the country and the state of Coahuila in the period of the COVID-19 crisis, to observe the trend of wage differences in the period 2019 – 2022. Mincerian wage equations (1974) were estimated for each gender with data from the National Occupation and Employment Survey (ENOE), for subordinate workers. The variables considered the sector in which the employee works and the condition of the working day. The Gender Wage Gap was estimated using the Blinder and Oaxaca (1973) methodology, with selection bias correction (Heckman, 1979). It was observed that the Gender Wage Gap in the context of crisis generally tended to close, this was because in the formal and informal sector the salary difference for women tended to decrease in 2020, while in 2022, during the economic recovery the Gender Wage Gap returned to the parameters of 2019 both nationally and in the state of Coahuila.

Wage Gap, Formal and Informal Sector, Crisis Periods

Resumen

Uno de los Objetivos de Desarrollo Sostenible de la agenda 2015-2030 establece garantizar la igualdad de remuneraciones entre mujeres y hombres por un trabajo de igual valor, dicho objetivo se retoma en el proyecto de nación 2018-2024 para México. En el proyecto el Gobierno Federal se propone eliminar las brechas de desigualdad entre mujeres y hombres, así como los obstáculos que enfrentan las mujeres en todos los ámbitos. El objetivo de esta investigación es estimar la Brecha Salarial por Género en el sector formal e informal del mercado laboral del país y del estado de Coahuila en el periodo de crisis COVID-19, para observar la tendencia de las diferencias salariales del periodo 2019 – 2022. Se estimaron ecuaciones salariales mincerianas (1974) para cada género con datos de la Encuesta Nacional de Ocupación y Empleo (ENOE), para trabajadores subordinados. En las variables se consideró el sector en el que labora el empleado y la condición de la jornada laboral. Se observó que la Brecha Salarial por Género en contexto de crisis en general tendió a cerrarse, esto se debió a que en el sector formal e informal la diferencia salarial para las mujeres tendió a disminuir en el año 2020, mientras que en el año 2022, durante la recuperación económica la BSG regresó a los parametros del año 2019 tanto a nivel nacional y en el estado de Coahuila.

Brecha Salarial por Género, Sector Formal e Informal, Periodos de Crisis

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1. Introduction

The Sustainable Development Goals (SDGs) of the 2015-2030 agenda, also called Global Goals, set out goals covering the economic, social and environmental spheres, where the fifth goal proposes to achieve gender equality and empower all women and girls, The fifth goal proposes to achieve gender equality and empower all women and girls through sound policies that support women's effective participation and equal opportunities for leadership, improve the use of information and communications technology to promote women's empowerment, promote shared responsibility in the home and family, and end all discriminatory practices, among others.

The eighth goal aims to promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all, to be achieved by ensuring equal pay for women and men for work of equal value, through equal opportunities for women and girls in employment, leadership and decision-making at all levels, and to eliminate discrimination and violence against women and girls (United Nations, 2018).

These objectives are taken up in the 2018-2024 project of nationhood for Mexico, where the federal government's inclusive project proposes to eliminate the inequality gaps between men and women, as well as the obstacles faced by women in all areas to advance their physical, economic and political autonomy (López Obrador 2018).

Empirical evidence exposes the existence of GPGs and helps to explain their increase or decrease based on structural or conjunctural changes; in this study it will be approached from the conjunctural approach by carrying out an analysis of economic crises.

Economic cycles have different impacts depending on their phase, which affect men and women unequally in terms of unemployment rates, allocation of temporary or part-time contracts and wage setting, in the face of changes in the economic situation.

In the crisis stage, there is a loss of household purchasing power and this is a reason that encourages the participation of more women in the labour market; and according to the characteristics of the economy under analysis, pro-cyclical and counter-cyclical impacts are observed in the GPG (Murillo and Simón, 2014; Peña-Boquete, 2014; Rodríguez, Ramos and Castro, 2017; and Castro, Rodríguez and Brown, 2018).

Throughout the 20th century, a decline in gender disparity in employment, earnings and occupations was observed, with a particularly notable reduction in the 1980s. However, it is questionable whether this gap will continue to narrow until it disappears completely; this uncertain trend is likely to be related to the gender gap in the amount of time spent on childcare and household responsibilities (Goldin, 2008).

In that sense, the objective of this research is to estimate the Gender Wage Gap in the formal and informal sector of the labour market in the country and the state of Coahuila in the COVID-19 crisis period, in order to observe the trend in wage differentials for the period 2019 - 2022.

Mincerian wage equations (1974) were estimated for each gender with data from the National Occupation and Employment Survey (ENOE), for subordinate workers. The variables considered the sector in which the employee works (formal or informal) and the condition of the working day (full or part-time).

The Gender Wage Gap was estimated using the methodology of Blinder and Oaxaca (1973), with selection bias correction (Heckman, 1979).

It was observed that the Gender Wage Gap in the context of crisis in general tended to close, this was due to the fact that in the formal and informal sector the wage gap for women tended to decrease in the year 2020, while in the year 2022, during the economic recovery the GPG returned to the parameters of the year 2019 both at the national level and in the state of Coahuila.

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This underlines the importance of generating reliable information that allows policy makers to regulate the labour market to provide jobs in conditions of gender equity International organisations have established their commitment to gender equality at global and local levels; therefore, the study of gender pay inequality has become relevant in academic, political and social work.

In the following, the background to the research problem is presented, followed by the methodology used for the estimations, results and conclusion.

2. Background

The gender pay gap has been studied in Mexico for more than 30 years, with different databases and methodologies, and it has been found that the behaviour of the phenomenon is temporally dynamic, as it manifests itself by reducing or widening according to the economic events that occur.

The neoliberal structure of the reforms caused the economic changes in developed countries to have globalised effects that impacted other countries to varying degrees, depending on their degree of integration. During periods of crisis, countries are exposed to adverse conditions in relative magnitudes in labour markets, such as increased unemployment rates, growth of temporary and part-time jobs, and declining real wages which in turn lead to a loss of purchasing power of household income. Consequently, crises are a reason for the incorporation of women into the labour market in the face of economic instability.

Therefore, it is of interest to know what is the behaviour of the GPG in times of economic crisis and what is the impact of recessions on the GPG? For this purpose, the decomposition of wages by gender contributes to understanding the movements in the GPG in the face of changes in the economic cycle, with a focus on recessions. In this respect, there is no theoretical basis to support the behaviour of the GPG in this area, or, alternatively, sufficient empirical evidence to support the results of the studies presented (Murillo and Simón, 2014; Peña-Boquete, 2014; Rodríguez, Ramos and Castro, 2017; and Castro, Rodríguez and Brown, 2018).

In order to study the effect of recessions on the GPG, research compared estimates from a period of crisis versus a period of economic boom (Aláez and Ullíbarri, 2001; Domínguez and Brown, 2013; Murillo and Simón, 2014; Rodríguez, Ramos and Castro, 2017; and Castro, Rodríguez and Brown, 2018); and agreed that in periods of crisis real wages tend to decrease and there is a loss in the purchasing power of households (Aláez and Ullíbarri, 2001; Domínguez and Brown, 2013; Murillo and Simón, 2014; Rodríguez, Ramos and Castro, 2017; and Castro, Rodríguez and Brown, 2018); Finio, 2010; Domínguez and Brown, 2013; Murillo and Simón, 2014; Peña-Boquete, 2014; Rodríguez, Ramos and Castro, 2017; and Castro, Rodríguez and Brown, 2018), a situation that causes women to decide to join the labour market to compensate for the reduction in household income, and this possibly leads to the closure of the BSG.

Moreover, if women are employed in greater proportion in economic sectors that are more exposed to the impacts of the crisis, it would be expected that women's wages would be affected in greater proportion and the gap would tend to increase; but if men are concentrated in activities with greater sensitivity, then men's average wages would be reduced and consequently the GPG as well (Finio, 2010; Peña-Boquete, 2014; and Rodríguez, Ramos and Castro, 2017; and Castro, 2017).

With reference to the increase in temporary or part-time work, it is argued that women are more likely to engage in flexible working time activities and in times of crisis they would be expected to be less affected in terms of wages and unemployment, but the effect is not entirely clear; On the one hand, the GPG is likely to decrease at a time when unemployment affects men's working hours and wages significantly; and on the other hand, if the increase in the share of women's part-time jobs puts significant downward pressure on average wages, the GPG would widen.

To conclude the study of the GPG under the more fundamental crisis approach, it is recommended to investigate the business cycle in order to have a wider scope of results.

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The economic cycle has different impacts on the availability of jobs and the wages set, which affect men and women differently in terms of an unequal position in employment in the face of changes in the economic climate (Finio, 2010; Murillo and Simón, 2014; Peña-Boquete, 2014; and Castro, Rodríguez and Brown, 2018).

It is established that when measuring the impact of the economic cycle, a long period of time should be taken into account in order to contrast the effects of the stages of the cycle and compare the behaviour of the GPG when there are periods of growth or crisis (Finio, 2010).

Two possible effects of the crisis on the GPG were proposed, for which there is no consensus in the empirical evidence, as the GPG changed according to the characteristics of the labour market in question, resulting in pro-cyclical and counter-cyclical impacts. According to the counter-cyclical impact, it is argued that in periods of crisis women are more affected than men because unemployment is positively related to the creation of temporary or part-time jobs, which are occupied in greater proportion by women, and consequently the GPG widens. In this case, women have a higher inelastic supply curve in downturns, as their relative share of temporary or part-time jobs increases, putting downward pressure on their average wages (Domínguez and Brown, 2013; and Murillo and Simón, 2014).

On the contrary, in line with pro-cyclical behaviour in the downturn stage of the cycle there is a tendency for the GPG to fall, at a time when the share of part-time and temporary jobs held by men increases at a faster pace than that of women, given that the average wages of temporary workers are lower. The fact that men possess a more inelastic labour supply curve with respect to women is posited, as in this situation men would prefer to keep their jobs, even if the crisis affects their pay (Finio, 2010; Peña-Boquete, 2014; Rodríguez, Ramos and Castro, 2017; and Castro, Rodríguez and Brown, 2018).

The empirical evidence showed three positions, counter-cyclical, pro-cyclical and neutral BSG behaviour, without having an argument that generalises the effects.

On the other hand, in the context of crisis it should be taken into consideration that in the formal and informal sector the GPG has differentiated behaviour.

In the process of globalisation, governments are deregulating labour markets, promoting labour reforms with new contracts that incorporate more flexibility and facilitate subcontracting, informal jobs or working from home (Domínguez and Brown, 2013). In this regard, in a period of crisis, the question arises: In which segment of the labour market is there more GPG, formal or informal?

According to the literature, one way to identify formal jobs is to classify workers who enjoy social benefits provided by the state, through quotas contributed by the workers, while informality consists of workers who do not have an employment contract, benefits, social security, unemployment insurance or pension plan (Domínguez y Brown, 2013; Popli, 2013; y Rodríguez, Ramos y Castro, 2017). Few studies have analysed the GPG in terms of market segmentation (Domínguez and Brown, 2013; Popli, 2013; and Rodríguez, Ramos and Castro, 2017), although other studies have estimated the effect of formality on the earnings function (Pagán and Ullíbarri, 2000; and Ñopo, Daza, and Ramos, 2012).

Subcontracting jobs generate flexible employment opportunities, so women have the opportunity to enter paid employment at a higher rate or can work from home without neglecting household responsibilities (Domínguez and Brown, 2013; Popli, 2013; and Meza, 2018). Thus, compared to men, women tend to be more concentrated in firms in the informal segment of the economy (Pagán and Ullíbarri, 2000), and are characterised by lower human capital, lower wages and higher GPG (Pagán and Ullíbarri, 2000; and Rodríguez, Ramos and Castro, 2017), with the unexplained part of the wage differential affecting their remuneration to a greater extent (Pagán and Ullíbarri, 2000).

In summary, we highlight the absence of studies that address the GPG based on labour market segmentation, with the aim of enriching the empirical evidence to support the development of public policy to protect workers in the informal segment.

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The empirical evidence shows that crisis periods, and public and private sector approaches, have mechanisms that affect the GPG differently, in some cases tending to increase it and in others encouraging closure. Therefore, it is of interest to investigate the percentages of GPG prior to the COVID-19 crisis period and post-crisis.

3. Methodology

A non-experimental research is carried out, with application of the quantitative method, descriptive and correlational design, in which the mean values of labour participation by gender and GPG are presented.

To obtain the wage gap, a Mincerian equation is estimated using OLS, in which the average returns to human capital endowments for each gender are measured (Mincer, 1974). This theory establishes that the higher the level of human capital, the higher the expected income; then, the wage gap by gender is measured using the Oaxaca-Blinder technique (1973) and the selection bias is corrected with the Heckman command (1979).

The database used was the microdata from the National Occupation and Employment Survey (ENOE, 2019, 2020 and 2022), the third quarter was taken as the most stable in terms of staff turnover and the target population is composed of subordinate salaried workers, aged 15 to 70 years. The following variables were selected from the survey:

- Gender: the variable is classified into male and female, defined by the sex of the respondent (proxy variable).
- Gender: the proxy variable sex of the survey was considered, men are assigned the number one and women two, with this variable the gender is classified in the models.
- Age: variable with consecutive values from 15 to 70 years.
- Logarithm of hourly wage: variable defined according to hourly income, due to the fact that workers have different working hours per month, and by means of this variable the calculation of wage inequality is objective; the natural logarithm of income variable was created, based on hourly income.
- Education: Consecutive variable defining years of formal education.
- Experience: Consecutive variable capturing years of work experience.
- Diminishing returns to experience: Consecutive variable that captures the square of the years of work experience and defines the negative return to human capital.
- Marital status: This variable is constructed in a dichotomous way, married people were assigned a value of one and the rest were given a value of zero, in order to measure the contribution of married marital status to income.
- Zone of residence: this variable takes into account the number of inhabitants per locality and was created in a dichotomous way by assigning a value of one to individuals belonging to localities with more than 15,000 inhabitants and zero to those belonging to localities with up to 14,999 inhabitants; this criterion was taken from the ENOE survey. The area variable assumes that belonging to an urban area increases the individual's wage, this is attributed to the externalities generated by this environment.
- Working hours: this is constructed as a dichotomous variable based on the length of the working week as defined in the ENOE survey; workers who worked up to 39 hours per week were classified as half-time and were given a value of zero, while those who worked 40 to 72 hours per week were assigned a value of one, this being the full working day; with the intention of estimating the contribution to wages according to the allocation of working hours and to know if this variable affects the earnings of women, since they occupy more part-time positions.

The wage equation model for each gender is defined as follows:

$$Lny_i^G = \beta_0^G + \beta_1^G Edu^G + \beta_2^G Exp^G + \beta_3^G Exp^{2\,G} + \beta_4^G Civ^G + \beta_5^G Zon^G + \beta_6^G Lab^G + \varepsilon^G \quad (1)$$

Subsequently, it is possible to employ the decomposition of the wage differential with the Oaxaca-Blinder (O-B) command developed by Jann Benn (2008), with selection bias correction with the Heckman command, in the STATA statistical package; to determine the amount of the earnings gap that corresponds to differences in human capital endowments, as well as the unexplained part that is attributable to existing labour market discrimination towards women.

4. Results

This section presents the average values of labour participation by gender and the results of the OLS wage equation models and their decomposition with the B-O methodology (Blinder, 1973, and Oaxaca, 1973) and the Oaxaca command in Stata (Jann, 2008) for Mexico for the years 2019, 2020 and 2022. The objective of this application is to identify the effect of shocks on wages by gender and the GPG, in order to understand the behaviour of labour participation by gender in the formal and informal economic sectors and how it impacts on wage inequality.

As a first point, labour participation by gender is presented (Table 1), in the year 2019 an average participation of 39 per cent in subordinate women was observed at the national level; in contrast, in the same year for the state of Coahuila female participation in the labour market was 37.5 per cent overall, i.e., lower than the national percentage by 2 per cent. When reviewing this criterion by economic sector, the percentage of female labour participation is higher in the informal sector, as was assumed, as well as a higher female participation in part-time work.

The percentages of women's labour participation in 2020 reported changes in values as a result of male unemployment in formal and full-time activities, resulting in a decrease in the percentage of women's participation in the informal sector and part-time work, although it does not necessarily mean that the number of women in these working conditions has decreased, but rather that due to the context of economic recession, men who for some reason lost their formal and full-time jobs, have had the need to be employed in informal or part-time jobs, this situation in both regions, nationally and for the state of Coahuila.

Subsequently, in 2022, in a post-pandemic and economic recovery context, labour participation by gender returned to proportions similar to those of 2019 and in some cases the same, both nationally and for Coahuila. What does the above behaviour of labour participation by gender mean? It shows that in crisis contexts, the proportion of women employed in the formal sector increases, due to the dismissal of men from their formal jobs and their entry into informal activities, on the one hand.

In addition, women who were outside the economically active population need to enter the labour market to support their households' economy.

In summary, crises affect the dynamism of labour participation by gender by encouraging women to enter the labour market, although, once the economic situation improves, female labour participation returns to prevailing informal and part-time jobs.

	2019				2020				2022			
	National		Coahuila		National		Coahuila		National		Coahuila	
	Man	Women	Man	Women	Man	Women	Man	Women	Man	Women	Man	Mujer
General	60.9	39.1	62.5	37.5	60.2	39.7	62.3	37.6	59.9	40.1	62.1	37.9
Formal	61.0	39.0	64.0	36.0	58.4	41.6	61.8	38.1	61.0	39.0	63.5	36.5
Informal	60.7	39.3	57.8	42.2	64.4	35.5	65.3	34.6	59.0	41.0	57.9	42.1
Full Day	61.7	38.3	63.4	36.6	65.1	34.8	65.9	34.1	60.3	39.7	62.9	37.1
Half Day	46.9	54.1	41.1	58.9	46.9	53.0	52.1	47.8	45.2	54.8	41.9	58.1

Table 1 Labour participation by gender in 2019, 2020 and 2022 (figures expressed as percentages)
Source: Own elaboration with data from the ENOE 2019, 2020 and 2022 survey, from INEGI

On the other hand, regarding the analysis of the parameters of the Gender Wage Gap (Table 2), the GPG was estimated for the country and the state of Coahuila, with the intention of comparing the phenomenon for the two regions.

	2019		2020		2022	
	National	Coahuila	National	Coahuila	National	Coahuila
General	3.2	4.3	-1.4	0.08	3.7	4.8
Formal	2.0	8.3	0.5	-0.1	4.5	4.5
Informal	3.5	7.2	1.0	5.0	1.9	2.4
Full Day	6.3	13.9	6.1	5.9	6.7	14.3
Half Day	3.9	1.5	-3.2	4.3	0.3	0.8

Table 2 Gender Pay Gap in 2019, 2020 and 2022 (figures expressed as percentages)
Source: Own elaboration with data from the ENOE 2019, 2020 and 2022 survey, from INEGI

The behaviour of the GPG in the period stands out, as its percentages tended to close in 2020 in a context of crisis and subsequently expanded again in 2022, during the period of reactivation of activities and economic recovery.

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In the overall estimate for the year 2020 in the country, it was observed that the percentage of GPG was negative, i.e. a disadvantageous gap towards the male gender was estimated. This means that women's wages were slightly higher than men's and the difference was counted in negative parameter. In the same year in Coahuila, the gap was practically closed in the general and formal sector estimation, although in full-time jobs there was almost a 6 per cent gap, a situation that was accentuated in the year 2022, as a 14.3 per cent wage gap was estimated in full-time jobs to the detriment of women's earnings. In other words, women employees in general are affected in their wage income, however, the International Labour Office (2018) agrees with the statement that women employed in part-time jobs are less affected in their hourly earnings compared to those in full-time jobs.

Conclusions

The gender pay gap in Mexico is a phenomenon that has narrowed over time, and research for the country agrees that the central factor in the narrowing of the gap is the increase in women's average education, resulting in greater opportunities in the labour market; however, a substantial part of the GPG remains unexplained.

On the other hand, it is argued that crisis periods tend to reduce the gap because overall average wages are pushed down and tend to level off with those of women, but there is no consensus on this. Similarly, labour market segmentation infers that the GPG tends to increase, as women seek flexible jobs that are more often obtained in the informal market with lower average wages and no benefits.

With the review of empirical evidence and the estimates made, it is shown that the GPG tends to decrease, but it persists and the reason for its existence cannot be fully justified.

Based on the above arguments, public policy recommendations focus on reducing the differences in the professional growth and performance of individuals in the labour market regardless of gender.

A key element is the improvement in the coverage and quality of education in the country, because the higher the level of education, the better opportunities and salaries for women in the labour market. Specifically, professional education provides women with negotiation tools that help to reduce the GPG, eliminate the glass ceiling and denounce acts of gender discrimination, which guarantee their professional development.

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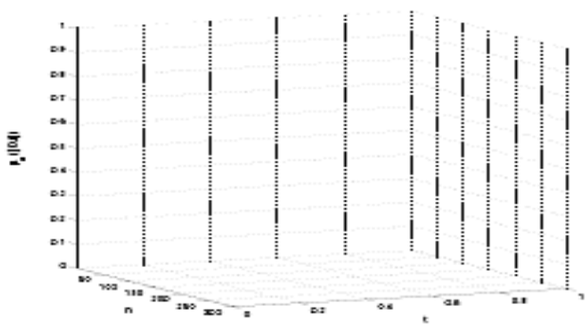

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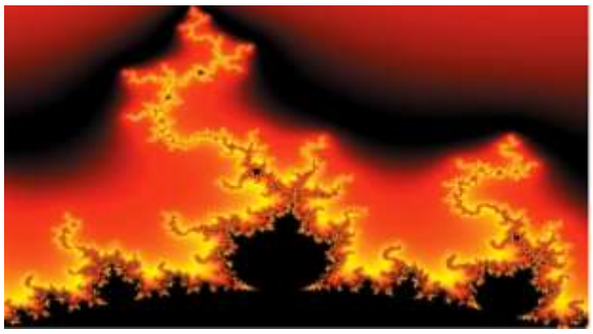

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