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In the first chapter we present *A systematic literature review of financial reporting risks: What's next?*, by SEGOVIA-VARGAS, María Jesús, CAMACHO-MIÑANO, María del Mar and PÉREZ-PÉREZ, Yolanda, with adscription in the Universidad Complutense de Madrid, as next article we present, *Analysis of learning styles in engineering students after the COVID-19 pandemic*, by ORTIZ-SANCHEZ, Pedro Alfonso Guadal, SÁNCHEZ-ITURBE, Patricia Guadalupe and ORTIZ- Y OJEDA, Pedro Tomás, with adscription in the Instituto Tecnológico de Mérida and Instituto Tecnológico de Tuxtla Gutiérrez, as a next article we present, *Trajectory of public private associations. Case: wastewater treatment plant "Agua Prieta" - Jalisco*, by MORENO-ORTIZ, Alba Lucia, ZABALA-PINEDA, María Jesica and AGUILAR-JUÁREZ, Oscar Aguilar, with adscription in the Universidad de Zaragoza, Universidad Politécnica de Texcoco and Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco, A.C., as the next article we present, *Proposal to improve the organizational performance of SMEs in Ciudad Obregón, Sonora*, by NAVARRO-ARVIZU, Elba Myriam, LEYVA-OSUNA, Beatriz Alicia, VÁSQUEZ-TORRES, María del Carmen and GONZÁLEZ-NAVARRO, Nora Edith, with adscription in the Instituto Tecnológico de Sonora, as next article we present, *Cost-benefit analysis of the best combination of organic and inorganic sources to supply zinc deficiency in pecan (Carya illinoensis [wangenh] k. Koch)*, by ORTEGA-MONTES, Fabiola Iveth, RUBIO-ARIAS, Héctor Osbaldo, CLEMENTE-SANCHEZ, Fernando and URANGA-Valencia, Luisa Patricia, with adscription in the Universidad Autónoma de Chihuahua.

Content

Article	Page
A systematic literature review of financial reporting risks: What's next? SEGOVIA-VARGAS, María Jesús, CAMACHO-MIÑANO, María del Mar and PÉREZ-PÉREZ, Yolanda <i>Universidad Complutense de Madrid</i>	1-19
Analysis of learning styles in engineering students after the COVID-19 pandemic ORTIZ-SANCHEZ, Pedro Alfonso Guadal, SÁNCHEZ-ITURBE, Patricia Guadalupe and ORTIZ- Y OJEDA, Pedro Tomás <i>Instituto Tecnológico de Mérida</i> <i>Instituto Tecnológico de Tuxtla Gutiérrez</i>	20-25
Trajectory of public private associations. Case: wastewater treatment plant "Agua Prieta" - Jalisco MORENO-ORTIZ, Alba Lucia, ZABALA-PINEDA, María Jesica and AGUILAR-JUÁREZ, Oscar Aguilar <i>Universidad de Zaragoza</i> <i>Universidad Politécnica de Texcoco</i> <i>Centro de Investigación y Asistencia en Tecnología y Diseño del Estado de Jalisco, A.C.</i>	26-42
Proposal to improve the organizational performance of SMEs in Ciudad Obregón, Sonora NAVARRO-ARVIZU, Elba Myriam, LEYVA-OSUNA, Beatriz Alicia, VÁSQUEZ-TORRES, María del Carmen and GONZÁLEZ-NAVARRO, Nora Edith <i>Instituto Tecnológico de Sonora</i>	43-54
Cost-benefit analysis of the best combination of organic and inorganic sources to supply zinc deficiency in pecan (<i>Carya illinoensis</i> [wangenh] k. Koch) ORTEGA-MONTES, Fabiola Iveth, RUBIO-ARIAS, Héctor Osbaldo, CLEMENTE-SANCHEZ, Fernando and URANGA-Valencia, Luisa Patricia <i>Universidad Autónoma de Chihuahua</i>	55-59

A systematic literature review of financial reporting risks: What's next?

Una revisión bibliográfica sistemática de los riesgos en la información financiera: ¿Y ahora qué?

SEGOVIA-VARGAS, María Jesús†*, CAMACHO-MIÑANO, María del Mar and PÉREZ-PÉREZ, Yolanda

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Abstract

This paper aims to review the main results of auditing research literature examining the risk of financial reporting. Our research analyzes theoretical and empirical studies on the controversial topic of the role of external auditors in the context of the financial crisis, the greater complexity of financial information and COVID-19 to offer solid reflections about the biggest challenges and limitations that require further study. Theoretical and empirical research studies were investigated and then systematized and analyzed by using SciMAT and VOSviewer to guide a literature-based analysis and critique of the relevant literature published about this topic. Our findings reveal that the risk of financial reporting has gained importance after 2008 and, although this topic has been researched extensively in the past, neither theoretical nor empirical research studies have been performed in the last five years, in particular concerning the changes carried out in the new accounting and auditing regulation that implies important changes. No works were found that deal with this subject in a broad, longitudinal manner, as this systematic review does. Another important contribution is the identification of new topics for further research in the post-COVID-19 era and future crises.

Resumen

Este artículo trata de revisar los principales resultados de la literatura de investigación sobre auditoría con relación al riesgo de la información financiera. Nuestra investigación analiza estudios teóricos y empíricos sobre el controvertido tema del papel de los auditores externos en el contexto de la crisis financiera, la mayor complejidad de la información financiera y la COVID-19 para ofrecer reflexiones sólidas sobre los mayores retos y limitaciones que requieren un estudio más profundo. Se analizaron trabajos de investigación teóricos y empíricos y luego se sistematizaron y analizaron mediante el uso de SciMAT y VOSviewer para guiar un análisis basado en la literatura y la crítica de la literatura relevante publicada sobre este tema. Nuestros resultados muestran que el riesgo de la información financiera ha ganado importancia después de 2008 y, aunque este tema ha sido ampliamente investigado en el pasado, no se han realizado estudios de investigación teóricos ni empíricos en los últimos cinco años, en particular en lo que se refiere a los cambios llevados a cabo en la nueva normativa de contabilidad y auditoría que implica importantes cambios. No se han encontrado trabajos que traten este tema de forma amplia y longitudinal, como lo hace esta revisión sistemática. Otra contribución importante es la identificación de nuevos temas para futuras investigaciones en la era post-COVID-19 y futuras crisis.

Financial reporting, Expectation gap, Auditing

Información financiera, Brecha de expectativas, Auditoría

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Introduction

The impact of financial information risks is a topic of growing importance for many company stakeholders: for investors since it is important in their decision-making processes (Van Helden, 2016), for companies since it involves preserving their value in terms of going-concern and reputation; for regulators, since they are responsible for ensuring the smooth operation of the market and for external auditors since they are providers of the greatest monitoring of financial reporting (Sunder, 2015). Investors recognize that, due to factors such as the lack of enough detail in qualitative information, there is a large gap between the financial information used in their decision-making processes and its effectiveness (PWC, 2014). Because of this information asymmetry, we have seen various financial scandals over the last two decades, with losses running into the millions and other social problems being caused as a result. This has shown the importance of financial information risks and the need for the regulator to focus on them.

Risk regulation originated in the US, especially through the Stock Exchange Commission (SEC) and the Public Company Oversight Board (PCAOB) and has been a particular feature since 2002 due to the Enron scandal. Consequently, the first stage has been to analyze this Anglo-Saxon context. The still-growing material weaknesses in financial reporting by companies, as well as the number of inspections by regulators, are trigger indicators of the importance of financial information risks. The International Auditing and Assurance Standards Board (IAASB), aware of the need for change in the approach to audit reports, has approved new international standards on audit reports that incorporate major changes in the information they contain. This has been integrated into the regulatory framework for auditing in Spain (IFAC, 2013). One of the major changes is the obligation for listed companies to produce an audit report disclosing the key audit matters (KAMs) and the audit work performed in relation to those matters (KPMG, 2016a; KPMG, 2016b).

The objective of this study is to identify which topics have already been studied and addressed in relation to financial reporting risks before the pandemic and which are currently the biggest challenges and limitations that require further study. To address these questions, we decided to use a Systematic Literature Review (SLR) as a valid methodology to identify relevant papers in scientific databases related to our topic. Our study contributes to analyse the latest important changes in the risk reporting regulations in the fields of accounting and auditing in different geographic areas, such as the aforementioned ISA 701. We update Elshandidy et al. (2018)'s study. When comparing our research with the results obtained from the previous study, there are some common conclusions but, in other areas, they differ due to the different periods of analysis. The agreements are regarding the lack of clarity and consistency around risk, the controversial benefits of standard-setters and the main themes around the informativeness of risk reporting. In our study, these conclusions are explained above all in the disclosure and regulation areas of research. However, in our study, we have not identified a specific focus on the degree of obligation or automatization of risk reporting and on the differences between financial and non-financial firms. While it is true that most of the research analyzed in this study relates to non-financial firms, no comparisons have been identified as the basis for the conclusions of these articles. Finally, regarding the analysis by country, in our analysis most of the articles analyzed are based on the Anglo-Saxon regions, this point remaining a topic for future research. Thus, our contribution is to add value to the previous research literature and help other researchers and practitioners in identifying possible research areas and questions for future research.

The rest of the paper is organized as follows. Section 2 describes the research methodology applied and the process for collecting relevant research papers. Section 3 presents the results of the papers collected and the data extracted. Section 4 discusses the study and answers the research questions. Section 5 concludes the paper.

Research methodology

This section describes the process followed to perform an SLR, which is based on a known and validated methodology (Kitchenham et al., 2008; Grant & Booth, 2009; Booth et al., 2014; O'Leary 2014; Moher et al., 2015), which comprises the following stages: setting the criteria for selecting the studies, data collection and cleaning to identify the relevant studies, data coding and summarizing and reporting the results. SLR involves a rigorous methodological review of the research results and helps to develop evidence-based guidance for professionals involved in the area of study (Kitchenham, 2004) and identify the state of the art on the research question (Levy & Ellis, 2006).

To meet our objectives, the PRISMA methodology (Moher et al., 2009; Gjaltema et al., 2020) was used to select which papers to include in the analysis. The universe was all papers reported in Web of Science (WoS), published from 1900 to 2020, and that included "risk*" and "financial reporting" in the abstract, title or keywords. We have limited the year end to 2020 as this is the last year before the pandemic. During and after the pandemic, risk management has dramatically changed and could be a distortion issue. After filtering out the literature that did not fit the criteria, 759 papers remained. A bibliometric analysis using the SciMAT tool and VOSviewer was subsequently performed to establish a conceptual map of the literature on financial reporting risks. Of these 759 papers, a manual review was performed to select only those papers that included this risk from an accounting perspective. A systematic literature review was then conducted on the resulting 78 papers.

Bearing all the issues mentioned before, we aim to analyse the evolution of prior research on financial reporting risks, as risks are essential to managers and firms. Our study has the following research questions:

RQ1. How has the literature on financial reporting risks evolved over time?

RQ2. What are the main subjects and issues in the scientific literature on financial reporting risks?

RQ3. What are the current research gaps and, therefore, the future directions for research on financial reporting risks?

Data and method

The sample selection was determined using the PRISMA methodology (Moher et al., 2009) following these steps:

1. The universe: it is all papers or conference papers published in peer-reviewed journals indexed in the databases Web of Science Core Collection (Thomson Reuters). These databases were selected since they provide interfaces that make it possible to perform simultaneous searches on different sources using a common set of search strings. In a broad way, i.e., without any restrictions on the journals, periods or areas of knowledge, studies from 1980 until the beginning of February 2021 were identified. This deadline is justified as the effect of pandemic in publication issues. These databases were also used to calculate both the Journal Citation Report (JCR) indicator and the SCImago, Journal Rank (SJR) indicator, which shows the visibility of the journals contained in the 1996 Scopus® database.
2. The results were segmented by searching WoS for papers published between 1900 and 2020 by using this criterion:

TOPIC: (risk*) AND TOPIC: ("financial reporting") Refined by: LANGUAGES (English or Spanish) AND DOCUMENT TYPES (article or review) AND WEB OF SCIENCE CATEGORY (business finance or economics or management or business).

3. A total of 759 papers were included in the bibliometric analysis. After eliminating duplicate papers, the abstracts and reference information on the papers were downloaded in .csv format and imported into the SciMAT and VOSviewer tools for bibliometric analysis.

4. Exclusion criteria: this research excluded papers that were not about both risk and financial reporting from the business and accounting perspective; did not provide empirical research or a literature review; were not peer-reviewed; or were not written in the English or Spanish languages. Only publications of the "Article" type were selected because they have undergone a rigorous peer review process prior to publication. Moreover, these works also contain all the information necessary (metadata) to undertake bibliometric analysis, with authors, references, number of citations and date of publication (Carvalho et al., 2013). Papers that did not meet the above requirements were rejected under the quality criterion (Kitchenham & Charters, 2007; Kitchenham et al., 2008).
5. Inclusion criteria: this research included papers that had a literature review and empirical research; focused on financial reporting risks in the context of the accounting, business and financial domains; and examined, among others, the regulatory framework, quality of reporting, performance and financial reporting matters.

Bibliometric analysis (Ikpaahindi, 1985) and content analysis (Dورياu et al., 2007) techniques were applied to identify the range of scientific literature on financial reporting risks, describing the trends and main topics discussed. These analyses are complementary since the first approach attempts to identify patterns in the literature based on publication dates while the second captures information on the main topics, approaches and methods relating to the subject in question (Carvalho et al., 2013).

Bibliometric analysis is intended to answer RQ1 relating to the evolution of financial reporting risks over time. This analysis can be defined as a set of techniques to classify the process of written communication, making it possible to identify the most productive authors, the journals and periods in which the publications were produced, the evolution of publications over time, the most influential articles in a particular set of studies and the subjects most closely related to the research question (Prasad & Tata, 2005).

The following specific analyses have been performed: evolution of publications and breakdown by country, their relevance based on the SCImago Journal Rank, strategic mapping using the SciMAT tool and the network of key occurrences using the VOSviewer tool.

Regarding the tools, SciMAT illustrates a complete overview of the literature and the dominant topics in each subject on a Cartesian plane. This map allows for the monitoring of a scientific field, the categorization of research subjects and the understanding of a subject's intellectual, social, conceptual and cognitive structure.

The X-axis of the Cartesian plane represents centrality, and the Y-axis represents the density of the related keywords in the analyzed literature. Centrality measures "the degree of interaction of a network with other networks, and it can be understood as the external cohesion of the network." Density "measures the internal strength of the network, and it can be understood as the internal cohesion of the network". The diagram shows the conceptual map of the subject analyzed according to the centrality and density of each keyword.

VOSviewer was used to produce a labelled bibliometric map, which allowed us to obtain a graphical visualization of the keywords by means of labelled nodes and thematic groupings, or clusters (Van der Vegt, 2018).

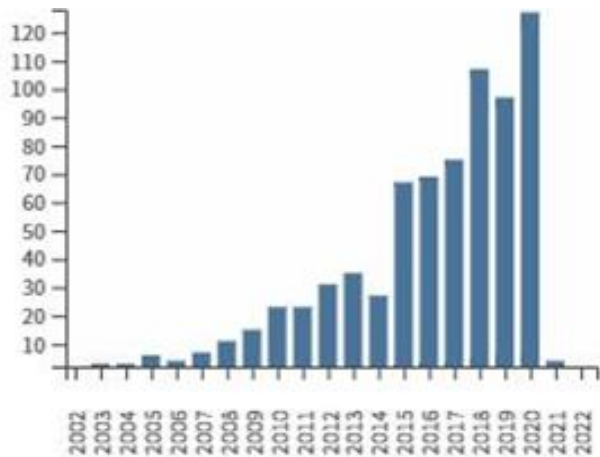
Content analysis techniques were used to answer RQ2 and RQ3. We divided the papers into specific areas of research according to their subject, based on the main topic of each paper. The members of the research group met to identify the major subjects related to the work in question and to propose a categorization of the topics while systematically organizing them.

Results

Bibliometric analysis

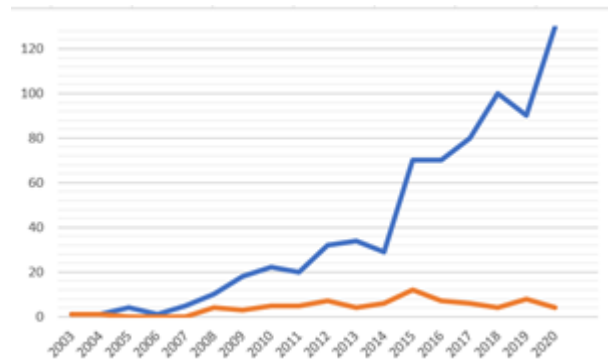
This subsection contains the results of the process of surveying the quantitative data relating to the periods, publications, authors, citations and other information for the periodicals forming the sample.

a) Evolution of the publications based on the WOS graphics: since the year 2008, the number of publications relating to financial reporting risks has consistently increased, showing a particular rise since 2015 as displayed in Graph 1. Thus, it seems that this is a hot topic in the accounting field, still attracting the attention of many researchers around the world.



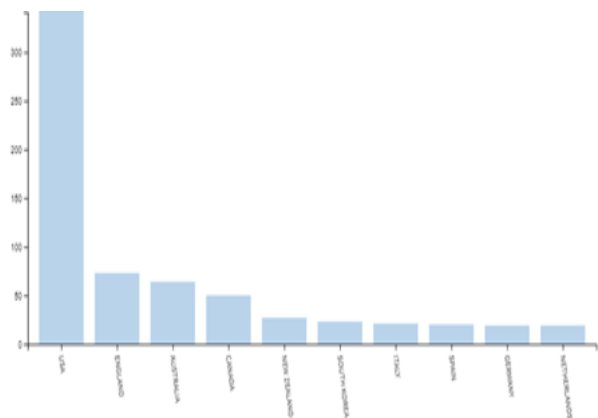
Graphic 1 Evolution of the number of articles published on the Web of Science database data each year related to the topic of “risks” and “financial reporting” before pandemic era
Source Web of Science Database

The sample covers the period from 1980 to February 1, 2021, the prepandemic period, and contains 78 publications; 6 of them (7.7%) were found up to 2008, 30 (38.5%) are from 2009 to 2015, the year that saw a peak in publications, with 12 (15.4%) in that year alone. The period between 2016 and 2018 accounts for 21.8% of the sample, with 17 publications. 2019, with 8 publications (10.3%), represents other peak year for publications. The last period saw 5 publications (6.4%) in just one month. As shown in Graphic 2, the sample follows the same pattern as the trend in the number of articles released. 60% of the publications are from 2008 to 2015, clearly showing the intensity, topicality and increased interest in the subject among researchers.



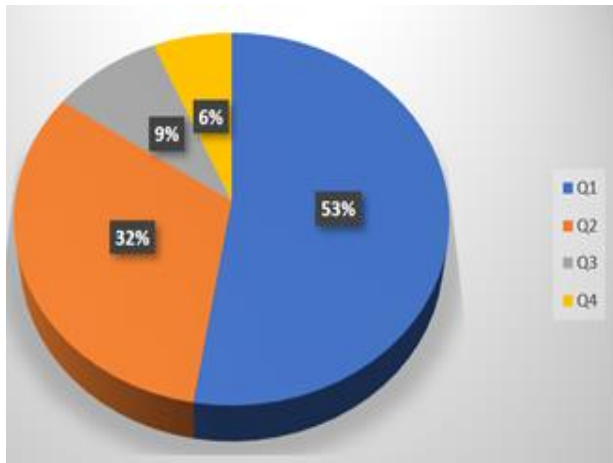
Graphic 2 Evolution of the citations on the Web of Science database data each year on the topic of “risk” and “financial reporting”
Source: own elaboration based on the Web of Science Database

b) Breakdown of publications by country: according to the data provided by WoS, the distribution of publications in the universe is mostly concentrated in the Anglo-Saxon countries as shown in Grap 3. It is consistent with the regulatory changes regarding financial reporting and in particular the changes in the IAS in recent years.



Graphic 3 Breakdown of publication by country on the Web of Science database data
Source: Web of Science Database

c) Relevance of the publications based on the SCImago Journal Rank: Graph 4 shows the number of publications by JCR and SCIMAGO indicator. Half of the articles are in quartile 1 (Q1) and the first two quartiles together (Q1 and Q2) account for 85% of the total number of articles. This means it is a topical issue and that the most important journals in the field are publishing these articles. This justifies for further research on this topic.



Graphic 4 Analysis of the number of journals by quartile
Source: Own elaboration based on SCIMAGO

- d) Strategic mapping using the SCIMAT tool: based on the strategic map provided by SciMAT, the lower left quadrant represents the subjects with low levels of centrality and density, which makes it possible to highlight the issues that require further development and constitute a future line of research, which in this case relate to corporate governance (compensation and agency costs). In the upper-right quadrant, with high centrality and density, the main themes identified were ‘control deficiencies,’ ‘litigation risk’ and ‘market’. This is no surprise since these topics are related to the impact of financial reporting risks on auditors and managers when identifying control deficiencies, and the consequences of not performing this well in terms of litigation risk and the impact on the market. The upper-left quadrant, with high centrality but low density, features the highly developed but isolated themes ‘IFRS’ and ‘judgements’, indicating that these are well-developed themes that are marginally related. These themes discuss the importance of regulation in this area associated with accounting and auditing standards. In the lower-right quadrant, with low centrality, but high density, cash-flows and restatements are the least relevant and most studied themes. This is because the impact in economic and reputation terms is the consequence of other relevant topics such as the quality of the financial statements, the role of auditors in supervision, the right regulation adapted to current and new information needs, the impact of financial reporting on cash-flows and other economic figures, etc.

Restatements of the financial reporting mean that the financial statements for the previous year contained errors and had to be corrected.

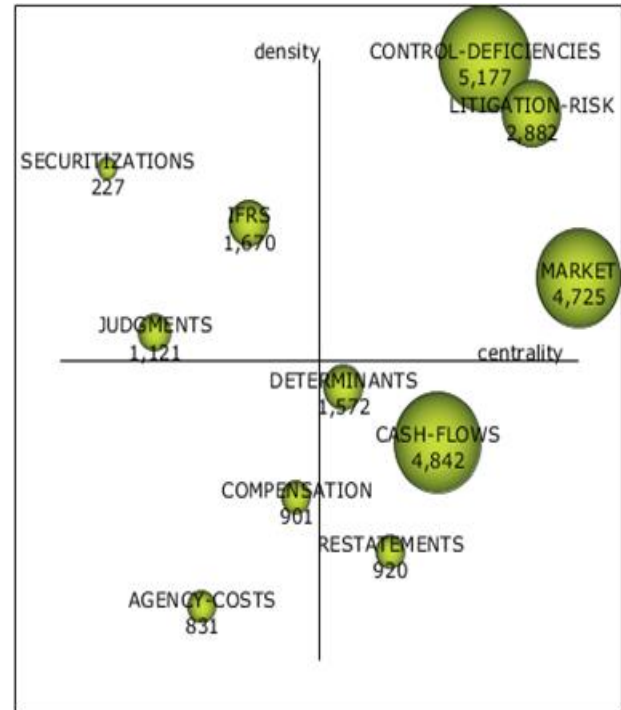


Figure 1 Strategic map by using SCIMAT tool
Source: SciMAT output

- e) Network of key occurrences using the VOSviewer tool: as shown in Fig. 2, the intensity of the lines that connect the nodes represents the intensity of the relationships between the most frequent keywords in the articles in the sample. The network results in 4 clusters: disclosure and quality (red), performance (green), regulation (yellow) and auditor (blue). In this network, the words relating to audit fee, opinion and audit quality appear grouped around the word auditor, which is the most cited one, showing the frequency and topicality of these terms, the interest among researchers and the relevance of the subject.

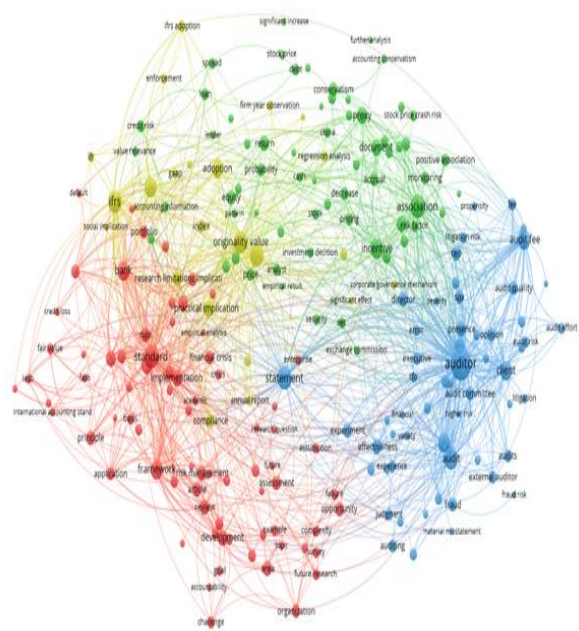


Figure 2 Network of key occurrences by using VOSviewer tool

Source: VOSviewer

Content analysis

Based on the systematic literature review methodology, only 78 articles remain in our study, as they link both concepts, namely risk and financial reporting. To systematize and organize the literature, we divided the papers according to their subject matter into five research areas, according to the main topic of each paper: disclosure, quality, performance, regulation and auditing.

Areas of research	Number of articles	%
1.Disclosure	9	12
2.Quality	10	13
3.Performance	14	18
4.Regulation	10	13
5. Auditing *	35	45
Audit quality	10	13
Audit fees	5	6
Audit report	20	26
Total	78	100

Table 1 Areas of research and number of articles. *Note: As this area of research is almost the half of the total number of articles, and the main topic from Vosviewer tool, several subareas of research have been identified

Source: Own elaboration

Discussion

This first research question is answered in the discussion of the bibliometric analysis performed in the previous section. To sum up, the number of publications related to this topic has increased in recent years and it remains of interest to researchers.

To answer the second research question, we have reviewed the list of articles following the classification performed using the methodology explained, as well as the details of each study. The main conclusions of each research area are set out in the following subsections.

Disclosure

As mentioned in Table 1, the first research area analyses the association between financial reporting, risk and disclosure. After carefully reading the 9 papers in this area, two main insights are produced. The first emphasizes the importance of financial reporting for the decision-making processes of the users of financial reporting, with a particular focus on risk disclosures of particular use for market analysis (Elshandid et al, 2018; Monjed & Ibrahim, 2020). The second provides proposals on how financial reporting disclosures should be improved to meet the needs of those using financial reporting (Sunder, 2015) who are becoming increasingly demanding (Nichita et al., 2015). This is from the perspective of (i) companies, by linking corporate risk management with accounting estimates and disclosures (Cohen et al., 2017); (ii) the regulators, seeking greater transparency in financial reporting accounting estimates, judgements, etc. (Caplan & Duta, 2016) and providing clear and concise disclosure methods and standards (Magnan & Markarian, 2011) and (iii) accountants and auditors to encourage firms to provide open and informative discussions of the risks to their financial reports (Ryan, 2012) through their review and oversight role.

Quality

The second research area is based on the link between financial reporting, risk and quality with 10 articles. The key insight from this area is that higher quality financial reporting, in terms of proper disclosures with firm-specific information, complying with the reporting deadlines, etc. (Cohen, 2008; Rajgopal & Venkatachalam, 2011; Verdi, 2012; Cao et al., 2016) leads to better business decisions. Another important insight is that information on risks is one of the most cited factors conditioning the quality of financial reporting in the context of the decision-making process (Lawrence et al., 2016; Oliveira et al., 2018) as risks involve judgement and can be affected by subjective components such as conservatism (Alam & Petruska, 2012; Ho et al., 2015; DeFond et al., 2016)

Performance

The third research area is based on the link between financial reporting, risk and performance, understanding financial performance in terms of financial variables or key ratios such as EBITDA, ROE and ROA. There are 14 articles. The key insight from this area is in line with the previous ones, showing that financial reporting has an impact on the performance of companies. This impact has been studied from different perspectives: as a predictor of crisis/bankruptcy, fraud, business development and capital markets.

Regarding its role as a predictor of crisis/bankruptcy, most of the studies show that traditional financial reporting is typically not a good predictor of future financial performance (Kristensen & Westlund, 2003; Beaver et al., 2012) and nor did it fulfill its task of reporting on risk ahead of the recent crisis (Singleton-Green, 2012). To deal with this issue, some studies propose other variables that could serve as an indicator of financial reporting risks, such as reporting delays (Lukason & Camacho-Miñano, 2019), or a greater review of the accounting information on which bankruptcy prediction models are based (Li & Faff, 2019).

In relation to fraud, this has been extensively analyzed in the literature from the perspective of the different users of financial reporting. On the regulatory side, for example, in the US, the Accounting and Auditing Enforcement Release (AAER) issued by the SEC is an indicator of firm performance as AAER firms are more likely to fail in the post-AAER period (Leng et al., 2011). On the auditor side, future misstatements are unrelated to the Material Weakness (MW) types disclosed in the last SOX report, suggesting that some MW types are unacknowledged and, hence, control problems are even more pervasive than identified (Myllymaeki, 2014). On the investor side, they rely more on analysts, regulators and external auditors to detect and report fraud, while relying less on low and mid-level employees, senior management, the media, and short-sellers for fraud detection and reporting (Brazel et al., 2015).

On the management side, weak internal controls increase the risk of financial reporting fraud by senior managers (Donelson et al., 2017) and fraudulent financial reporting should lead to an increase in the cost of equity capital as a firm's future cash flows become less certain (Nicholls, 2016).

From the perspective of business development, the quality of internal control relating to financial reporting risks is an important driver in companies increasing their value, not only to comply with the law but to increase their profits or reduce their losses as it has an impact on production, capital investment, mergers and acquisitions, research and development, advertising, and hiring or expansion decisions (Feng et al., 2009).

Finally, regarding the impact on capital markets, some studies show that poor quality financial reporting induces information risk asymmetry and therefore leads to different results compared to expected returns (Chen et al., 2019), cash flow forecasts (Mao & Yu, 2015), capital stock estimates (Kang et al., 2015) and the cost of capital (Zhou, 2019).

Regulation

The fourth research area is based on the link between financial reporting, risk and regulation and, in our database, there are 10 papers. The key insight from this area is that from a regulatory perspective, there is still room for improvement in financial reporting, especially after the financial crisis (Bushman et al., 2010) and despite the efforts of the regulators. As examples of these efforts, some authors cite different accounting frameworks: (i) the International Financial Reporting Standards to promote the comparability and transparency of financial statements and to improve the quality of financial reporting (Bhimani, 2008; Brown et al., 2014; Khalil et al., 2015; Kitching et al., 2015) and (ii) the American Sarbanes-Oxley (SOX) regulation to put companies under pressure to produce more reviews and disclosure of accounting risks, in particular, by questioning the role of the Audit Committee (Cohen, 2010 and 2014) and the auditors (Kelly & Tan, 2017).

Other authors have focused more on analyzing how corporate governance has tried to promote guarantees to stakeholders about future viability (Klumpes et al., 2017; Agyei-Mensah, & Buerter, 2019) through corporate risk identification, measurement, evaluation and monitoring practices.

Audit

Audit area represents the majority of the papers analysed in our database, with 35 papers, 45% of the whole articles. The existing literature is focused on the increasing complexity of financial reporting and the subsequent reinforcement of audit procedures and the audit report (this being analyzed in 57% of the articles in this sub-area). The main insights are specifically related to the informative value of the audit report. Some authors emphasize that financial reporting scandals in the 21st century have led to subsequent changes in the regulatory financial reporting framework arising from some questions including the measurement of the associated risk, both actual and as perceived by various stakeholder groups, communication and education concerning these risks, and mechanisms to share or transfer these risks (Camfferman & Wielhouwer, 2019).

Some authors focus on how the new audit reporting requirements could in some way mitigate this risk by helping improve the quality of financial reporting (Czerney et al., 2014, Reid et al., 2019) and even non-financial reporting (Demartini & Trucco, 2017a and b). An in-depth analysis on some specific paragraphs of the audit report has also been performed. For instance, Abad et al. (2017) prove that firms with qualified audit opinions demonstrate higher information asymmetry levels than those with unqualified opinions and there is a stronger effect on the level of informational asymmetry in the case of going concern qualifications. Kelton and Montague (2018) analyze the emphasis of matter paragraph concluding that this has the impact of increasing investors' perceptions of management credibility, leading to a higher likelihood of investment. So, this area seems to be fairly controversial in relation to a particular analysis of each part of the audit report.

It is also important to note that most of the previous literature up to 2014 is focused on the auditor's opinion of the Internal Control over Financial Reporting (ICOFR) that it compulsory for companies listed in the US and is not used in European countries, as this is a specific US regulation. Some authors focus on the effectiveness of this report. For example, some authors demonstrate through empirical studies that (i) compared to an unqualified opinion, an adverse audit opinion on the ICOFR is significantly associated with investors considering there to be a higher risk of financial statement misstatement, a higher risk of a future financial statement restatement, greater information asymmetry, lower financial statement transparency, higher risk premium, higher cost of capital, lower sustainability of earnings, and lower earnings predictability; (ii) firms receiving adverse ICOFR opinions are more likely to subsequently dismiss their auditors and switch to higher quality auditors; (iii) the classification of internal control deficiencies involves a very difficult judgement for auditors (Lopez et al., 2009; Bedard & Graham, 2011; Ettredge et al., 2011; Asare & Wright, 2012). Thus, it seems that there is a lack of literature on the new audit report, and the consideration of risk within this new report, resulting from recent accounting regulations in other parts of the world such as Europe.

The new audit report

As a result of our review, we have observed that the most developed topics in terms of the number of articles are those relating financial reporting risks to auditing, specifically to the external audit report. For this reason, we decided to extend our research by looking at the extended audit report.

Using the same SLR methodology, the Web of Science provided 198 results when we searched for "audit report content" as the "Topic" as of February 12, 2021. After a thorough review of all the articles, 175 papers have been excluded because their main focus was on different aspects of auditing, not specifically on audit reporting. Therefore, our study was finally based on the analysis of the remaining 23 articles. As we wanted to identify any articles relating to the extended audit report resulting from the recent audit reform, additional research was conducted using the same filters but searching for "extended audit report" as "Subject".

As a result, 8 additional articles have been included in our literature review. To systematize and organize the literature, we decided to categorize the papers according to their main theme using three research areas: the impact of the new global audit reform, the analysis of the extended audit report and the key audit matters (KAMs).

To supplement these articles, we have included additional working papers (Carver & Trinkle, 2017; Kipp, 2017; Manoel & Quel, 2017; Ratzinger-Sakel & Theis, 2017; Gold & Hellmann, 2019; Kachelmeier et al. 2020; Liao et al, 2019; Löew & Mollenhauer, 2019; Köhler et al., 2020; Porumb et al., 2021), because of their relevance and topicality in relation to the new audit reports and we incorporate their contributions below. After reviewing the literature on the content of the audit report, it was found that research articles have focused primarily on (i) analyzing the impact of audit reforms on stakeholder motivations (Guiral-Contreras et al. , 2007; Coram et al., 2011; Deumes et al., 2012; Reid et al., 2019), (ii) their impact on audit quality and financial reporting (Kilgore et al., 2014, Garza Sanchez et al., 2017; Prasad & Chand, 2017); (iii) the content, structure and language of the auditor's report (Cox, 2013; Hategan et al., 2015; Fakhfakh, 2016; Christensen et al., 2019;) and (iv) the impact of KAMs, about which there is controversy among researchers (Boolaky & Quick, 2016; Gutierrez et al., 2018; Sirois et al., 2018; Kachelmeier et al., 2020; Lennox et al., 2022¹).

Concerning the impact of audit reforms, the literature review provides two important insights: i) audit reform can increase the communicative value of the auditor's report for users of financial information, especially through the description of KAMs; and ii) the expanded audit report should help users to focus on issues that are likely to be important in their decision-making process.

In terms of the content, structure and language of the auditor's report, empirical research so far has focused on three relevant issues: the number, type and level of detail of KAMs. Regarding the number of KAMs, Gambetta et al. (2019a) find that the number of disaggregated KAMs in the UK in the first year of adoption of ISA 701 (2013) was 4.4, while in 2016 it was 4.5, so it cannot be demonstrated that the number of KAMs in audit reports is increasing with experience. Sirois et al. (2018) conducted a study on the effect of the communication of KAMs in the auditor's report on users of financial information when analyzing financial statements. One of the main findings of the paper is that when auditors break down several KAMs in audit reports, users of financial information pay less attention to the remaining paragraphs in the report. Regarding the type of KAMs, Filipović et al. (2019) find that the KAMs most frequently disaggregated relate to the accounting items of income, asset impairment and valuation and the recording of provisions. Gambetta et al. (2019b) analyzed the influence of auditor and client characteristics on the number and type of KAMs disclosed in the audit reports of FTSE 100 companies in the UK during the period 2013-2016 and concluded that auditor and client characteristics are determinants of the number of KAMs disclosed. Furthermore, these factors determine the type of KAMs in audit reports.

Considering the level of detail of the risk description, some authors (Rematzki, 2018; Smith, 2023) provide empirical evidence that narratives in KAM disclosure are more effective in enhancing the informative value of auditors' reports for investors than the mere presence of KAM sections. In a complementary study, Rematzki (2018) finds that KAM sections can serve as a beneficial mechanism for users of financial information when KAM descriptions are firm-specific. There is no consensus in the research community on the impact of KAMs. Therefore, in this area of research we have subclassified the articles according to the effect of KAMs (positive or negative) considered by the authors who have focused their analysis on this area. If we look at the positive effects of KAMs, there are studies that analyze these effects from the perspective of some corporate stakeholders (auditors, lenders, investors, readers of annual accounts in general, company management and the audit committee).

Thus, from the auditor's point of view, some authors have examined the effects of KAM disclosures in the auditor's report on the auditor's legal exposure, concluding that KAM disclosure is unlikely to increase and, in certain circumstances could even reduce, the auditors' litigation risk if an audit fails to detect a material misstatement (Brazel et al., 2015; Stevens et al., 2019). Some authors even show that due to the obligation to describe KAMs, auditors exhibit more skeptical judgement (Ratzinger-Sakel & Theis, 2017). Many other studies have analyzed the importance of the new audit report from the lenders' point of view, concluding that the impact of extended audit reports, and especially KAMs, has a significantly positive impact on lenders' perceptions of the quality of the financial statements, the audit procedure and report, as well as on their credit approval decisions (Booak & Quick, 2016), since they are better able to assess the risks associated with the borrowers (Loew & Mollenhauer, 2019; Porumb et al. 2021). This positive effect is especially attributed to the increased information found in extended reports related to KAMs, additional information about the going concern and auditors' judgement in this regard, as well as procedures relating to fraud risk (Trpeska et al., 2017).

Considering investors, Ozlanski (2019) shows that KAMs increase investors' perceptions of the credibility of management reporting when the area of financial statements is disaggregated through a particular KAM. For readers of annual accounts in general, the communication effect of the audit report has also increased following the breakdown of KAMs, with greater attention being paid by users of financial information (Sirois et al., 2018). For company management, Gold et al. (2020) showed that the implementation of KAMs in auditors' reports affects their reporting behavior, specifically, the accuracy of information (company-specific versus non-company-specific information), improving the quality of financial management reports.

For management bodies, specifically the audit committee, the new expanded audit report has improved the quality of oversight by these management bodies as the breakdown of KAMs allows committee members to ask complex questions about management's key accounting estimates (Kang, 2019; Löew & Mollenhauer, 2019).

However, some authors consider that from the perspective of different stakeholders the effects of KAMs have been negative as well, fostering an interesting debate. The articles analyzed have mainly focused on auditors and investors. In relation to auditors, contrary to the findings of Brazel et al. (2015) and Stevens et al. (2019), some authors show that since there are no precise guidelines on the description of KAMs they can, on the one hand, reduce the degree to which juries perceive that this limitation exists, leading to increased auditor liability (Gimbar et al., 2016; Kachelmeier et al., 2020) and, on the other hand, they do not influence the auditor's skeptical judgement (Asbahr & Ruhnke, 2019). Gold and Hellmann (2019) add further arguments, such as efficiency losses in terms of increased audit fees and delays in the issuance of audit reports, as well as a possible loss of auditor independence as management is involved in reviewing KAMs with the auditor prior to issuance. From the investors' point of view, some studies show that there is no evidence that KAMs provide investors with more information (Liao et al., 2019) and therefore they have no effect on investment decisions (Carver & Trinkle, 2017; Gutierrez et al., 2018; Kipp, 2017; Köhler et al., 2020). In particular, the new extended audit report is found to lack incremental information for investors because most of the risks had already been previously communicated by management through regular communications to the markets (earnings communication, annual report, etc.) Therefore, investors were already informed about most of the risks before they were disclosed by the auditors in the extended audit reports (Czerney et al., 2019; Lennox et al., 2022).

4.3 RQ3. What are the current research gaps and, therefore, the future research directions for financial reporting risks?

Given the existing literature, we have identified the following gaps and possible future lines of research. First, the bibliometric analysis shows that the number of publications has increased in recent years, with peaks seen in 2008, 2015 and 2020. This coincides with changes in the economic circumstances, for example with the financial crisis of 2008, or changes in the accounting/audit regulations, with the publication of new ISA such as ISA 701 in 2013, compulsory since 2015, and the new IFRS regulation which comes into force in 2020 and 2021.

For this reason, we consider that a possible gap could be the analysis of the impact of the COVID pandemic in 2020 on the financial statements of 2021 and 2022. It could be interesting to analyze the impact not only on the financial statements but also on the audit report and how different auditors have treated this topic.

Another interesting insight is that the empirical literature on KAMs is scarce yet and this may be because this topic is new in Europe (with auditors in the UK and the Netherlands being the first to adopt these changes in the audit report in 2014). In fact, no work has been found that compares KAMs after the first-year adoption, given the data time series available now. However, there are three specific professional studies (FRC, 2015, Mazars, 2018 and Auditanalytics, 2019) that have analyzed this issue. All of them are descriptive and from a professional approach. A future research project aims to respond to this gap in the research by providing a critical approach, empirically comparing the first and second year of implementation of KAMs. We have also not found any empirical studies analyzing the correlation between financial information risk and performance by using a specific rating, and this may be another line of future research. In summary, our study confirms that there is scope for future research in the light of the new accounting and auditing standards.

Conclusion

The impact of risk on financial reporting is an increasingly important topic for many stakeholders: for investors since it is relevant for their decision making process; for companies as it preserves their value in terms of going concern and reputation; for regulators who are responsible for overseeing the smooth operation of the market; and for external auditors as providers of the greatest level of assurance about financial reporting. This topic has been of more interest to the business and academic community after the financial crisis, which brought to the forefront the need for companies to effectively manage their risks and increase their transparency in the market. In response, the regulators have made some changes in relation to financial reporting risks.

This study contributes to improving our understanding of financial reporting risks in three ways. First, it maps the evolution of the literature on financial reporting risks based on solid relevant academic knowledge. No works were found that deal with this subject in a broad, longitudinal manner, as this systematic review does. In the years 2008 to 2020, the number of publications relating to financial reporting risks consistently increased, demonstrating the huge importance of this topic for researchers. Second, the article identifies the key topics and trends on financial reporting risks: disclosure quality, performance, regulation and auditing. The research subcategory “audit report” appears with great regularity in this work and represents the most sensitive aspect at the moment, also linked to the new regulations for the audit opinion in the context of the new ISAs, particularly ISA 701. These issues reflect the concerns of researchers and practitioners in the business about the fundamental decisions made by managers and auditors involved in the financial reporting process. Third, future studies can be undertaken in the area by comparing and validating the results presented here, especially with expanded search criteria and databases. Moreover, other analytical techniques, such as semantic analysis, could be used in the search for new concepts or definitions that would better characterize the works, as well as validate the findings of this systematic review. Other interesting areas for future research could focus on the current context that has not yet been studied, such as the implications of the COVID 19 pandemic on financial statements and audit opinions, the evolution of KAMs in countries with more experience and those that are new adopters, like the US, and the need for empirical research that analyses the relationship between KAMs and performance, for example by using proxies such as credit rating.

Inevitably, this work has intrinsic limitations deriving from the research design, particularly from the determination of the sample. These include the selection of the time range, the databases and the inclusion and exclusion criteria that may have narrowed the research sample. The exploratory nature of this research must also be acknowledged, involving subjectivity in relation to the content analysis of the surveyed sample. Moreover, the authors opted to direct most of their research effort to subject areas relating to the new audit report.

As practical implications, in this work there are a significant number of issues for researchers, practitioners and managers in relation to these topics so we think that regulators, analysts, auditors, managers and investors could benefit from the results of this study.

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Analysis of learning styles in engineering students after the COVID-19 pandemic

Análisis de estilos de aprendizaje en estudiantes de Ingeniería después de la pandemia de COVID-19

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Abstract

The research was carried out with the objective of knowing aspects that are interesting for researchers about learning; such as the analysis of the learning styles currently in the post-pandemic period, manifested by students of different degrees. Identifying and analyzing learning styles and relating them to current teaching practices will allow applying teaching strategies that could reduce the current high dropout and failure rates. The results obtained show the trends by educational institution, by semester and by career. Significant differences were found in the results in the active style between schools; by semester, most of the students of the initial semesters are visual and sensitive, in later semesters, there is a tendency to be intuitive and by career they show a tendency to be sensitive and visual; As a conclusion, a student can have different learning styles, but in general they have a certain affinity for a learning profile.

Objective. Identify and analyze the current learning styles in Engineering students, derived from the abrupt changes in study modalities that occurred due to the Covid 19 pandemic.

Methodology. A validated survey (Cronbach's α : 0.872) was applied to students of Electrical Engineering, Electronic Engineering and Biochemical Engineering. The following learning styles were considered to be identified and analyzed: active-reflexive, sensitive-intuitive, visual-verbal, and sequential-global. A scale of dichotomous variables was chosen, they were valued according to the proposal of Felder and Silverman (Felder and Silverman, 1988), the answers were set in the categories of learning styles proposed by the author in active or reflective, sensitive or revealing, visual or verbal, and sequential or global, were quantified, tabulated, and analysis of variance (ANOVA) for parametric samples.

Contribution. This research made it possible to identify the learning styles of undergraduate students in the post-pandemic period, to find out the current learning preferences, which can be applied to propose, where appropriate, the necessary adjustments within the teaching strategies of teachers interested in reduce the current high rate of failure and dropout

Learning styles, dropout rate, failure rate

Resumen

Esta investigación se realizó con el objetivo de conocer aspectos que resultan interesantes para los investigadores acerca del aprendizaje, como es el análisis de los estilos de aprendizaje que actualmente en periodo pospandemia, manifiestan los estudiantes de diferentes licenciaturas. Identificar y analizar los estilos de aprendizaje y relacionarlos con las actuales prácticas docentes, permitirá, aplicar las estrategias de enseñanza que pudieran disminuir los elevados índices de deserción y reprobación actuales. Los resultados obtenidos muestran las tendencias por Institución educativa, por semestre y por carrera. Se encontraron diferencias significativas en los resultados en el estilo activo entre escuelas; por semestre, la mayoría de estudiantes de los semestres iniciales son visuales y sensitivos, en semestres posteriores, hay una tendencia a ser intuitivos y por carrera muestran tendencia a ser sensitivos y visuales; a manera de conclusión, un alumno puede tener diferentes estilos de aprendizaje, pero en general tiene cierta afinidad a un perfil de aprendizaje.

Objetivos. Identificar y analizar los estilos de aprendizajes actuales en estudiantes de Ingeniería, derivado de los cambios abruptos de modalidades de estudio que se dieron por la pandemia de Covid 19.

Metodología. Se aplicó una encuesta validada (α de Cronbach: 0.9728) a estudiantes de Ingeniería Eléctrica, Ingeniería electrónica e Ingeniería Bioquímica. Se consideraron los siguientes estilos de aprendizaje a identificar y analizar: activo-reflexivo, sensitivo-intuitivo, visual-verbal y secuencial-global. Se eligió una escala de variables dicotómica, fueron valoradas de acuerdo a la propuesta de Felder y Silverman (Felder & Silverman, 1988), se ubicaron las respuestas en las categorías de estilos de aprendizaje propuestos por el autor en activo o reflexivo, sensitivo o intuitivo, visual o verbal y secuencial o global, se cuantificaron, se tabularon y se hicieron análisis de varianza (ANOVA) para muestras paramétricas.

Contribución. Esta investigación permitió identificar los estilos de aprendizaje de estudiantes de nivel Licenciatura en el período pospandemia, para conocer las preferencias de aprendizaje actuales, que pueden aplicarse para proponer, en su caso, los ajustes necesarios dentro de las estrategias de enseñanza de los docentes interesados en disminuir la alta tasa de reprobación y de deserción actuales

Estilos de aprendizaje, índice de deserción, índice de reprobación

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Introduction

Much research has been done considering learning styles, Gibson's original idea (Gibson, E.J., 1969), but the term was proposed by Keef (Kolb, 1984) who explained them as the intellectual and affective attributes with which learners understand and interact with their learning environments; learning styles provide insight into different ways of approaching, planning and undertaking learning needs and can be classified in a variety of ways (Rivas *et al.*, 2018).

Education systems need to consider that students experienced different and varied learning practices during the period from 2020 to 2022, depending on the conditions for distance learning, at home, influenced by educational level, motivation, mood, access to devices and connectivity, socio-emotional and mental health challenges when there were family losses, time available and quality of materials offered by schools, to name a few, highlighting the need to implement appropriate interventions to overcome this stage. There is no one-size-fits-all solution to the challenges faced by education systems. Among the priorities to be taken into consideration are the need to look for initiatives to re-engage students who have dropped out or failed; to focus on review and reinforcement of unseen topics for skills development; in case of proposing hybrid digital and face-to-face teaching schemes, to create quality content for these purposes; to offer support outside school hours; and to develop activities to promote mental health and decrease post-pandemic stress (UNICEF and UNDP report Evidencia Impacto de La Pandemia En La Educación, n. d.).

As part of the development of these ideas, recognising that different learning styles exist and identifying how they are now manifesting themselves and the conditions that enable them to apply their skills should be an important aspect of the development of the current conditions of the learning process.

For a long time, traditional education favoured a formal, rigorous, strict and theoretical education in which students were passive elements of the learning process: the teacher dictated, they took notes, memorised and were evaluated with a final exam, those who did not conform to this model were considered bad students, the grades obtained were accepted as a measure of the student's intellectual capacity.

Later research showed that it was not always the student with the best grades who was the most successful in their professional performance and that some students with dubious academic backgrounds were able to develop the necessary activities that allowed them to progress in their profession; traditional teaching assessment began to be considered less reliable because in many cases it became evident that people can learn and develop particular skills depending on the environment in which they find themselves.

Learning styles refer to individual differences in learning, expressed as responses to different stimuli and information that determine the most appropriate conditions for students to develop competences, and to which the actions mentioned in the previous paragraph can be attributed (Díaz Mosquera, 2012).

The knowledge of learning styles dates back to the second half of the last century, a great variety of learning styles are mentioned, from visual, verbal, logical, auditory, social, intrapersonal, physical or physical learning, logical, auditory, social, intrapersonal, physical or kinaesthetic and kinaesthetic and naturalistic learning. Although there is no single classification, the following are some of those referred to by different authors, the Neurolinguistic Programming (NLP) of Grinder and Bandler, refers to the preference of people for visual, auditory or kinaesthetic activities to process information, to learn, being dynamic processes that can interact with each other and that at any given time there may be a dominant one. This model, questioned as a "myth", can be considered within the learning process as a possible tool to improve academic performance (Jaruffe Romero, Arlinthon David; Pomares Jacquin, 2011). According to Kolb (Kolb, 1984), plausible learning requires processing the knowledge transmitted in four aspects: concrete experience, reflective observation, abstract conceptualisation and active experimentation. Also Felder and Silverman (Felder & Silverman, 1988), trying to know the learning preferences of engineering students proposed the following dimensions of learning styles: sensory or intuitive, visual or verbal, active or reflective, sequential or global and likewise, students may have a preference for any of these, or use some aspects of the others.

Hermann's Brain Preference Model proposes that the brain can be divided into 4 different areas of cognitive development and explains the way of learning according to the major area of development that can be presented, it is still used as a reference to know the personality styles and how they influence their abilities or talents (Rojas et al., 2006). The VARK model provides a quantification of students' learning styles, assessing four sensory modalities: visual, auditory, textual and kinaesthetic, and each individual can present from one to all four, with all their combinations, as a learning style.

Similarly, there are different proposals to evaluate the student's learning style in each of the proposed models, among them is the ILS questionnaire (Sabry & Baldwin, 2003) which is integrated with four cognitive aspects: processing, perception, comprehension and representation, which evaluates perceptual preferences along with environmental, emotional, sociological and information processing preferences. The VARK Questionnaire, developed by Fleming (Fleming, 1992), which assesses learning preferences without considering personality characteristics, information processing and social relationships in the classroom, consists of 16 questions with four response options, each corresponding to a different learning style (visual, auditory, reading/writing and kinaesthetic).

Methodology to be developed

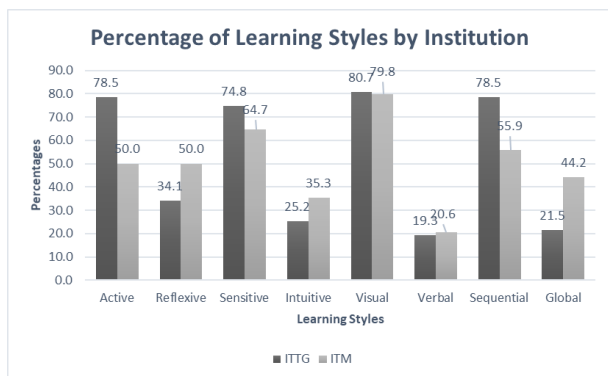
The universe of this analysis was 169 engineering students from the courses of Calculus, Algebra, Unit Operations and Food Specialty of the Tecnológico Nacional de México, Campus Mérida (ITM) and Campus Tuxtla Gutiérrez (ITTG). These students are taking these subjects, which are curricularly obligatory and from different degree courses such as Electrical Engineering, Electronic Engineering and Biochemical Engineering. Students from different degree courses and semesters participated: from Electronic Engineering (ITM) students were studying from the 1st to the 4th semester; from Electrical Engineering and Electronic Engineering from the 1st to the 4th semester and from Biochemical Engineering (ITTG) from the 6th to the 8th semester.

They were selected because they represent a group of students of interest to the research, being from different academic areas, different subjects and semesters and although they are all TecNM students, they are from different campuses, considering that the main objective of the research is to know the learning styles currently preferred by undergraduate students, to manage this knowledge in the form of a diagnosis and to be able to make them known in a general way to the teachers responsible for the different areas of study, in an attempt to support the idea of avoiding as far as possible the high degree of failure and desertion that is currently occurring in our institutions. The learning style expressed by the students can be applied by teachers to improve their educational practice. For the very purpose of the research a purposive sampling was carried out, characterised by obtaining representative samples by introducing typical groups, varied in terms of the area of knowledge. The purpose of the research was explained to each group of students in each subject, and their cooperation was requested in answering a survey in an objective and reflective manner, with the observation that their answers would be anonymous and that those who did not wish to answer could do so. The Felder and Silverman survey (Felder & Silverman, 1988) was sent out, a Google form was developed for this purpose and shared in the respective groups to be answered during a face-to-face class in each of the subjects. This survey was used, after analysis of the options of evaluative questionnaires of learning styles by the teachers participating in the research, who decided to use it due to the characteristics and versatility in terms of the learning style options that could be detected with this questionnaire, which has a high reliability index (0.9728, Cronbach's α), being a survey that allows the student to express their acceptance or not in each question. The total of the responses obtained were evaluated according to Felder and Silverman's proposal (Felder and Silverman, 1988), the responses were placed in the categories of learning styles proposed by the author in active or reflective, sensitive or intuitive, visual or verbal and sequential or global, they were quantified, graphed and analyses of variance (ANOVA) were carried out to find out if there is a significant difference between the results of learning styles between institutions, semesters and degrees. These results could be applied, in a propositive way, to act assertively in teaching activities, with the aim of reducing the high rates of failure and desertion present.

Results

There are different abilities in young people to process information, some individuals prefer visual information, with diagrams, presentations, etc., while others opt for verbal instructions, lectures and guides.

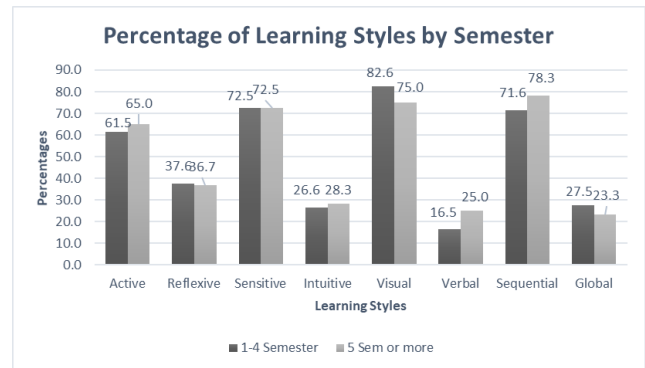
There are also those who learn through practice, others prefer to work with concrete information and experiments, while others like abstractions, mathematical models and theory, i.e. they present different learning styles, among others. The learning styles of the total sample of students from the Tuxtla Gutiérrez Campus (ITTG) and the Merida Campus (ITM) are as follows: The largest number of students from ITTG turned out to be visual (80.74%), and from ITM (79.41%), in both institutions were classified as active 78.52% and 50%, reflective 34.07% and 50%, sensitive 74.81% and 64.71%, Intuitive 25.19% and 35.29%, verbal 19.26% and 20.59%, sequential 78.52% and 55.88%, global 21.48% and 44.18% respectively, finding significant difference only in the active status between both institutions. Graphic 1 summarises the above information.



Graphic 1 Results of the survey to determine learning styles by educational institution
Source: Own elaboration

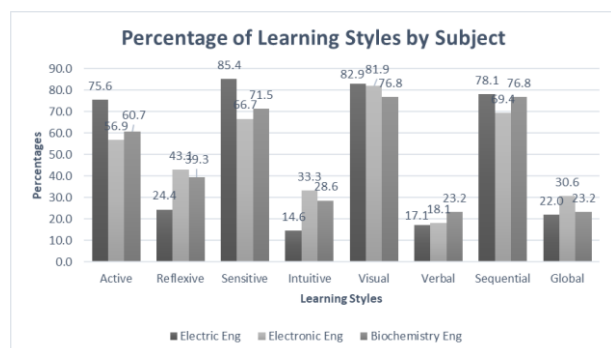
Analysing the learning styles by semester (graphic 2), the following results were obtained: The highest percentage (82.57%) in students from 1st to 4th semester (1-4th semester) was in visual style and from 5th semester onwards (5th semester or more) 78.33% was sequential. In students of 1-4 semester the active style was 61.47% and the reflective 37.61%, and in students of 5th semester and above the active style was 65% and the reflective 36.66%; in students of 1-4 semester the sensitive style was 72.48% and the intuitive 26.6%, in those of 5th semester and above the sensitive was 72.47%, while the intuitive style was 28.33%.

In the verbal strategy, students in the 1st-4th semester accounted for 16.51% and those in the 5th semester and above for 25%. Finally, in the sequential strategy 1-4 semester students accounted for 71.56% and in the global strategy 27.52%; students in 5th semester or more in the global strategy accounted for 23.33%. In none of these cases was there a significant difference between groups.



Graphic 2 Results of the survey to determine learning styles by semester
Source: Own elaboration

For the analysis of the answers given by degree courses, the following results were found (see graphic 3). The students of Electronic Engineering (IEL) with 81.94% in visual style and Electrical Engineering (IE) both in visual and sensitive style presented the highest percentages, being 82.92% and 85.36% respectively. In the active style Electrical Engineering (IE) showed 75.61%, IEL 56.94% and IBQ 60.71% and in the reflective style IE with 24.39%, IEL 43.05% and IBQ 39.28%. In the sensitive-intuitive style pair, IE reached 85.36% and 14.63%, IEL had 66.66% and 33.33% and IBQ 71.46% and 28.57% respectively. In the visual-verbal styles IE obtained 82.92% and 17.07%, IEL 81.94% and 18.05% and IBQ 76.78% and 23.21% respectively; finally in the sequential-global styles the values of IE 78.05% and 21.95%, IEL 69.44% and 30.55% and IBQ 76.78% and 23.21% are shown in the given order, with no significant differences between active-reflective, Sensitive-intuitive, visual-verbal and sequential-global pairs.



Graphic 3 Results of the survey to determine learning styles by degree

Source: Own elaboration

Taking into consideration the objective of this research, to identify and analyse the learning styles of the students of different areas of Engineering of the two campuses of the TecNM, it was found that the students of the two Institutions have predominance by the visual style, who learn preferably with the use of images, diagrams, animations, figures, they can use this style to carry out all or some of their activities; By semesters, being 1-4 semesters, students of Basic Sciences, were visual in a 82.57% and in second place sensitive with 72.48%; students from 5th semester onwards, 78.33% were sequential and in second place visual with 75%. Students with sensitive styles prefer to obtain information by immediate application of theorems, they like to learn with concrete materials, with practices or practical applications, with real-life facts, project-based learning, applicative problems, giving less importance to developing the imagination, and sequential students develop linear, step-by-step ways of thinking, preferring activities in which they solve problems with continuous solutions, which do not require them to go beyond knowing a defined, unchanging sequence. In a similar analysis to the previous ones, applied by career, IE students were 85.36% sensitive and in second place visual with 82.92%; IEL obtained 81.94% as visual and in second place as sequential with 69.44%, in visual and sequential styles with the same percentage of 76.78 and in second place with 71.46 sensitive were IBQ students. It is observed that the predominant learning styles among the students are visual, sensitive and sequential, which were obtained as a personal decision, optional but not exclusive of the other learning styles.

No specific learning style profile is known for Engineering students, however, according to (Caballero, 2014) Engineering students could, by the very nature of the profession, be more active, sensitive, visual and sequential learners than reflective, intuitive, verbal or global learners, characteristic styles that have also been reported in Biochemistry and Nursing students (G. Campos & Campos, 2018). The results obtained show that they have very marked styles, in the sense that the three learning styles indicated are dominant, many of the recommended teaching activities are in line, commonly used by TecNM teachers, applying visual presentations, carrying out and developing problems, case analysis, laboratory practices, teamwork, industrial visits; The result of this research also allows to visualize the possibility of stimulating in the academic formation of the students all the learning styles and not only those in which they demonstrate to have certain strengths, as an example if their main learning style is the visual, why not stimulate their learning to the reflective style, so that they can be more versatile in their academic performance.

Acknowledgement

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Conclusions

The main learning styles in Engineering students were reviewed and identified according to Felder and Silverman's proposal (Felder & Silverman, 1988) mostly as visual, sensitive and sequential.

In addition to the above, it is necessary to support the student by applying teaching strategies according to their learning style, recognising that the high failure and dropout rate is a complex problem that depends on many other factors such as personal interests, motivation, social context, etc., and must be taken into account. and should be taken into account, considering that even when teachers apply a diversity of teaching strategies and resources, a subject should incorporate activities for all learning styles, varying the strategies and being flexible in teaching in order to take advantage of the strengths and seek to develop those styles less applied by the students.

From the results obtained, it can be seen that there is a great variety of styles in the process of acquiring competences; learning is defined by the environment, social and economic conditions of the context in which the pedagogical activity is developed. As a consequence, learning styles oscillate from visual to sensitive in the course of their academic training, perhaps due to prolonged exposure to digital devices in their daily lives on a permanent basis, so it will be necessary in future research to determine whether this factor or another is a determining factor in the development of learning styles.

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Trajectory of public private associations. Case: wastewater treatment plant "Agua Prieta" - Jalisco

Trayectoria de las asociaciones público privadas. Caso: planta de tratamiento de aguas residuales "Agua Prieta" – Jalisco

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Abstract

Objectives: Public-private associations (PPPs), for the government sector, an opportunity to take advantage of the experience and efficiency of the private sector to improve the representation of services and develop the necessary infrastructures for economic and social development. PPPs generally involve large-scale projects, but unfortunately some sectors, such as water management, exclude the opinion of experts, giving rise to monopolies that greatly benefit the private sector, even excluding them from responsibilities by not fully resolving the problem for which they were created. contracted, the costs being absorbed by the public sector. Methodology: Confirming the success of PPP participation in works still in operation is premature, but an analysis of the current results is made, taking as a case study, the "Agua Prieta" Wastewater Treatment Plant (PTAR). Contribution: The results show that the collaboration of community groups in carrying out a participatory diagnosis and having follow-up and evaluation mechanisms to monitor the performance of the private partner, are actions that further improve the chances of success of the project; On the other hand, competition and the adequate selection of private partners represent the biggest failure factor in the implementation of PPPs.

Administration of Public Resources, Institutional and regulatory framework, wastewater treatment

Resumen

Objetivos: Las asociaciones público-privadas (APP) representan, para el sector gubernamental, una oportunidad para aprovechar la experiencia y la eficiencia del sector privado para mejorar la prestación de servicios y desarrollar las infraestructuras necesarias para el desarrollo económico y social. Las APP generalmente involucran proyectos de gran envergadura, pero desafortunadamente algunos sectores como la gestión del agua, excluyen la opinión de expertos, gestándose monopolios que benefician ampliamente al sector privado, incluso excluyéndolos de responsabilidades al no resolver en su totalidad la problemática por la que fueron contratados, siendo absorbidos los costos por el sector público. Metodología: Confirmar el éxito de la participación de las APP en obras aun en operación es prematuro, pero se hace un análisis de los resultados actuales, tomando como caso de estudio, la Planta de Tratamiento de Aguas Residuales (PTAR) de "Agua Prieta". Contribución: Los resultados evidencian que la colaboración de los grupos comunitarios en la realización de un diagnóstico participativo y contar con mecanismos de seguimiento y evaluación para monitorear el desempeño del socio privado, son acciones que mejoran en mayor medida las probabilidades de éxito del proyecto; por otra parte, la competencia y la selección adecuada de los socios privados representa el mayor factor de fracaso en la implementación de APP.

Administración de Recursos Públicos, Marco institucional y regulatorio, saneamiento de aguas residuales

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Introduction

The drive for infrastructure development in a country is aimed at activating the domestic economy and projecting new investment expectations from foreign capital. The financial crisis of governments has led to budget cuts, which has motivated the implementation of new approaches to public services with the participation of the private sector. This has led to infrastructure projects in the transport sector; however, other areas of the economy, due to increased demand, such as healthcare, have pushed for the introduction of private sector participation to manage the delivery of these services (Acerete, Gasca, Stafford, & Stapleton, 2015).

The Programme for the Promotion of PPPs in Mexican States (PIAPPEM) clarifies that PPPs do not necessarily focus on the construction and financing of new infrastructure but can include in the same contract the operation/provision of a public service. In this sense, the use of this type of scheme, according to the same PIAPPEM, is used in Mexico for the development of projects in sectors such as roads, health, education, infrastructure, water sanitation, among others (Rebollo Fuente, 2009).

With regard to risk sharing, this is another characteristic of this contractual relationship, where both sectors take part in the event of a claim. Regarding risk-taking, Sresakoolchai and Kaewunruen (2020) consider that one of the most positive aspects of adopting PPPs is the appropriate allocation of risks in order to optimise the benefits for PPPs.

Acerete Gil (2003), for his part, comments that PPPs "bring together a series of structures and concepts that involve collaboration between the public and private sectors in the design and implementation of infrastructure projects and public facilities, for the sharing of risks and responsibilities", since according to De la Fuente (2008), the objectives of PPPs are to address investments in infrastructure and generate profitable businesses, where the interests of the parties combine to achieve their objectives, as well as to supply and guarantee public goods and services.

In this way, it can be seen that the changes and the international vision registered in the 1990s for PPPs, is handled as an innovative strategy, where this interaction between the public private sector is not new and that until 1970 there was no presence of PPPs among international organisations and relations were few between donors and national governments directly (Almeida, 2017). By 1969, the term was coined in the Pearson Commission Report "Partners in Development: Report of the Commission on International Development".

The momentum of PPPs was boosted by the economic crisis of the mid-1970s; to alleviate it, international organisations such as the World Bank (WB) and the International Monetary Fund (IMF) promoted changes in economic structures and public policies. In addition, the increase in poverty and social inequalities in the world strengthened PPPs in the late 1980s and early 1990s, finding a relationship with international development aid and cooperation.

Although there are those who are against this financing scheme due to the results, political management and interests, among other questions, Moore (2006) finds that there is an increase in trust towards the private sector to improve living conditions, economic and technological development within a society, thus assuming a social responsibility.

From this government-private contractual relationship, it should be noted that PPPs serve as a legal tool that regulates the financing of investments from the private sector, and are intended to promote infrastructure to provide public services. Both sectors have different objectives: the public sector guarantees social welfare, public services through infrastructure works, among others, while the private sector generates income for the capital invested, guaranteeing the results agreed in contracts of this alliance. A specific time is stipulated, generally in the long term, to carry out its objectives with the fulfilment of a task, work, improvement, activity, acceptance of specific risks, surveillance, etc., all aspects regulated by the law that each country applies in the matter.

Currently in Mexico there is a lack of information and open access on issues related to impact monitoring and evaluation, application of penalties in response to untimely response and objectives not achieved by the investor, in works under this financing scheme. In countries such as Mexico, this issue is relatively new and is regulated by their respective Public-Private Partnerships Law, both in force since January 2012; in practice, there are different implementation models, from the construction, modernisation, maintenance, conservation and operation of infrastructure works, aspects linked to the development and growth of these Latin American countries.

The objective of this article is to describe the trajectory that PPPs have had internationally and their development in Mexico, through the analysis of governance in water sanitation in the Metropolitan Area of Guadalajara (AMG) with a case study of the Wastewater Treatment Plant (WWTP) of "Agua Prieta", in order to assess the performance obtained so far with respect to the expected results in the social and environmental sphere, through a review of specialised literature, information from public entities with open access and interviews with key actors.

Concepts of Public-Private Partnerships

The figure of PPPs has crossed borders, as they are currently enjoying acceptance and growth in different countries. The interest of governments, organisations, corporations, transnationals, among other actors, in attending to the welfare of humanity has become relevant in the decisions and regulations on the public function of each country.

Korab-Karpowicz (2020) mentions that for several years, PPPs have been handled internally as a government instrument to operate, but nowadays the intervention of actors as a nation-state takes different actions in the face of the generation of new international relations. The strength of PPPs as a partnership for international relations helps to solve governance problems beyond nation-state actors, leading to the acceptance of more democratic and accountable global governance.

The evolution of the model also generates new concepts that define the relationship. The fact that a new actor or third sector intervenes within a state structure to meet the same need gives rise to the term "Third Way". Patiño (2016) comments that the presence of a new institutional structure, including private parties with the intention of fulfilling the same objectives and activities as the public sector, generates a characteristic feature of this new alliance. The different schemes between the public and private sectors seek first and foremost to achieve an "optimal contract", where the private sector guarantees and ensures maximum efficiency through its experience and knowledge to guarantee social welfare (Barreto Nieto, 2011).

The World Bank Reference Guide (2014) details that the functions that are the responsibility of private parties may vary, and will depend on the type of good and service involved. Among others, contract types include functions such as design, concerning the development of the project from its original concept and requirements to the design specifications of the completed construction. PPPs relating to construction or rehabilitation are developed to create infrastructure that requires private parties to build and equip it. On the other hand, where PPPs involve existing assets, the private party would be responsible for rehabilitating or extending the asset. As for maintenance, PPPs assign maintenance responsibilities to the private party for the duration of the contract. In terms of financing, a PPP that includes the construction or rehabilitation of the asset requires private initiative to partially or fully finance the capital needed for the works. And with respect to the operation, the private party's responsibility may vary depending on the nature of the asset or service in question, whether it is providing technical support and providing a service to the government. In addition to the technical operation of the asset, the private party may provide services directly to the user, as in the case of public lighting and the water distribution system in several entities of the country.

Table 1 is presented below to illustrate different concepts addressed by different authors when referring to PPPs.

Concept	Source
"PPP is a mechanism by which the public sector (government or other state organisations) uses the capacities of private sectors (including cooperatives, private, charitable, non-governmental organisations (NGOs, etc.) such as knowledge, expertise and financial sources to provide infrastructure services (water and wastewater system, transport system, health system, education system, etc.). The private sector, on behalf of the government, plays the service delivery role."	Azami-Aghdash, Sadeghi-Bazargani, Saadati, Mohseni & Gharaee (2020)
"The concept of a PPP refers to a long-term agreement between public and private entities that allows the private sector to provide public services".	(Engel et al., 2014) citado por Liu y Xiongzhi (2019)
"Public-private partnerships can be defined as "the formation of cooperative relationships between government, for-profit businesses and private non-profit organisations to fulfil a policy function".	(Linder y Vaillancourt Rosenau, 2000, p.5) citado por Korab-Karpowicz (2020)
"They are voluntary arrangements between state and non-state actors, are based on a set of norms and rules, and involve the formulation of policy and the delivery of public goods, which distinguishes them from occasional public-private interactions or lobbying.	(Streck, 2002) Citado por Bjärsting (2017).
"Through PPPs, the state can take advantage of the private sector's capacities (financial, technological, administrative) to generate goods and services. Thus, in recent years there has been a trend that reflects a greater interaction between public and private actors to carry out tasks and activities in science and technology".	(Cimoli, 2000) citado por Navarro Arredondo (2013).
"A PPP is an agency relationship in which the government serves as the principal, and the private investor is commissioned to design, execute and manage a long-term investment project, transferring responsibility for the delivery of public goods or services, linking the return and utility of the investment to the sustained, high quality performance of the project".	Polack, Martínez Silva & Ramírez Chaparro (2019).
"The PPP is a form of public service provision that operates by agreement between the public sector and the private sector, whether it is a private or state initiative. Through this modality, part of the services, the implementation and management of which are originally the responsibility of the public sector, are handed over to a private entity for their provision".	Gallo Aponte, Fácio, Rodelo, Brito Jaime & Abcarius Racines (2018).

Table 1 Concepts Public-Private Partnerships

Source: Own elaboration, based on the above-mentioned authors

Background

As investment models, PPPs originated in 1992 in the United Kingdom; their purpose was to promote the participation of private capital in public sector projects, to develop infrastructure works for sanitation and health services that could not be financed by the sector (Vasallo Magro and Izquierda de Bartolomé, 2010).

For its part, Spain had already developed the figure of concession, today known as PPP, before the United Kingdom implemented it. In this sense, the concession as a legal figure is "the most common contractual manifestation of PPPs in Spain and in other countries with an administrative tradition" (Rebollo, 2009). In addition, in their evolution, PPPs went through "a process developed worldwide as a result of the crisis of the State since the seventies of the last century" (Sada Correa and Sada Correa, 2014), registering a boom at the beginning of the millennium in countries such as Germany, Portugal, Korea and Australia, among others.

The history of PPPs can even be traced back to European countries, where private investment in public infrastructure was already being generated in the 18th century. As a reference, one can mention the concession contract for the supply of drinking water in Paris, the Suez Canal and the Trans-Siberian Railway, already in the 19th century.

Tang, Shen and Cheng (2010) relate three generations as antecedents in the evolution of the model: presence of errors due to lack of experience for both sectors; large companies develop specialised projects in the urban sector, generally hiring PPP project managers who worked for public entities; and finally, in this third generation, social development emerges.

However, for other authors such as Warshawsky (2016), PPPs have been present in one form or another for many centuries, and have gained momentum in the 1990s and 2000s as an alternative or third way of partnership with the aim of changing welfare: private sector participation is sought in the development of projects, mainly in public service.

Internationally, the UK, as mentioned above, has extensive experience in PPPs. Acerete, Shaoul, Stafford and Stapleton (2010) highlight this nation as a global player in the field, where it has implemented the management of different financing schemes involving the private sector, including the construction of crossings and roads, and subsequently the expansion and maintenance of roads (Design, Build, Finance and Operate - DBFO).

In Spain, Acerete, Stafford and Stapleton (2011) record as a precedent the financing of a hospital with a PPP structure in operation for more than 10 years, carried out solely under this model, where the initial contract was never financially viable (it was very costly for the government) and a second contract improved its viability due to the financial benefits. In the financial sector, on the other hand, the authors highlight that regional non-profit savings banks are socially obliged to invest in the region for their communities.

Background in Mexico

As mentioned above, PPPs are an alternative financial strategy to boost Mexico's economic development through infrastructure development, mainly in the road construction sector.

However, failed results, deficiencies, lack of involvement of society, corruption and the search for profitability, regardless of quality and social benefit on the part of the private sector, have generated a strong controversy for this investment scheme between the public and private sectors (Lozano Montero, Godínez López and Albor Guzmán, 2017). The little regulation of PPPs in Mexico, according to Érick Díaz, generated great benefits "only for the private sector". He adds that there is little literature in Mexico because it is a relatively new topic, but other countries in the 1950s and 1990s developed the concessions that have been part of PPPs since the 19th century, and have been adapting to legal changes.

Prior to the legal recognition of PPPs in Mexico, three participation models or mechanisms can be distinguished as antecedents to PPPs: Productive Investment Projects with Deferred Registration in Public Expenditure (PIDIREGAS), Projects for the Provision of Services (SPSS) and Concession Schemes (Rojas de Paz and Delgadillo Díaz, 2017).

The creation of the Public-Private Partnerships Law came to regulate the implementation of this model in the country; its main objective is to regulate contractual relations between the public and private sector to achieve a social purpose. Thus, Article 2 of this legislation considers that "public-private partnership projects must be fully justified, specify the social benefit sought and demonstrate their financial advantage over other forms of financing".

This law clarifies that long-term contracts must not exceed 40 years of concession, including term extensions, and in the case of contracts that exceed this period, they must be approved by law (articles 87 and 98).

In addition, articles 14, 21, 25, 38 and 59 of this legislation set out the institutional framework, contracting mechanisms, required studies, approval procedures, PPP registration, fiscal management and other issues that make up the country's public-private partnership policy.

This legislation and its regulations set out the institutional responsibilities for conducting a PPP tendering process, and describe the process for evaluating the bids received and selecting the winning bidder.

The Centro de Estudios de las Finanzas Públicas (CEFP) (2016), as a technical collaborating body in legislative matters of Public Finance and Economy, integrates extensive information on the subject, from the background of PPPs, their trajectory, projects, legal framework, modalities, cases, among others.

The description of the background and the most relevant aspects registered in Mexico on the subject are included in Table 2.

Project	Background	Contract	Conditions
Productive Infrastructure Investment Projects - PIDIREGAS	Deferred Registration for Public Expenditure. Born in 1995 as a reform in response to the economic crisis of December 1994, scarce public resources and the development of infrastructure projects for PEMEX and CFE.	Procurement through international competitive bidding.	Commitment to build the projects with own resources or markets. With the start of income generation once the projects were completed, the obligation would be paid.
Concessions	Emerging after PIDIREGAS in the early 1990s. Aimed at road works projects and service provision. Given the economic crisis of 1994, terms of less than 10 years, increasing tariffs and decreasing demand, it was concluded that the projects were not profitable.	Road concession programme (52 concessions) to develop new roads - 5 thousand kilometres	50% bank loans 20% public subsidies 30% concessionary company
New Concession Scheme	The SCT and Banobras reorganise the previous scheme. Participation of state, federal and private resources. Maximum term of 30 years to keep the concession.	Public tender	Toll collection, rates regulated by the SCT. Concessionaires are responsible for cost overruns.

Table 2. Background on the legal framework and first PPP projects in Mexico.

Source: Own elaboration with data from CEFPE, (2016)

López Toache, Amado and Martínez de Ita (2018) mention that PPPs in Mexico have been favoured by the economic reforms of the 1980s to the present day, taking on greater momentum and momentum to materialise as new privatisation structures in the 21st century that undermine the public sector.

In this sense, Espejel Espinoza and Díaz Sandoval (2015) argue that the reform on PPPs in criminal matters is worrying, because private parties go from being simple contractors to administrators for twenty to thirty years - subject to renewal - responsible for the construction, maintenance and/or management of prisons. With this, they point out, the government commits itself to pay year by year for the use of the facilities and services, but if the private sector does not fulfil its obligations and commitments, the loss will be absorbed by the nation and the private companies involved will not be called to account.

Background of PPPs in Wastewater Treatment Plants in Mexico

Public-Private Partnerships (PPPs) in Mexico have emerged as a strategic tool to encourage investment and the development of infrastructure projects. These partnerships are based on the collaboration between the public and private sectors to carry out projects of public interest, seeking to combine the resources and capacities of both parties to achieve more efficient results. In the PPP approach, a private company is responsible for the financing, construction, operation and maintenance of the facilities, according to agreed quality, service or other standards (Engel, Fischer and Galetovic, 2014).

The development of PPPs in Mexico has had ups and downs over the years. At the federal level, PPP projects in Mexico had their beginnings in the context of major reforms of liberalisation and privatisation of Mexican markets. They can be considered to have started in the late 1990s and early 2000s, as it was during this period that Mexico began to implement the PPP model as a tool to promote private investment in public infrastructure projects. However, it was not until 2012 when the Public-Private Partnerships Law was enacted, which established the legal framework and guidelines for the implementation of PPPs in the country. (Sada Correa and Sada Correa, 2014).

During the first years of implementation, several projects were carried out in sectors such as roads, airports, ports, telecommunications and energy. The federal and state governments started to use PPPs as a tool to boost the modernisation and development of infrastructure in the country. (López Toache and Chavez Maza, 2020).

Some examples of projects developed under the PPP scheme can be seen in Table 3.

Project	*Year	Description
Cancun International Airport	1989	During this period, a PPP was carried out for the construction and operation of Cancun International Airport, one of Mexico's main tourist destinations.
Mexico-Toluca Highway	1994	A PPP was established for the construction and operation of the Mexico-Toluca highway, an important communication route between Mexico City and the city of Toluca.
Container Terminal of the Port of Manzanillo	1994	A PPP was implemented for the construction and operation of the Container Terminal at the Port of Manzanillo, one of Mexico's most important ports for international trade.
Mexico-Puebla highway	1995	This PPP was in charge of the construction and operation of the Mexico-Puebla highway, one of the country's main highways connecting Mexico City to the city of Puebla.
* Year of implementation		

Table 3 Main pioneering projects developed with the Public-Private Partnership model.

Source: Own adaptation. Ministry of Communications and Transport (SCT) (1996) (1997). Airport and Auxiliary Services (2016)

On the issue of water sanitation in Mexico, PPPs have played an important role. These partnerships have allowed the implementation of infrastructure projects and services to improve water management, wastewater treatment and drinking water supply in different regions of the country.

One of the flagship projects in the field of water sanitation is the PTAR Atotonilco. This PPP was established for the construction and operation of a wastewater treatment plant located in the state of Hidalgo. The plant, inaugurated in 2015, is considered one of the largest in Latin America and has the capacity to treat wastewater from various sources to reduce pollution and improve water quality in the region (Rodríguez, Molina, del Cuvillo Martínez-Ridruejo and Bozzano, 2014).

In the state of Guanajuato, a PPP was carried out for the construction of the Salamanca WWTP. This initiative aimed to improve water management and reduce pollution in the city. The treatment plant, inaugurated in 2017, allows for the proper treatment of wastewater before it is released into the environment (Pantoja-Espinoza, Proal-Nájera, García-Roig, Cháirez-Hernández and Osorio-Revilla, 2015).

In terms of drinking water supply, the city of Puerto Vallarta in the state of Jalisco has experienced significant improvements thanks to a PPP that was established to improve the drinking water supply and sanitation system in the city. Through the expansion and improvement of existing infrastructure, it has been able to provide a more reliable supply of drinking water to the community (Sistema de Agua Potable y Alcantarillado de Puerto Vallarta, 2020).

In recent years, Mexico has experienced a significant increase in the use of PPPs as a mechanism to drive the development of key infrastructure. According to a World Bank report (2019), Mexico is among the Latin American countries with the largest number of PPP projects underway, covering various sectors such as transport, energy, water and sanitation, health, among others.

One of the main benefits of PPPs lies in the ability to attract private investment for projects that otherwise might not have the necessary resources for their implementation. The participation of the private sector makes it possible to diversify the sources of financing and transfer part of the risk to the investor, which reduces the fiscal burden on the government and allows resources to be allocated to other priority sectors.

In addition to investment, PPPs can also generate efficiencies in project management and operation. The experience and expertise of the private sector can improve the quality of services and the timely delivery of projects. In addition, competition among private participants can foster innovation and cost reduction, generating benefits for both government and end-users.

However, it is important to mention that PPPs also pose challenges and risks. These include appropriate project selection, equitable allocation of risks and benefits between parties, transparency in tendering and contracting processes, and protection of public interests. Clear regulatory frameworks and effective oversight mechanisms are essential to ensure the long-term success and sustainability of PPPs. In Mexico, there are institutions in charge of promoting and regulating PPPs, such as the Ministry of Finance and Public Credit (SHCP) and the Investment Unit of the Ministry of Economy (UISE). These entities are in charge of establishing guidelines and criteria for the implementation of PPPs, as well as evaluating and monitoring ongoing projects.

Despite the potential benefits of PPPs, there are also challenges and criticisms associated with their implementation in Mexico. Some authors (Bracey and Moldovan, 2006; Sanger and Crawley, 2014; Sandoval Ballesteros, 2016) argue that PPPs can lead to further privatisation of public services and generate imbalances in the distribution of benefits. The need for greater transparency and accountability in the process of private partner selection and project management has also been pointed out.

To address these concerns, the Mexican government has implemented measures to strengthen the regulatory framework for PPPs and ensure greater transparency. For example, clear rules have been established for the tendering of projects and mechanisms for monitoring and evaluation of partnerships have been improved.

Involvement of PPPs in Infrastructure Works for WWTPs in the AMG

In Jalisco, the authorities in charge of water issues and hydraulic works are at the federal level the National Water Commission (CONAGUA), at the state level the Jalisco State Water Commission (CEA) and at the municipal level in the AMG the Intermunicipal System of Drinking Water and Sewerage Services (SIAPA) (Flores Elizondo, 2016) (Flores Elizondo, 2016).

According to the 2010 CONAGUA report, Jalisco treats only 3,493.5 litres per second out of a total of 14,144 litres per second, registering a critical situation, as only 24.7% is treated (Villanueva and López, 2014). The wastewater treatment plants for the sanitation of wastewater out of operation in this regard Anda Sánchez (2017) comments that in 2013 in the state of Jalisco there were 273 WWTPs in different municipalities, where 50% were not operating (22 abandoned and 63 about to be decommissioned), due to the high costs of maintenance, operation and electricity according to the report of the State Water Commission of Jalisco (CEA) and an interview with officials of the state water system.

Given the inequality and use of water in Mexico and as an alternative for the sanitation of wastewater or domestic water in an area of Zapopan, Jalisco, Caro, Vizcaíno, Hernández, Reyes and Díaz (2019), comment that there are studies that propose the construction of Treatment Plants with natural, ecological and sustainable processes based on plants, physical, chemical and biological sediments that carry out a purification process. In 2016 in the town of Las Cañadas de San Isidro in the municipality of Zapopan, it promoted the Natural and Sustainable Ecological Systems to contribute to the discharge of sewage or wastewater, helping 60 families to improve water sanitation in the area, training and awareness to improve the environment. Unfortunately in Mexico there is an imbalance in the consumption and availability of water, as most of it is used by industry, which contributes a high percentage of the Gross Domestic Product (GDP), but there are other alternatives that can be promoted by governments and communities to contribute to this problem of sanitation for domestic wastewater.

Case study

The different health, environmental and social problems that have been triggered by the contamination of the Santiago River by industrial discharges and the scarce legislation to control these discharges, hinder the operation of the WWTP designed to treat sewage or domestic wastewater from the AMG (McCulligh, 2013). Another problem that exacerbates the pollution of the Santiago River is due to irregular settlements and the lack of planning for an orderly growth of the AMG, giving rise to marginalisation and poverty in certain areas due to lack of infrastructure such as schools, hospitals, roads, among others, but mainly the lack of works such as drainage and sewerage, increasing the risk indices for the population with health, safety, social and environmental problems. Torres-Rodríguez (2018), comments that the metropolisation of this area has transformed soils suitable for agricultural activity into industrial and urban areas, demanding greater natural resources, including water, mainly for industrial and housing processes, causing an imbalance with the environment and social development.

According to data provided by the State Government of Jalisco (2012) in a report issued by the State Water Commission (CEA), the Rio Blanco WWTP served only 3% of sanitation for a population of approximately 3.3 million people in the AMG in 2012. The AMG's wastewater sanitation system is being expanded with the integration of two WWTPs. The first one is El Ahogado, starting operations in 2012 to serve 20% of the wastewater treatment and Agua Prieta to serve 80%, starting operations in 2014. The treated water is used for electricity generation using the biogas produced at the "Valentín Gomez Farias" hydroelectric plant of the Federal Electricity Commission (CFE), registering its final discharge in the Santiago River.

Both WWTPs are located within urbanised areas or regular low-income housing developments and irregular housing units, as well as large industries in the south of the AMG.

The "Agua Prieta" WWTP is the second largest in the country and the third largest in Latin America, and its construction is being promoted due to the contamination of the Santiago River by discharges generated by the AMG. This initiative is made possible by the support of the three levels of government, federal, state and municipal, through the financing of private capital in the PPP scheme with a period of 20 years, under the Build, Operate and Transfer (BOTT) model, which addresses the design, construction, financing, operation and maintenance. The financial distribution and characteristics of the project are illustrated in Table 4.

AGUA PRIETA" WASTEWATER TREATMENT PLANT		
INVESTMENT SOURCES (Figures in millions, excluding V.A.T.)	El Ahogado and Agua Prieta Sewerage and Collectors WWTPs	Treatment Plants D.B.O.T. Scheme Agua Prieta 8,50 m3/s
Federal Expenditure Budget (PEF)	\$1.842,5	
State of Jalisco	1842,5	
Trust Fund. National Infrastructure Fund (FONADIN)		\$948,0
Private Investment		\$1.657,3
Subtotal	\$3.691,0	\$2.605,3
Winning consortia:	Tender No. 43111001-090-08 Trust No. 1004	Controladora de Operaciones de Infraestructura S.A. de C.V. (CONOISA) 50%; Atltec S.A. de C.V. 34%; Servicios de Agua Trident S.A. de C.V. 16%

Construction start dates	2007 - 2011	Site 36 months Operation 207 months Operation in 2013
*Includes Financial Expenses Note: The private sector is contracted under the DBOT (design, build, operate and transfer) scheme, with a concession period of 20 years. Typology: Hydraulic Infrastructure.		

Table 4 Project characteristics

Source: CNA (2012) National Infrastructure Programme 2007-2012. De la Peña, Ducci & Zamora - IDB (2013). Own adaptation

This work was financed with federal non-refundable support from FONADIN with 49% and private investment (51%) recoverable through a service provision contract, convened by the Ministry of the Interior (2008) in public tender No. 43111001-090-08, for the Agua Prieta WWTP project: "provision of wastewater treatment services at the Agua Prieta WWTP with a capacity of 8,500 lps. which includes the executive project, construction, electromechanical equipment, operation tests, capacity tests, operation, conservation, maintenance, as well as the removal and final disposal of biosolids and solids generated in the monofill, under the lump sum modality with mixed, private, partial and recoverable investment, within 27 months from the date of signing the supervision contract".

Among its objectives is the sanitation of 100% of the wastewater of the AMG, promoting environmental benefits such as improving water quality and reducing diseases, odours, employment generation (1,500 direct and 4,500 indirect), generation of electricity, sludge treatment in compliance with NOM-004-SEMARNAT-2002, which guarantees improvements in soils for agriculture, among others.

The Government of the State of Jalisco, with the support of the State Water and Sanitation Commission (CEAS), the CNA, promotes sustainable alternatives for the environment, environmental protection and economic engine for projects. For this project, the intervention of the private sector in the participation of the corresponding percentage of the State Government through the municipalities of the AMG in the course of the work, allows a financing alternative to the lack of economic resources of any of the parties, to conclude works of relevance for social benefit (National Institute of Sanitary Management (INGESA) (2008).

The results after years of initiating these projects have both positive and discouraging comments, given this investment of millions of dollars by the Mexican government, where investors must guarantee optimum results in response to the government's initiative to include the private sector in the financial model of the Public-Private Partnership in public works that resolve social problems.

Relevant information in interview

As fieldwork, an interview was conducted with a former government official from the state of Jalisco, who is knowledgeable and expert in this wastewater treatment project for the AMG, under the PPP financing scheme. A description of the background and general details of this project were obtained in order to understand the problems and the final objective of this infrastructure. Given that there are few studies in specialised databases on this specific WWTP, we were guided by the public and private entities involved in this project to search for information.

Among the data to be highlighted are:

- This project is awarded through a tender.
- It will benefit more than 3.5 million inhabitants.
- This project is the third largest in Latin America and the largest plant in Mexico.
- The cost per cubic metre for water treatment is 98 cents, the lowest in the country.
- Capacity of 8,500 litres per second.
- It will cover 80 percent of the wastewater produced by the AMG.
- As an important part of the AMG's wastewater sanitation system, the San Gaspar-Agua Prieta collector has not yet been built, which would go to the edge of the Huentitán ravine in the Atemajac Basin, which would take the sewage from the east of Guadalajara, the San Gaspar, Osorio and San Andrés basins, to the Agua Prieta WWTP, where it would finally be treated and discharged into the Santiago River. It is known that there have been settlements in the area of the Barranca, without any interceptor tunnel, throwing the sewage directly into the river through the ravine.
- This collector would be in charge of CONAGUA and the State Government, as the State Government did not budget for it in the total project.
- The biogas will be used to generate electricity.
- The PTAR Agua Prieta was planned to treat 8,500 litres per second, but in the absence of this collector, it only treats 6,000 litres per second from the San Juan de Dios River, the remaining 2,000 litres of sewage fall directly into the Santiago River without any process. It can be said that this magnificent project is useless.
- The project does not contemplate the treatment or sanitation of industrial or agro-industrial water, only domestic or waste water. This limitation has not allowed the objective of 100% wastewater treatment in the AMG to be achieved. On the other hand, the permissibility of the authorities and the strictness of the law to oversee and monitor the waste produced by all the companies located in the AMG. It is known that there are permanent and constant discharges of industrial waste, prohibited by national and even international law.
- There were no agreements to buy land for the construction of the WWTP, because it is close to the Federal Electricity Commission (CFE), the "Agua Prieta" WWTP.
- Concrete actions were carried out for the construction of the Agua Prieta and El Ahogado WWTP, by the State Government through the Comisión Estatal del Agua y Saneamiento (CEAS) and in coordination with the Sistema Intermunicipal de Agua Potable y Alcantarillado, (SIAPA) and the Comisión Nacional del Agua, (CNA).
- The resources will come from the following distribution, it is clarified that the difference between the cost of the project and the total amount of investment will be financed by the company with risk capital and / or credit.
 - a) The risk capital, equivalent to 25% of the cost of the project.
 - b) The resources from the credit, equivalent to 28.5% of the cost of the project.

- c) The support of the fund, equivalent to 49% of the cost of the project with the support of the fund.

The distribution of percentages among the municipalities participating in this AMG project is listed below. See Table 5.

MUNICIPALITY: AGUA PRIETA	
El Salto	-
Tlajomulco de Zuñiba	-
SIAPA	100.0%
Guadalajara	50%
Tlaquepaque	8%
Tonala	11%
Zapopan	31%
TOTAL	100%

Table 5 Percentage distribution

Source: own adaptation based on interview data.

- The reality is that today the results are far from the commitments, objectives and promises that were made before this millionaire investment. The government and the investors did not diagnose in depth the problem of pollution of the Santiago River, leaving aside the pollution that companies and industries in the AMG produce every day, as the damage is mainly generated by industrial and chemical waste rather than by wastewater and domestic water. Academics, society, experts, local farmers, key actors, among others, were not involved. Finally, the laws are permissive and protect the investor, as the responsibility and risks fall on the public sector.
- The state of Jalisco has several WWTPs that are not functioning, not operating, so it should carry out a technical study with experts and, based on the experience of other WWTPs in Mexico and the world, include local and regional communities and different social and economic sectors to study the possibility of reactivating, adapting and modernising these infrastructures, considering that their presence can avoid further environmental damage and destruction of land and natural resources in the face of new proposals that are millions in the millions since their construction, which in many cases only put the state and the federation in debt.

- Finally, there is a problem that exacerbates the wastewater sanitation situation in the AMG, which is the indiscriminate and unplanned growth of low-cost housing developments allowed by the authorities to real estate companies or developers in the vicinity of the AMG river or basins that do not have adequate infrastructure for the provision of services, including aqueducts and sewage. Likewise, irregular settlements without control by the municipalities and authorities, where they improvise channels or outlets for wastewater into natural basins, giving rise to an area with high levels of pollution, which in turn strengthens the urban stain of marginalisation, insecurity and poverty, generally of immigrants or families with very low incomes.

Analysis of results

Promoting public works that guarantee the development of a country's economy through programmes and projects is an issue that every government handles in different ways, although its applicability defines its level of development. The contractual alliance as a financial strategy between the public and private sector through Public Private Partnerships (PPP) is an alternative to strengthen the different sectors of the economy, where governments adopt, regulate and govern PPPs to promote works that provide public services for social welfare, when the finances of the state do not allow to provide 100% of the capital. In Mexico it is relatively new and its implementation in some cases has been more of an experiment than a project analysed to solve the real problem.

Unfortunately, in some sectors, such as water management in metropolitan areas, monopolies have been created that largely benefit the private sector, even excluding them from responsibilities by not fully resolving the problem for which they were contracted, with the costs being absorbed by the public sector. The proposals presented by the investor were not always the most suitable for solving the problem of water sanitation.

In Mexico, the impact of PPPs represents a real challenge, given that monitoring initiatives are practically new and there is a lack of official information from the institutions involved.

Unfortunately, in water management in metropolitan areas, monopolies have been created that largely benefit the private sector, even excluding them from responsibilities by not fully resolving the problem for which they were contracted, with the costs being absorbed by the public sector. Furthermore, the proposals put forward by the investor were not always the most suitable for solving the problem of water sanitation.

Infrastructure management activities, traditionally carried out by the public sector, include construction, financing, operation, maintenance, regulation and control. However, the private sector may also be involved in whole or in part under policies established by law.

The changes in the international market economy, globalisation and the different designs and political schemes developed for these associations have allowed the dynamisation of a network of their own aspects and characteristics that today strengthen their legitimacy at a global level. As structured institutions with more grounded objectives, the literature shows diverse antecedents for PPPs with supported data and formalised records.

One of the justifications used to promote the implementation of PPPs in countries such as Mexico is the lack of adequate infrastructure to meet the demand for citizen services, which leads to a reduction in basic rights.

For this financing scheme, in Mexico, the Public-Private Partnerships Law (LAPP) legally ratified the legality and promotion of this contractual relationship between the public and private sectors, with the signature of Felipe Calderón, then President of the Republic, on 16 January 2012 (Diario Oficial de la Federación. DOF, 2018). Since then, these regulations have generated conflicting opinions, including the generation of corruption, the granting of privileges, public indebtedness, the handing over of control of public sector administration to private entities, among others.

The aim of this legislation is to improve the efficiency and effectiveness of these projects, as previous legal provisions had loopholes that - as in the Mexican case - fostered vices carried over from previous concession models, such as cost overruns, lack of transparency and poor coordination between government entities and private parties.

A review of the Mexican context of PPPs shows that they have made use of concessions that opened the door to private capital to jointly address major infrastructure deficiencies, such as the creation and maintenance of highways and road projects.

It was noted that in the last decade of the last century, in the absence of specific legislation on the subject, Mexico faced difficulties in the application of PPPs such as cost overruns, lack of compliance in delivery, lack of planning and coordination, unforeseen environmental impacts, corruption, and so on.

However, the experience allowed learning from the deficiencies and generating robust regulations that, a little more than a decade after coming into force, have given way to a variety of concession projects in areas as diverse as road infrastructure, health, drinking water supply and sanitation, as well as other public works that have been built thanks to the participation of private capital.

With all of the above, scholars from other disciplines could deepen their analysis of current or completed projects under this scheme with a sharper vision and a focus that measures social welfare, environmental impact and the legality of the contracts signed, as well as their compliance, since it is the taxpayers or users who pay for these million-dollar works that generate debt for the nation.

These results could strengthen or refute opinions in favour or against this form of financing that governments adopt as an alternative to solve social problems through public works.

Conclusions

The concept of Public-Private Partnerships (PPP) arises from the participation of the public and private sector in the construction of works for the development of infrastructure in a country. The intervention of this model in different countries around the world can be justified by the lack of economic capacity of governments to promote infrastructure development that guarantees an improvement in the quality of life of their citizens.

PPPs are alliances or contractual relationships whose intention is to achieve particular objectives for both the state and the investor with its private capital. Arguably, their origins date back several centuries and have evolved to the present day.

Developing countries may find in PPPs a financial strategy to promote economic development and social welfare, especially given their legal regime, regulations, financial models, contractual relationships, geography and the experience of other countries.

As a financing alternative, PPPs are currently being implemented by governments in Latin America, where Mexico is no exception, as they have become a strategy to boost economic development through public works infrastructure in both countries since 2012.

The literature reviewed shows the opinions of experts, scholars, academics and international organisations in favour and against, based on the results, the costs of public works, the political management that has been given to the projects, the fulfilment of objectives safeguarded in promises and hopes to benefit the majority of citizens.

On the other hand, it should be remembered that there are several models that involve the private sector in projects of this nature; as there is a wide range of schemes, the criteria for selecting a particular one should take into account aspects such as the ability to mitigate demand risk and payment risk, as well as the ability to make the projects attractive to all parties, i.e., users/citizens, investors and the public sector.

In Mexico, the impact of PPPs represents a real challenge, given that monitoring initiatives are practically new and there is a lack of official information from the institutions involved.

Finally, it is important to highlight that currently the federal government's major public works are carried out with mostly public funds managed by the Ministry of National Defence (SEDENA) and Banobras, leaving aside the participation of private capital in projects such as the Felipe Ángeles International Airport, the Mayan Train or the Dos Bocas refinery, despite the technical and financial benefits of PPPs described in this document.

Public-private partnerships in Mexico have been an important tool to promote the development of infrastructure and services in the country. While they have faced criticisms and challenges, the government continues to work on improving its regulatory framework to promote greater transparency and accountability in these partnerships. The effective use of PPPs can contribute significantly to economic growth and social welfare in Mexico through their potential to attract private investment and thus foster collaboration and improve the quality of life of citizens, which makes them an option to consider in the Mexican context.

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Proposal to improve the organizational performance of SMEs in Ciudad Obregón, Sonora

Propuesta para mejorar el desempeño organizacional de las PYMES de Ciudad Obregón, Sonora

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Abstract

The present study is of a qualitative and descriptive approach, where a diagnosis was made to the administrative process of SMEs in the locality, and based on the results obtained, proposals for improvement to their organizational performance were prepared, contributing to the increase in the probabilities of success and permanence in the market, thus fulfilling the established objective and responding to the question posed: How to improve the organizational performance of local SMEs to increase their chances of success and permanence in the market? As a contribution of this research is to provide support to local SMEs to solve problems and/or areas of opportunity detected, and in this way make proposals for improvement that are precise, timely, adequate and focused on the findings obtained, impacting in the same way on the economic development of the region, since when these proposals are implemented, SMEs are strengthened, improving services offered to clients, in addition to minimizing risks and possibilities of failure.

Improvement of organizational performance, SMEs, Administrative Process

Resumen

El presente estudio es de enfoque cualitativo y de tipo descriptivo, donde se realizó un diagnóstico al proceso administrativo de PyMEs de la localidad, y con base en resultados obtenidos, se elaboraron propuestas de mejora a su desempeño organizacional, contribuyendo en el aumento de probabilidades de éxito y permanencia en el mercado, cumpliéndose así con el objetivo establecido y dando respuesta a la interrogante planteada: ¿Cómo mejorar el desempeño organizacional de PyMEs de la localidad para aumentar sus probabilidades de éxito y permanencia en el mercado? Como contribución de esta investigación está proporcionar apoyo a PyMEs de la localidad para solucionar problemáticas y/o áreas de oportunidad detectadas, y de esta manera realizar propuestas de mejora precisas, puntuales, adecuadas y enfocadas en los hallazgos obtenidos, impactando de igual forma en el desarrollo económico de la región, ya que al implementarse dichas propuestas, las PyMEs se fortalecen, mejorando servicios ofrecidos a los clientes, además de minimizarse riesgos y posibilidades de fracasar.

Desempeño organizacional, PyMEs, Proceso Administrativo

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Introduction

According to a study by Ropega (2011), reasons for SME failure can include management errors, insufficient control mechanisms, operational inefficiencies and lack of financing or poor management.

According to Del Ángel (2016) SMEs represent 97% of companies in Mexico, generating 80% of employment and 36% of the Gross Domestic Product, which justifies attending to and supporting this type of companies as they are the basis of the Mexican economy, the same opinion provided by Díaz (2010), who assures that this type of organisation plays an important role in the generation of employment, contributing to prevent poverty from increasing, however, they are the least supported and when they are provided with some type of support, it is not well focused. On the other hand, Franco and Urbano (2010) in their research assert that it is important to define the parameters of success of companies, considering that in the literature there are various ways of measuring success: quantitative, where sales, number of employees, cash flow, returns on investment are taken into account; and qualitative, evaluating the satisfaction of entrepreneurs in relation to the results of the company, comparing the results of the company with those of the competition and the permanence of the company in the market over time. Therefore, the success of an SME is generally related to its consolidation and growth, job creation and profit for its shareholders. However, the authors state that "quantitative measures are not always adequate to measure the success of SMEs, as many of them require the long term to show positive financial results" (p. 83).

In addition, Fatoki (2014) analyses the causes of the high failure rate of new SMEs in South Africa, revealing that the causes are both internal and external. Internal factors include lack of management experience, lack of functional skills, poor staff training and development, and poor attitudes towards customers. External factors include the unavailability of a logistics chain and high distribution costs, competition, rising business costs, lack of finance and crime. The study suggests the need for owners of new SMEs to develop their personalities, especially in the area of business management skills through training.

It also suggests that government agencies should organise training courses for new SME owners on how to prepare business plans and manage enterprises. Awareness of the training programmes should be created through advertisements in the local and national media. In addition, government agencies can establish a mentoring approach to assist new SMEs; and concludes that the high failure rate of SMEs in South Africa negatively affects their ability to contribute significantly to job creation, economic growth and a more equitable distribution of income in the country.

Based on the above, the following question arises: How to improve the organisational performance of local SMEs in order to increase their chances of success and permanence in the market?

Justification. As Santamaría (2018) rightly mentions, organisations must improve their performance and become more efficient, which will lead them to seek ways to reinvent themselves, helping them to ensure their permanence in their environment. Due to this, it is considered important to provide support to local SMEs to solve the problems and/or areas of opportunity they present, carrying out an administrative diagnosis in order to, based on the results obtained, develop improvement proposals that contribute to the quality of their products and/or services, strengthen their performance and provide the company with greater probabilities of success and permanence in the market.

Similarly, Ramírez (2017) states that the support that can be given to SMEs consists of providing them with advice on competitiveness, teaching them the factors that have the greatest impact in this area, such as human resources, innovation, quality, technology applied to processes, strategic management, among others; without forgetting social responsibility, which can lead to certification as a socially responsible company (ESR); the country cost, which means that the better infrastructure a nation has, the cheaper it is to carry out commercial transactions with it, and finally, the business incubator factor, where support is provided to entrepreneurs through qualified consultancy to start up activities and increase their chances of success, which is what this research seeks to achieve.

In relation to the above is what is stated by Costa et al. (2023), who state that small and medium-sized enterprises should be given specific attention, as they represent 90% of all enterprises and 50% of employment worldwide. In addition, SMEs have very particular characteristics that distinguish them from large enterprises, they tend to be less productive and pollute more, they have more flexibility and agility to adapt to new circumstances, their resources are more limited and they have specialisation capabilities. However, SMEs require specific dimensions, variables and mathematical tools to measure their performance. Also, Vargas and Cárdenaz (2019), state that due to the importance that SMEs have for the economy in Mexico, it is necessary to implement strategies that support them in their consolidation, mainly because, according to INEGI (2016), cited by the authors, the life expectancy of this type of companies is very short, being the national average of 6.9 years; this is due to the different challenges they face, one of them being the administrative type, as they are usually managed by people who make all the decisions despite not having external advice, thus affecting the correct implementation of plans, as well as the effective way of carrying out the processes and the correct measurement of the expected results; one more reason to provide them with the appropriate advice and support to SMEs in the locality.

Objective

The objective of the research is: To elaborate improvement proposals for the organisational performance of local SMEs based on the results of a diagnosis carried out on their administrative process, thus increasing their probabilities of permanence in the market.

Frame of Reference

Organisational performance. According to Barradas et al. (2021), this term is difficult to conceptualise because "there is no single universally accepted definition" (p. 23), as it has been evolving over time.

These authors provide various definitions of organisational performance, among which are those provided by Shu-Mei and PeiShan (2014) who state that "It is the level of objectives achieved, as well as an assessment of the effectiveness of individuals, groups or organisations" (p. 25); Crook et al. (2005), who state that "It is the economic outcome that arises from the interaction between the organisation's behaviours, attributes and environment" (p. 25).

In their research, Barradas et al. (2021) conclude that to measure organisational performance it is not possible to consider only a general indicator, because this will depend on the strategies and goals established by each organisation. They also state that organisational performance should be evaluated considering two dimensions: objective and subjective. Within the subjective measurement, aspects such as customer satisfaction, leadership style, quality, innovation, work climate and interpersonal conflicts, employee satisfaction and stakeholder perception should be taken into account. For objective measurement, sales, cash flow, growth rate, market share, investment in research and development, financial indicators, market value and productivity should be considered, which will help to "delimit, establish and prioritise the problems detected and thereby design concrete actions that contribute to the effectiveness of the organisation" (p. 35). Miller and Proctor (2016) conduct research on change performance across more than 300 organisations and 400 000 data points over a 21-year period, where they present five main capabilities: adaptive leadership, effective execution of individual change, managing the demand for change, hiring resilient people, and creating the context for successful change; they also offer a practical roadmap for organisations to close the gap between the change they want to achieve and their capabilities to do so.

Related to this, Contu (2020) concludes in his study that organisational performance depends on the leader's ability to create a cooperative work climate and lead a team, and that individual performance can influence the performance of the whole organisation in a positive or negative direction. The study emphasises the importance of leadership in achieving organisational performance and the need for continuous learning to achieve the proposed objectives.

Based on the above, it can be said that an improvement in organisational performance will have an impact on several areas of the company, reflecting positively on financial issues as well as on aspects related to customer and employee satisfaction, organisational climate, quality of products and/or services offered, etc.

SMEs. In the literature review of the research conducted by Kotane and Kuzmina-Merlino (2017), they state that SMEs can be described as catalysts of the economy of the future, citing Forsman (2008) who considers it necessary to accelerate their growth and improve their competitiveness. The authors mention that SMEs have some specific characteristics according to their size and possibilities; they also point out that lack of resources can be considered as one of the main problems and a typical characteristic of this type of enterprises, taking into account that resources do not only refer to personnel, but also to management as well as financial stability and security.

For his part, Romero (2006) provides a statistical definition of SMEs, which is related to the number of employees and states that it differs in each country, the most common being to consider them in this category when they have between 10 and 250 employees, distinguishing them from micro enterprises because they have fewer than 10 workers, and from large ones, since they have more than 250.

"They are economic entities that generate employment, economic income, improve the standard of living of society and represent a substantial contribution to the gross domestic product (GDP) of each nation" (Basuki et al., 2021, cited by Lara and Cervantes, 2022, p. 38). They are led by entrepreneurs who have very particular, but well-defined characteristics; some with academic studies and others with empirical knowledge.

For their part, Shirokova et al. (2020), assures that this type of companies face adverse scenarios, which makes them be in constant defence against the unusual situations they face, which makes them seek to improve their performance and implement unplanned strategies that in turn cause expenses, due to the fact that they were not considered in a strategic plan from the beginning.

The above reinforces the importance of supporting this type of companies, providing them with advice that will result in an improvement in their performance, which will give them greater opportunities to remain in the market and continue contributing to and impacting the economy of the region where they are established.

Administrative Process. It is defined by Hernández and Hernández (2019) as a series of stages that are used for administrative practice, ensuring that this process is the beginning of any administrative activity whose main objective is the systematisation of knowledge to achieve efficiency. They also refer that currently the most universally accepted phases are: planning, organisation, management and control. The authors state that planning is considered to be the most important stage, since it is where objectives are set and it functions as a support for rational decision-making. The organisation stage is about achieving the objectives that were set in planning. The management phase seeks to delegate authority and coordinate activities; and in control, the criteria to be applied to measure and evaluate the results obtained are defined.

Coinciding with the above is what is stated by Blandez (2014) who assures that it receives the name of administrative process because in all organisations "all the important activities for the achievement of objectives are systematised" (p. 10), first, establishing them, then delimiting the necessary resources, coordinating the activities and, finally, verifying that the objectives have been met. Some other authors consider that another stage of the administrative process is forecasting, which consists of confirming whether the conditions exist to be able to do what is being planned.

Likewise, Mero (2018), assures that there are authors who call it the "administrative cycle" and that it is composed of stages that are continuous or cyclical: planning, organisation, management and control, which are of vital importance for decision making within the company.

However, Vargas and Cárdenaz (2019), conceptualise it as the basic methodology for implementing administration; the means that integrates different activities to be able to implement the organisational strategy, once the company's objectives have been defined and the strategy to be developed has been formulated, carrying out an analysis of the environment that surrounds it, the tasks to be performed, as well as the technology and people involved for it.

Finally, Márquez et al. (2021) defines the administrative process as "a set of cyclical, systemic, holistic, interdependent and flexible administrative management operations" and, whose main characteristic is "morphogenesis", which means that, as an open system, organisations can "modify their basic structure to better respond to internal and external stimuli" (p. 371).

After analysing the concepts provided by the different authors, it can be concluded that the administrative process is the series of cyclical stages that are carried out in an organisation to ensure that it functions effectively, achieves the established objectives and supports decision-making.

Methodology to be developed

This is a qualitative and descriptive research, where an administrative diagnosis was carried out in order to obtain information about the organisational performance of SMEs in Ciudad Obregón, Sonora, Mexico, participants in the study and, based on this, to develop recommendations in the areas of opportunity detected.

Subjects of the study. There are six companies participating in this study. They are small and medium-sized enterprises from Ciudad Obregón, Sonora, Mexico, which showed interest and willingness to participate in this research.

The participating companies are named as companies A, B, C, D, E and F, in order to respect their confidentiality.

Company A belongs to the industrial aquaculture sector and has 22 employees, of which four are female and 18 are male, their level of education ranges from high school, technical school to university degree. The products offered are frozen and fried shrimp.

Company B is a family business dedicated to the purchase and sale of agrochemicals, fertilisers, seeds and agricultural inputs. It has 140 employees, consisting of 75 women and 65 men. Most of the company's employees have a bachelor's degree and two have a master's degree.

Company C, also a family business, sells clothing, footwear, perfumery and accessories for men, women and children. It has four female employees, all of whom have a high school education.

Company D is a family business dedicated to providing marketing services, with 11 employees, seven of whom are women and four of whom are men. The level of education of the people involved is one with a master's degree and the rest with a bachelor's degree.

Company E offers toilet and portable sink rental services, as well as cleaning of septic tanks, grease traps and rubbish containers. It has 33 employees, of which four are women and 29 are men. The educational level of these workers is six with a bachelor's degree, 15 with high school and 12 with basic education.

The last company, F, is a family business that sells and rebuilds automotive parts; it has eight employees, of which two are women and six are men. The educational level of these employees is three with a bachelor's degree and five with a high school education.

Instruments. Two instruments were designed, one to characterise each of the participating SMEs and the other to obtain information to carry out the diagnosis of the administrative process, evaluating the phases that make it up: planning, organisation, integration, management and control, applied to each of the participating companies.

The first instrument, the characterisation of the company, is divided into three sections; the first is to obtain general data on the business, such as its name, address, telephone number, RFC, date of commencement of operations, background or history of the organisation, its main activity, size, number of employees and their level of education, as well as its main products and/or services to offer, customers and suppliers.

The second instrument was designed to obtain information about the administrative process implemented in the company. This instrument is divided into five sections:

- a) Planning, where we asked about the philosophical platform of the business (mission, vision, values, objectives), as well as its strategies, regulations, policies, budgets, programmes and procedures.

- b) Organisation, where we asked whether the company has an organisational chart and whether it is updated or not, whether it has job descriptions and specifications, and whether it has administrative manuals.
- c) Integration, where we inquired about the recruitment, selection, hiring and induction of personnel.
- d) Management, questioning about aspects of leadership, motivation and communication within the company.
- e) Control, to obtain information about the measures and types of control implemented by the business, as well as the establishment of standards, the use of formats and reports for the follow-up of actions.

Procedure. The process followed in this research is based on the one proposed by Hernández (2018), with some adaptations, as follows:

1. Compilation of theoretical information on the research topic. A bibliographic search was carried out on the variables to be investigated, in order to have prior knowledge on the subject of study.
2. Determination and selection of the sample size. Different local SMEs were invited to participate in the research, and six businesses agreed to take part in the study.
3. Design of the measurement instruments. Two instruments were designed to collect the necessary information about the characteristics of the participating SMEs, as well as to carry out a diagnosis of the administrative process implemented by them, questioning the phases of planning, organisation, integration, management and control.
4. Application of the designed instruments to the participating SMEs. The two instruments designed were applied through interviews with the representatives of the SMEs to obtain reliable and trustworthy information about what we wanted to know.
5. Analysis and interpretation of the results obtained. Once the instruments were applied, an analysis of the information obtained was carried out, which resulted in

knowing the current situation of each of the participating SMEs in terms of the implementation of the administrative process.

6. Elaboration of improvement proposals for each of the participating SMEs. Based on the findings obtained, improvement proposals were designed for each of the SMEs studied, as each of them presented specific and particular areas of opportunity.
7. Drawing up conclusions and recommendations. Conclusions and recommendations were drawn up for the implementation of the improvement proposals designed.
8. Preparation of the final report. Each of the studied SMEs was given the findings of the present research, as well as the improvement proposals specifically elaborated for them.

Results

These are presented in two sections: the findings obtained in the diagnosis of the administrative process, for each of its phases, followed by the proposals for improving organisational performance made to each of the SMEs participating in the study.

Results of the diagnosis of the administrative process

The information obtained through the application of the instrument designed to diagnose the administrative process of each of the companies participating in the study is as follows:

Company A. In Planning, it was found that it does not have any of the types of plans formally established in writing. It only has budgets defined and established in writing. Organisation: in this phase the only deficiency found is that it does not have a procedure manual for the human resources area. Integration: there is no procedure for the recruitment of personnel and no external sources or means of dissemination for this purpose. For the selection of personnel, no knowledge or skills tests are applied to candidates, nor are medical examinations requested prior to recruitment to verify their state of health. Management: little work is done in groups or teams, which affects the level of performance, innovation and motivation generated by working in this way. Control: No areas of opportunity were observed in this phase.

Company B. Planning: there is a mission and vision, however, they lack certain elements and most of the staff are not aware of them; contrary to the values, which are known and accepted by the staff. Organisational objectives exist, however, it was found that not all areas have specific objectives.

There are no defined strategies. Policies are not known to all staff. There are no written procedures or programmes. There is a general budget and there is oversight to ensure that resources are not diverted, however, the needs of all areas are not taken into account when defining the budget. Organisation: There is no organisational chart. Although there are all the job descriptions that exist in the company, they are not up to date and do not have the specifications required by the occupants.

There is no organisation, procedures or induction manual. Integration: there is a formal process and only internal sources are used for recruitment and selection of personnel, however, no knowledge or medical examinations are carried out at this stage, only the candidate's profile is considered. There is also no induction programme, which delays the incorporation and adaptation of the new employee. Management: a lack of empathy on the part of the leader was detected, which prevents harmonious working.

Staff are motivated through monetary incentives, but the impact of this is not measured. In terms of communication, there is no mechanism for the management and control of information. Teamwork is not supported. Control: there are no control measures, no standards, objectives or indicators are set to measure the performance of the areas, they are only used for the sales area. The only form of control used is concurrent and feedback, they do not make a preliminary control to avoid problems. The critical points necessary for the control of each area are not identified, nor are the actions and reports presented followed up, and there are no formats designed to be applied to the actions that require it.

Company C. Planning: has a mission and vision, but they lack the essential elements to be considered as such, and they are not placed in any visible place in the company, so they are unknown to the employees.

As far as objectives are concerned, there is one, but it is not formally set out in any document that can be used to verify that it is actually being fulfilled. In the same way, there is no formal establishment of strategies, those that are applied are empirical, without foundation, and it is not verified whether they provide the expected result.

In general terms, the company lacks policies, regulations, procedures, programmes and budgets. Organisation: there is no organisation chart, as the owner does not consider it necessary due to the small number of employees. As a result, there are no job descriptions, organisation manual, procedures manual or induction manual. Integration: there is no formal procedure for recruitment, selection, hiring and induction of staff. Management: The owner of the company considers that the leadership exercised in the company is adequate, as it influences people to follow it. The leadership that is managed has not caused problems in the company and favours working in harmony to achieve the objectives that the owner has in mind. It is customary to motivate employees with trips and also informally give them bonuses for the fulfilment of activities, but there is no evaluation of the impact of the motivation provided.

Communication within the company is personal, verbal and direct between the boss and the employees, so it is clear and without confusion. There is teamwork within the company, which increases the effectiveness of the functions. Control: The company uses measures to control its activities, however, they are not documented. The control measures are not made known to the employees as they are considered very sensitive. The company has no established standards, objectives or indicators to measure the performance of each area of the business. As a control mechanism, only inventory is managed, but this is done informally in a notebook for the control of the entrepreneur; no system or software is used for its management. In addition, monthly sales statistics are kept, but this is not done in a formal way either, they are only presented on a sheet of paper so that the accountant is aware of the income and expenditure for the period. The type of control commonly used by the company is preliminary and preventive.

Company D. Planning: they have a mission statement, but it is not visible anywhere in the company, but it is on the platform and everyone has access to it. Organisation: there is no structured and formally defined organisation manual, nor is there a procedures manual, but employees are aware of the activities they have to carry out. Integration: In the selection process for new staff, there are no skills or psychological tests and there are no staff selection policies. Similarly, there is a lack of a formal induction process and a manual to support this process, which hinders the integration of new employees into the company. Management: there is no evaluation of the impact of motivation on staff; there have been problems with written communication, when requesting an activity by mail or message it is not entirely clear to employees, thus causing delays in carrying them out. Control: employees are unaware that performance evaluations are carried out in a formal manner, according to them they are only evaluated by observing them when performing their work, but not in writing, and they are not provided with feedback, so they do not know the areas in which they need to improve. Nor is there a formal follow-up report on the company's actions that pays attention to suggestions, complaints and/or recommendations made by the clients to whom the service is offered.

Company E. Planning: there is a written mission and vision, but it lacks certain elements and it is necessary to have them in sight. Regarding the objectives, they are not known by the employees, so there are no evaluations to verify their fulfilment. Strategies are not formally established, nor are policies. There are rules, but they are not updated and are not known by the staff. There are also no formally established procedures. Organisation: there is an organisational chart, but it is not updated and is not known to the staff. There is a job description, but it contains very generalised information and is not detailed. There is no organisation manual. There is a procedures manual, but it is not available to employees. Integration: There is no formally established process for recruitment or selection of personnel, the questions in the interviews of candidates are asked as the conversation progresses, there is no written report, there are no knowledge tests, only anti-doping tests, nor are the data provided by the candidates verified. Nor is there any training for staff.

Management: in the area of motivation, there is only the financial incentive; in written communication there are problems, as the staff do not read the instructions given to them. Control: there are no checks on internal functioning, nor are there any reports to generate activity reports.

Company F. Planning: There is no officially written mission, vision or values, but the latter are put into practice.

There are general objectives, but they are not in writing, nor is there a means of supervision to verify compliance with them. There are also no policies, rules, procedures and budgets. Organisation: There is no established organisational chart, nor is there a job description, job specification, organisational manual or procedures manual. Integration: there is no formal recruitment or selection procedure for hiring new employees; when hiring, there is a process for integrating the personnel file and affiliation with the corresponding institutions, but there is no induction programme or manual; however, the direct boss is in charge of providing the necessary training. Management: the leadership that is exercised in the company is not adequate and therefore has caused problems, so it is considered that work must be done to achieve harmony towards the achievement of the objectives. However, the company constantly tries to motivate employees by giving them money and quality of working life according to their performance. Communication within the company is another point that needs to be worked on because, despite having personal communication, it is not clear between the boss and the subordinate, and there are often problems in written communication because there are no mechanisms for managing and controlling information. Control: Control measures are in place, but no standards, objectives or indicators are set to measure the performance of each area of the organisation. The most commonly used type of control is concurrent, as it is carried out when the action is being carried out and the critical points that need to be controlled in each of the company's areas are identified.

Proposals for improving organisational performance for the participating companies.

Company A. All types of missing plans (mission, vision, objectives, values, strategies, etc.) were designed in writing and included in an organisational manual and an induction manual that will provide support to welcome the new employee, ensuring a comprehensive knowledge of the institution and its functions within the company. A procedures manual was also designed for the human resources area, specifically for the recruitment function.

Company B. The mission and vision of the business was redefined for this SME, taking into account the elements that were lacking, and a quotation was provided to place these plans on acrylic sheet to place them in a visible place so that the staff would be familiar with them. Support was provided for the establishment of specific objectives for each area of the company, in addition to creating a control board to periodically verify compliance with these objectives, which in turn has an impact on the area of opportunity detected for the control phase. The organisation chart of the business was designed, as well as updating the descriptions and specifications of each position that make up the organisational structure. With the above information, the organisational manual was designed, as well as the procedures manual for the production area. An interview format or guide was designed containing questions related to the basic knowledge of the position to be filled. In order to improve leadership, motivation and effective communication in the organisation, training courses on these topics were quoted and presented to the manager.

Company C. The mission and vision of the business were redesigned, and were produced in an eye-catching, large format so that they could be placed in a visible place for both employees and customers. The objectives, values and strategies of the company were written down, as well as the company's policies and rules, and the company's budget was put in a formal document. In the same way, the organisational structure chart was designed, complemented with the corresponding job descriptions, which served as input for the design of the organisational and procedures manual. A written procedure was designed for the functions of recruitment, selection, hiring and induction of staff. An induction manual was drawn up to complement the previous processes and a proposal was made to the owner for the creation of new posts necessary for the optimal functioning of the company.

A training course on leadership and effective communication was also proposed. Documents were designed for the company to formalise its inventory control activities, sales, information on income and expenditure, as well as an instrument to keep track of its clients; and another one where employees are informed of the internal regulations and policies, and their signatures are obtained to ensure that they have been informed about them.

Company D. The marketing service company had its vision and mission statement updated and posted in a visible place for employees and customers. The objectives were set out in writing and the strategies that will help to achieve them were formulated. In the same way, the organisation manual and the procedures manual were drawn up with the actions and operations to be followed to carry out the general functions of the company in order to optimise them. Likewise, the policies for the personnel selection process were designed, which will allow for the effective recruitment of suitable personnel for each position, and for them to contribute to the company's mission and the achievement of its objectives, In addition to formally establishing an induction process, complemented with the design of a manual so that new staff feel familiar and identified with the company's way of working and ideology, facilitating their adaptation and integration into the organisation, as well as the responsibilities corresponding to their job. Likewise, an incentive plan was proposed to stimulate the work performance of the employees, increasing the productivity of the business. For the control phase, it was proposed to carry out performance evaluations of employees to determine their compliance and to be able to offer them adequate and timely feedback. An action follow-up report format was also designed to give the required attention to complaints and suggestions made by customers regarding the service offered by the company.

Company E. This company's mission and vision were updated and placed in a visible place for employees; the objectives were formally established in writing and made known to all employees, in addition to supporting managers in defining strategies, as well as the policies and regulations to be implemented in the business.

Likewise, the organisation chart was updated and made available to everyone; the job descriptions were complemented, detailing the activities according to the functions performed, and included in an organisation manual, which was designed according to the needs of the company so that it can perform its functions properly, as well as designing a procedures manual for each of the services provided by the company, in order to minimise work risks, maximise the performance and quality of service, as well as extend the life of the equipment used. Likewise, a manual for recruitment and selection of personnel was designed, in order to fill existing vacancies in the most appropriate way. A detection of training needs was carried out, and based on the results obtained, quotations were requested for courses in basic mechanics, safety, electrical systems, computers and technology, etc. Likewise, motivational strategies were designed for the staff, such as the placement of a mural with the employee of the month based on the fulfilment of goals, the granting of recognition to staff for their good performance, as well as offering incentives such as bonuses for goals achieved and prizes for the care of work equipment. Finally, it was recommended that internal audits be carried out in order to improve processes.

Company F. This SME dedicated to the sale and reconstruction of automotive parts had its mission and vision designed, as it did not have them; its values and objectives were established in writing, and its policies and regulations were drawn up. The organisational chart for the company was created, as well as the description of the positions that make up the organisational structure of the business, which served as input for the preparation of the organisational manual. The induction manual was also developed to support the induction process for new staff. Leadership, communication and motivation strategies were also designed, as well as the establishment of indicators to measure the performance of the different areas of the organisation. A format for weekly sales control was also designed, which will be used to identify the best salesperson of the month and award him/her with a stimulus or recognition, in addition to providing information on the sales made.

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Conclusions

It can be said that the present research fulfilled its objective, since proposals for improving the organisational performance of the local SMEs participating in the study were elaborated, based on the findings of the diagnosis of their administrative process, thereby seeking to increase their chances of remaining in the market.

As stated by Rodrigues et al. (2021) SMEs can achieve sustained growth and competitive advantage by focusing on success factors such as strategic planning, management capacity, entrepreneurship and innovation, human resources, networks and partnerships, and financing. In turn, Ojha et al. (2023) states that SMEs must constantly review and adapt their strategic plans to changing market conditions, customer needs and other external factors, which will allow them to respond in a more agile and timely manner to market changes.

Therefore, it is considered of utmost importance that the businesses studied implement what has been proposed as part of an efficient management; In turn, coinciding with Ramírez (2017) and Santamaría (2018) who state that providing advice to organisations so that they can be competitive, reinvent themselves and improve their performance, will help them to guarantee their permanence in their environment, so it can be said that this research is contributing to the local SMEs in providing them with this guidance, so that they can be successful in the market where they operate, hoping that they follow the specific and specific suggestions that were pointed out to them to obtain the best results.

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Cost-benefit analysis of the best combination of organic and inorganic sources to supply zinc deficiency in pecan (*Carya illinoensis* [Wangenh] k. Koch)

Análisis costo-beneficio de la mejor combinación de fuentes orgánicas e inorgánicas para suplir la deficiencia de zinc en el nogal pecanero (*Carya illinoensis* [Wangenh] K. Koch)

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Abstract

Zinc (Zn) is considered a trace element; however, this element is scarce in calcareous soils, so it is necessary to make applications to optimize performance. The objective of this study was to analyze the cost-benefit relationship of the best combination of applying organic and inorganic sources of zinc in the cultivation of walnut (*Carya illinoensis* [Wangenh] K. Koch) that maximizes the yield of pecan nut. Prior to the cost-benefit analysis, five Zn application treatments were evaluated; a control treatment (T1-no application); T2 was the application of 4.5 L H₂SO₄ + 3 kg ZnSO₄ in 100 L H₂O; T3 consisted of the application of 3 Kg ZnSO₄ in 20 L of worm leachate measured at 100 L of H₂O; T₄ was with the addition of 3 kg ZnSO₄ mixed in 25 kg of solid vermicompost; and T5 was the addition of 3 Kg ZnSO₄ in 25 kg of compost. A total of two applications per treatment were made. The parameters evaluated were the concentration of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), iron (Fe), copper (Cu), manganese (Mn) and zinc (Zn) in the leaf tissue and the yield in kilograms of walnut (kg ha⁻¹). The highest nut yield was obtained with T2 with 1,400 kg ha⁻¹ compared to 933 kg ha⁻¹ that were harvested in the control treatment; that is to say, a differential of 467 kg of walnut. A b/c ratio of 1.2861 was calculated for the best biological treatment, which was T2.

Resumen

El zinc (Zn) es considerado un elemento traza; sin embargo, este elemento es escaso en suelos calcáreos por lo que es necesario realizar aplicaciones para optimizar rendimiento. El objetivo de este estudio fue analizar la relación costo-beneficio de la mejor combinación de aplicar fuentes orgánicas e inorgánicas de zinc en el cultivo del nogal (*Carya illinoensis* [Wangenh] K. Koch) que maximice el rendimiento de nuez pecanera. Previo al análisis costo-beneficio se evaluaron cinco tratamientos de aplicación de Zn; un tratamiento testigo (T1-sin aplicación); el T2 fue la aplicación de 4.5 L H₂SO₄ + 3 kg ZnSO₄ en 100 L H₂O; el T3 consistió en la aplicación de 3 Kg ZnSO₄ en 20 L de lixiviado de lombriz aforado a 100 L de H₂O; el T4 fue con la adición de 3 Kg ZnSO₄ mezclados en 25 kg de lombricomposta sólida; y el T5 fue la adición de 3 Kg ZnSO₄ en 25 kg de composta. Se realizaron un total de dos aplicaciones por tratamiento. Los parámetros evaluados fueron la concentración de nitrógeno (N), fósforo (P), potasio (K), calcio (Ca), magnesio (Mg), sodio (Na), hierro (Fe), cobre (Cu), manganeso (Mn) y zinc (Zn) en el tejido foliar y el rendimiento en kilogramos de nuez (kg ha⁻¹). El mayor rendimiento de nuez se obtuvo con el T2 con 1,400 kg ha⁻¹ en comparación con 933 kg ha⁻¹ que se cosecharon en el tratamiento testigo; es decir, un diferencial de 467 kg de nuez. Se calculó una relación de b/c de 1.2861 para el mejor tratamiento biológico que fue el T2.

Analysis, Yield, Inorganic, Optimize

Análisis, Rendimiento, Inorgánicas, Optimización

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Introduction

The United States of America, with 75% of the world's pecan nut (*Carya illinoensis* [Wangenh] K. Koch) production, is considered the world's largest producer (USDA, 2020). Mexico ranks second in the world with approximately 20% of the production. Thus, the production in 2009 was 74,226 tons, where the state of Chihuahua with 65% is considered the first producer of this nut. The cultivation area has grown exponentially in Mexico; thus, SAGARPA (2013) specified that, only in a period of 10 years (2003-2013), 20,000 ha of walnut trees were established. By 2016, Mexico was harvesting 280,000 tons of walnut in an area of 112,156 ha with a production value of 622 million dollars (PAN-SAGARPA, 2017).

In the particular case of Mexico, pecan nuts are harvested in arid and semi-arid soils; which are classified in the soil taxonomy order as Aridisols and cover about 60% of the country's surface (Montaño et al., 2016). These soils cover about 1/3 of the world's surface and present unique characteristics such as high levels of CaCO₃ in their profile (calcareous-caliche soils), alkaline, presence of salts and low levels of organic matter. These characteristics are the result of low rainfall and high temperatures that further potentiate the desertification process (IPCC, 2007). The tree that produces the pecan nut belongs to the Juglandaceae family and is native to northern Mexico and southern United States of America (Hal, 2000).

Zinc (Zn) is considered a trace element and essential for plants because it plays an important role in physiological metabolism and hormone regulation (Ojeda-Barrios et al., 2014) as well as being involved as a cofactor in enzyme regulation and cell division (Hajiboland and Amirzad, 2010). However, Zn deficiency in plants growing on calcareous soils is common and, in particular, the pecan tree requires adequate Zn inputs to achieve good yields. It is clear that a Zn deficiency can lead to reduced photosynthesis and lower yields in the crop of interest. Consequently, it is necessary to evaluate cheap and easily accessible sources of this trace element to guarantee a good pecan nut production and to know its benefit-cost ratio.

The purpose of a benefit-cost (b/c) analysis, particularly in the agricultural sector, is to identify the rate of return on an investment and to identify a potential negative effect, if any. Ultimately, the aim is to increase the profitability of farmers in the agricultural sector, who are willing to incur additional expenditure in their production processes. It is important to mention that growth in the agricultural sector plays an important role in poverty reduction, as some estimates have determined that such growth is three to four times more effective than growth in other non-agricultural sectors (Christiansen and Martin, 2018). The objective of this study was to conduct a cost-benefit analysis of the best combination resulting from analysing various organic and inorganic sources to supply the element Zn in walnut (*Carya illinoensis* [Wangenh] K. Koch) cultivation to obtain the best pecan nut yield.

Methodology to be developed

An experiment was conducted in 2018 in the walnut orchard owned by the Faculty of Agricultural and Forestry Sciences (FCAyF) of the Autonomous University of Chihuahua (UACH). The orchard is located near the city of Delicias, in the state of Chihuahua, Mexico, and belongs to Irrigation District 005. The area is located at 28°11" North Latitude and 105°30" West Longitude and is at an altitude of 1,415 m above sea level. The area is considered to be semi-arid extreme, with an average annual temperature of 18.6° C, a maximum temperature of 42° C in summer (July-August) and a minimum of -13° C in winter (December-February). The average annual rainfall is 294.7 millimetres which occurs in the summer (June-August) and a relative humidity of 45%. The number of frost days is 110 and there are potentially 3 days of early frost in October and 4 days of late frost in April. The prevailing winds come from the southwest. The walnut trees are irrigated with a gravity irrigation system and one walnut tree was considered as experimental unit with four replications. A total of four treatments were evaluated, which were prepared with different sources of organic matter (OM) and sulphuric acid (H₂SO₄) plus the control treatment (T1). The second treatment was the application of 4.5 L H₂SO₄ + 3 kg Zn SO₄ in 100 L H₂O (T2); the third treatment consisted of the application of 3 kg ZnSO₄ in 20 L of worm leachate gauged to 100 L H₂O (T3); the fourth treatment was the addition of 3 kg ZnSO₄ mixed in 25 kg of solid vermicompost (T4); and the fifth treatment was the addition of 3 kg ZnSO₄ in 25 kg of compost (T5).

A total of two applications of each of the treatments were carried out; the first one was done on 5 April and the second one on 12 May. For the application of the treatments, a trench of approximately 30 cm depth was constructed. This trench was constructed in each experimental unit at a distance of 2m. In this trench, the amount of product corresponding to each treatment was applied, then the trench was covered and irrigation was applied. All other tasks in the orchard (irrigation, weed control, pest control, soil and foliar fertiliser application) were carried out according to the schedule of activities established by the institution. The parameters evaluated were the concentration of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), iron (Fe), copper (Cu), manganese (Mn) and zinc (Zn) in the foliar tissue and the yield in kilograms of nut. In the first week of August, a first sampling was carried out to determine these concentrations in the leaf tissue. These determinations were carried out in the soil fertility laboratory of the FCAyF. In November, the harvest was carried out to determine the nut yield by transforming the harvested nut into kilograms per hectare.

Statistical analysis of biological response

To determine differences between treatments, an analysis of variance (ANOVA) was carried out considering an arrangement of treatments without structure (Rubio and Jiménez, 2012). The analysis was carried out using the statistical package SAS (Statistical Analysis System) and when the ANOVA showed significant effects, i.e., when the F value was significant, we proceeded to use a comparison of means test with Tukey's method. In all cases the statistical analyses considered a significance value of 95%, i.e., $\alpha=0.05$.

Cost-benefit analysis

Once the best treatment evaluated in the Zn application treatments from the biological point of view had been determined, a cost-benefit analysis was carried out. To carry out this analysis, the simplest formula was used, i.e., the b/c ratio was calculated, where b represents the benefit and c the cost.

The benefit of each treatment is determined as a percentage, and its interpretation is: if the result is greater than 1 it is acceptable or profitable, if its result is equal to 1 it has no profit benefit or loss and if its result is less than 1 it is not profitable, therefore the treatment or project is rejected. Its formula: Profit Cost = Net Profit/Net Cost \times 100.

Results and discussion

The ANOVA results for nutrient concentration in walnut leaf tissue showed differences between treatments for the elements P, Fe, Cu, Mn and Zn ($P<0.05$) while no statistical difference was detected for N, K, Ca, Mg, Na and B ($P>0.05$). A detailed analysis of these results is not carried out as it is not the objective of this study. Of the treatments evaluated, the highest nut yield was obtained with T2, i.e., with the application of 4.5 L H₂SO₄ + 3 kg Zn SO₄ in 100 L H₂O (T2). The higher concentration obtained in this treatment is attributed to the effect of the sulphuric acid in lowering the soil pH, increasing the availability of Zn. In this regard, the researchers Miyamoto et al. (1975) mentioned that acidification of calcareous soil can temporarily lower the soil pH and, consequently, reactivate the solubility of Zn and other nutrients that were not available to the plant. In fact, this treatment had a positive effect on the availability of other elements (i.e., the elements P, Fe, Cu and Mn) which would favour better tree development. This assertion is confirmed by Lindsay and Norvell (1978) and Wallace and Mueller (1978) who indicated that acidification of small, banded soil areas with H₂SO₄ applications near the roots eliminated micronutrient deficiencies.

The highest nut yield was obtained with T2 with 1,400 kg ha⁻¹ compared to 933 kg ha⁻¹ harvested in the control treatment, i.e., a differential of 467 kg nut, in this treatment was obtained as a b/c ratio of 1.2861 and is the one that generated the highest return per invested weight and without any visible risk. Researchers Hosseinpour *et al.* (2022) conducted a study where they performed a b/c analysis in an urban agriculture design project in a sustainable environment. They found a value of 0.86 in the traditional system, which was not considered economically profitable. However, in their project proposal they found a value of 4.08 which tremendously outperformed the traditional project.

Most c/b ratio analyses around the world have focused on irrigation water use (Szott and Motamed, 2023). However, c/b analyses are indispensable for any activity that aims to increase crop yields. Ultimately, it is desired that the farmer adopts an innovation that will increase his yield in the field and, consequently, increase his income. In addition, the adoption of a certain practice can lead to the adoption of that practice by other farmers. For example, when a producer in Canada adopted strip grazing in a short period of time, this new technology (practice) supported other producers, who adopted it, increasing all their profits (Agriculture and Agri-Food Canada, 2016). Other advantages observed as a result of adopting this innovation were that producers did not fall into arrears, better understood the advantages of more extensive grazing, improved their grazing areas due to the organic manure left by livestock and reduced certain cultivation work.

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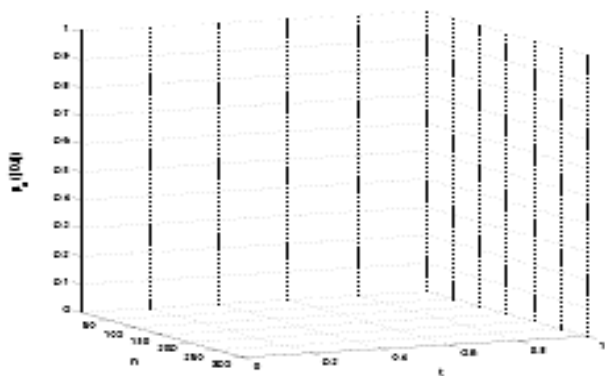
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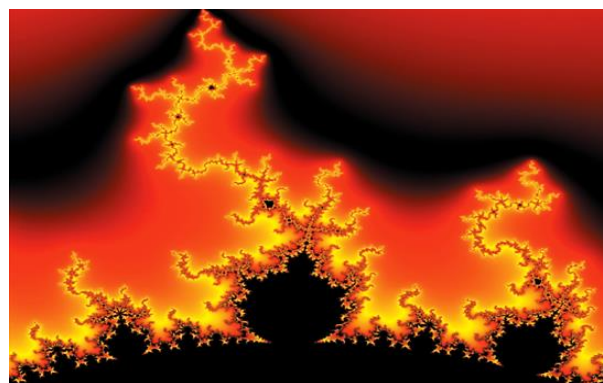


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