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# **Journal-Economic Development Technological Chance and Growth**

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## **Presentation of Content**

In a first article we present, *Bibliometric study on creative and cultural industries (2010-2020)*, by COTA-YAÑEZ, Rosario, ACOSTA-CHÁVEZ, Karen Yoselin, RODRÍGUEZ-BAUTISTA, Juan Jorge and ORTÍZ-FLORES, Erick Pablo, with adscription in Universidad de Guadalajara and Universidad Autónoma de Ciudad Juárez, as a second article we present, *Bibliometric analysis for the determination of fields of opportunity for new technological trends: augmented reality as quality control*, by FERNANDEZ-PEREZ, Vladimir Damian, ÁLVAREZ-AROS, Erick Leobardo, MIRANDA-SANCHEZ, Francisco Javier and FERNANDEZ-GOMEZ, Tomás, with adscription in the Universidad Popular Autónoma del Estado de Puebla, as the third article we present, *Approaches to the financial evaluation of the “El Ahogado” wastewater treatment plant in Jalisco, Mexico*, by MORENO-ORTIZ, Alba Lucia & VÁZQUEZ-ELORZA, Ariel, with adscription in the Center for Research Assistance in Technology and Design of the State of Jalisco, A.C. – CIATEJ, as fourth article we present, *Automatic document classification: the role of interclass similarity*, by SORIANO-BURGOS, Claudio Isaac, LÓPEZ-RAMÍREZ, Misael and GUZMÁN-CABRERA, Rafael, with adscription in the Universidad de Guanajuato.

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**Bibliometric study on creative and cultural industries (2010-2020)****Estudio bibliométrico sobre industrias creativas y culturales (2010-2020)**

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**Abstract**

The creative and cultural industries represent a brand-new topic when studying the local development as well as the economic and industrial growth, focused on attracting qualified personnel to generate knowledge. Its application has been extended to many industries, like the artistic and cultural ones, where goods and services are produced from sensory and symbolic objectives. Thus, it is important to know if the scientific community's contributions are enough for the study of the subject and which opportunity areas exist for further and complementary studies. This paper aims to collect, review, and analyze the scientific production of articles on creative and cultural industries from 2010 to 2020, and to obtain the main bibliometric indicators such as co-authorship, quality and secondary dissemination indexes.

**Creative industries, Cultural industries, Local development, Employment, Cities**

**Resumen**

Las industrias creativas y culturales representan una nueva vertiente en los estudios del desarrollo local y el crecimiento industrial y económico, enfocadas en la atracción de personal calificado con el objetivo de generar conocimiento. Su aplicación se ha extendido a diversas industrias, como las artísticas y culturales, donde se producen bienes y servicios a partir de objetivos sensoriales y simbólicos. Por ello, es importante conocer si las contribuciones de la comunidad científica han sido suficientes para el estudio del tema y qué áreas de oportunidad existen para estudios futuros y complementarios. Con este trabajo se pretende recopilar, revisar y analizar la producción científica de artículos sobre industrias creativas y culturales de 2010 a 2020, así como obtener los principales indicadores bibliométricos como índices de coautoría, de calidad y de difusión secundaria.

**Industrias creativas, Industrias culturales, Desarrollo local, Empleo, Ciudades**

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## Introduction

The term "creative industries" refers to the sector of industry or the economy that involves the generation of ideas and knowledge. It also has to do with the ability to attract skilled populations to cities with urban economies. In other words, creative industries create an enabling environment for the diversification of economic activity, economic growth and are linked to attractive lifestyles and consumption (Valdivia, 2014). The concept started to gain momentum following the 2007 publication on Creative Industries in Indonesia by the Ministry of Trade (Roos and Raafaldini, 2015). This might explain Indonesia's high participation in the scientific activity on the analysis of creative and cultural industries, which will be discussed in the following sections.

For their part, cultural industries are not only about the domain of culture within a given space, such as a city, but are related to cultural goods and services as part of a new economic sector that can be extended to other areas of knowledge. Its study dates back to the 1980s and was disseminated worldwide by the United Nations Educational, Scientific and Cultural Organisation (UNESCO), gradually incorporating a wide range of industries such as writing, art, music, design, media, among others. It was from the 1990s onwards that the topic was used to refer to the production of all those goods and services of industries whose core was a symbolic or expressive element and included innovation within their processes (Boccella and Salerno, 2016).

The main objective of this work is to collect, review and visualise in a practical way the research and scientific production concerning creative and cultural industries in the period 2010 to 2020. Specific objectives include: to obtain productivity by years, journals, authors, institutions, countries, states and languages; to examine the keywords used in the articles; to know the quality of the articles according to the number of citations and to consider the usefulness of further research in the field based on the existence of previous literature.

It is due to the importance that is currently gaining with the development of services that Skavronska (2017) points out that economic development and creativity cannot be seen as opposing forces, one of change and the other of tradition, but must be articulated as parts of a single, ongoing cycle of beneficial transformation. Thus, according to Daubaraitė and Startienė (2015), creative industries can contribute to the national economy in three different ways: by combating unemployment, by contributing to Gross Domestic Product (GDP) through the creation of added value, and by contributing to foreign trade (exports). Moreover, it has been revealed in theory that one of the factors contributing to the growing importance of this sector within the regions of a given country is that it does not require large initial investments, which in turn increases its importance in the global market. Even Howkins, a well-known expert on how to turn ideas into money, stated that creativity is the most interesting and profitable area of the economy (quoted in Skavronska, 2017).

Thus, creative industries are gaining importance because they have the capacity to generate jobs and their contribution to GDP is direct, as creative thinking makes innovation possible. Due to the latter, creative industries have become the important part of the economy of developed countries (Kloudova and Chwaszcz, 2014). However, the size of the impact of these characteristics is relatively small as creative industries are in their early stages of development. In fact, creative industries firms tend to be micro and small enterprises.

It is important to note that, although the creative industries represent a favourable impact on the economic development of regions, they still face certain conditions that hinder their development. One of these has to do with new types of employment and a new type of worker that, according to Castañeda and Garduño (2017) and Skavronska (2017), emerge with the creative industries. Although these industries have the capacity to incorporate entrepreneurs into the productive system, the forms of employment are often in the form of the informal economy or freelance, (i.e., they provide their services but without any monetary remuneration), which makes the working environment very unstable in terms of salaries and positions.

Also, product differentiation and employee qualification represent a challenge for the creative industries (Mon, 2012). These make the agents involved in these sectors face stiff competition to make their products stand out, as well as to hire employees who have the skills to achieve this task, which in many cases require specialised skills and knowledge in the branch in which they develop.

Another barrier to the development of the creative industries has to do with the agglomeration of these industries in cities. Educational centres that offer programmes related to the creative industries, as well as graduates of creative industries careers, are concentrated in the centre of the country in anticipation of greater employment opportunities (Castañeda and Garduño, 2017).

The tendency of the creative industries to concentrate in the central regions of a country is due to the fact that these are economic centres with a high flow of information, high business interaction and a higher rate of innovation than in other regions. The 2015 European Creative Industries Summit (cited in Boccela and Salemo, 2016) highlights the following:

"The creative economy is also associated with large cities and/or dominant regions within countries, or even concentrated within cities where thriving creative activity takes place. The creative industry sector can be a small enclave surrounded by poverty and social deprivation. The creative economy today tends to be concentrated in the world's major cities that are already central sites of financial capital, investment and power or have a significant historical legacy of social and cultural mixing."

The implication of this is that the concentration of the creative industries and these professionals reinforces unstable employment conditions as they face a saturated labour market and very poor wages.

Another obstacle facing the creative and cultural sector is that it is very large. Within the creative industries there is a wide variety of sub-industries which, despite generating economic dynamism, together with the different forms of informal employment in which various professionals in the creative industries are engaged, make it impossible to implement economic policies that meet the needs of all those involved in it (Ugarte et al, 2018).

Where public policy favours the creative industries, it is at the same time encouraging the emergence of a problem for cities, as Ugarte (2018) explains:

"This is gentrification, a phenomenon that consists of the displacement of people from one area of the city to another, forced by the rise in rental prices as a result of the revaluation of the area through tourist attractions, such as art spaces, trendy shops and bars, and massive renting by tourists."

## Methodology

Based on the methodology proposed by Navarro-Beltrá and Martínez-Polo (2020), the scientific production from January 2010 to July 2020 will be analysed using the databases Science Direct, Scopus and Dialnet. The three databases were chosen on the basis of access restricted to payment of a licence or membership fee, in order to visualise the impact of the articles in this type of electronic resource, their citations and downloadability. The period of analysis was selected because it is important to know the most recent studies on creative and cultural industries, as well as the possible boom or scientific interest that may be emerging in recent years. Thus, the following key concepts were used as the basis for the search, whose operators are listed in the table below. The information was compiled in a database using Excel and SPSS software to obtain descriptive analyses, frequencies and graphs of the variables (see table 1).

Database	Search operations
Dialnet	Search for documents: "creative industries" OR "creative economy" OR "cultural industries" "innovation" AND "cultural industries" OR "creative industries" "cultural industries" OR "creative industries" AND "local development" "cultural industries" OR "creative industries" AND "employment" "cluster" OR "creative industries" AND "cultural industries"
Science Direct	Search peer-reviewed journals, articles, book chapters, and open access content.: "creative industries" OR "cultural industries" "creative districts" AND "cultural industries" AND "local production systems" "innovation" AND "cultural industries" OR "creative industries" "cultural industries" OR "creative industries" AND "local development" "cultural industries" OR "creative industries" AND "employment" "cluster" OR "creative industries" AND "cultural industries"
Scopus	Search: "creative industries" OR "cultural industries" "creative districts" AND "cultural industries" AND "local production systems" "innovation" AND "cultural industries" OR "creative industries" "cultural industries" OR "creative industries" AND "local development" "cultural industries" OR "creative industries" AND "employment" "digital technology" OR "intellectual property" AND "creative industries" AND "cultural industries" "cluster" OR "creative industries" AND "cultural industries"

**Table 1** Key concepts and search operators

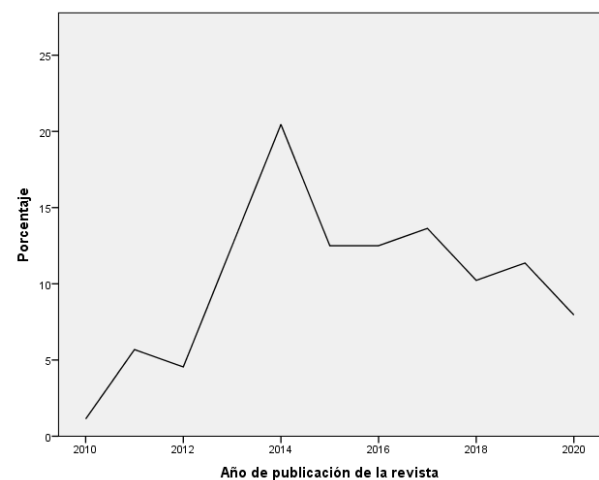
Source: Own elaboration

The protocol for the coding and classification of the variables allowed the integration of 44 variables, divided into 5 blocks, namely: internal identification controls (article number, article related to the subject, database, downloaded article), article identifiers (subject, DOI, ISSN, title, keywords, language), publication identifiers (journal, journal number, journal volume, year, number of SJR citations, ICDS, journal quartile), author control (number, names, gender, country and status of the authors) and institution control (number and names of institutions). A total of 88 articles were analysed after the database was cleaned and checked for repetitions.

## Results

### Articles

Figure 1 shows the distribution of articles by year of publication. It can be seen that from 2010 to 2014 there was a boom in research on creative and cultural industries, with 2014 being the most productive year with 20.5% of the publications of the decade. This is due to the incursion of the concept in the development plans of the different public spheres. However, there is also a downward trend in research on the subject from 2015 to 2020, with the most recent article in May. And in light of the events arising after the pandemic caused by COVID-19, they have been one of the hardest hit sectors according to Naylor, Richard et al., (2021) in an international level analysis, they found that cultural and creative industries are more dependent on physical experiences in specific spaces and places due to face-to-face linkage. National level studies consistently point to an overall drop in value added and performance during the period of the pandemic; income losses ranged between 20% and 40% in different countries; the greatest impact has been seen mainly in mega-cities and other large urban centres where these industries have been highly concentrated since their inception; and due to the inherent characteristic of the self-employed, they have experienced the highest levels of income loss and unemployment than other categories.



**Graphic 1** Year of publication

Source: Own elaboration

The level of noise in searches for articles on creative and cultural industries was 14.8%. That is, approximately 9 out of 10 articles found did have a direct relationship to the topic and addressed it in a primary or applied way. However, the topic spans multiple disciplines and this could increase the likelihood of distortion. Of the total number of articles in the sample, 15.9% were restricted access, even if accessed through institutional licences. In some cases only the abstract of the paper was accessible. The distribution of articles found in the databases was 42.0% in Dialnet, 38.6% in Science Direct and 19.3% in Scopus; this proportion was the lowest of the three databases sampled, mainly due to the restricted access articles, which appeared with higher relevance from the selected Boolean operators.

In terms of the main themes in which they could be classified, it is observed that more than half of the articles belong to the branch of "creative industries", followed by "creative and cultural industries" with 15.9% and "creative economy" with 11.4% (see table 2).

	Frecuency	Percentage	Percentage valid	Cumulative percentage
Creative cities	6	6.8	6.8	6.8
Creative economy	10	11.4	11.4	18.2
Innovation economy	1	1.1	1.1	19.3
Creative industries	51	58.0	58.0	77.3
Creative and competitive industries	1	1.1	1.1	78.4
Creative and cultural industries	14	15.9	15.9	94.3
Cultural industries	5	5.7	5.7	100.0
Total	88	100.0	100.0	

**Table 2** Article classification them

Source: Own elaboration

The search for articles was carried out on the basis of key concepts in English, which was the predominant language (83.0%). In addition, 15.9% of articles were collected in Spanish and one article in French.

### *Influence and quality of the articles*

Taking as a reference the SJR, an indicator constructed on the basis of the number of citations in other media and important newspapers or journals, the average number of citations in the articles analysed was 0.712, with a maximum value of 4.1 for a single article. About 20% of the articles have an SJR value between 0.1 and 0.2.

The Secondary Dissemination Index (SDI) was also obtained for most of the articles. This bibliometric indicator shows the visibility of the journals in different databases of national or international scope; the higher the ICDS, the more information sources of international relevance the journal is present in. The minimum ICDS value was 0.70 for 2 articles, with a maximum of 11.0 for 10 articles and a mean of 7.30. Finally, according to the quartile of the journals to which they belong, the articles can be classified as shown below. It is worth noting that, of the 88 articles in the sample, only 64% had information available on the quartile of the journal (see table 3).

	Frecuency	Percentage	Percentage valid	Cumulative percentage
0	16	18.2	28.1	28.1
1	1	1.1	1.8	29.8
1	18	20.5	31.6	61.4
2	9	10.2	15.8	77.2
3	9	10.2	15.8	93.0
4	4	4.5	7.0	100.0
Total	57	64.8	100.0	

**Table 3** Quartile of journal of publication

Source: Own elaboration

In addition, there are journals with a high frequency of articles published on creative and cultural industries, such as *Procedia - Social and Behavioral Sciences* (14.8%), *Technological Forecasting and Social Change* (5.7%) and *City, Culture and Society* (4.5%). Another interesting aspect is that there were even journals specifically dedicated to the topic: *Creative Industries Journal* and *Journal of Creative Industries and Cultural Studies* with 2 and 3 related articles found, respectively. In some cases, articles were grouped together in a single issue or journal volume in special issues dedicated to creative industries, cultural industries and innovation.

### *Keywords*

With regard to the keywords of the articles, it can be seen from the illustration below that the predominant terms in more than half of the key concepts are "creative industries" and "cultural industries", followed by "innovation", "capital" and "development", which stood out from 422 words analysed (see Figure 1). Keywords allow a quick visualisation of the concepts that are being used most frequently in the development of a topic.



**Figure 1** Keywords  
Source: own elaboration

### Authors

As far as authors are concerned, the co-authorship index or the average number of authors per article was 2.31 and the distribution of authors per article is shown in the table below. It can be seen that 28.4% of the articles have only one author and the rest had 2 or more authors. There are also some cases where the same author is related to several articles such as Dagmar Veselá from Slovakia and Ottavia from Taiwan with 2 publications each, in which they appear as main authors or co-authors.

Frecuency	Porcentaje	Percentage valid	Cumulative percentage
1	25	28.4	28.4
2	30	34.1	62.5
3	18	20.5	83.0
4	11	12.5	95.5
5	4	4.5	100.0
Total	88	100.0	100.0

**Table 4** Number of authors  
Source: Own elaboration

Regarding the gender of the authors, some authors were difficult to identify because the names were not very specific or did not show a clear reference on the internet. For example, in the case of names of Asian origin, some authors could be identified after searching for their name and reviewing their participation in congresses or conferences. However, this was not the case for all authors in this situation. Thus, in 55.7% of the cases, the main authors of the articles were male, 42.0% female and 2.3% unspecified.

In general terms, that is, counting all the authors found regardless of the order of appearance, there is a male participation of 52.8%, 43.7% of women and 3.5% unspecified. A total of 199 authors were obtained from the sample analysed.

### Institutions

The average number of institutions per article was 1.40, although more than half of the articles were published by authors belonging to the same institution, as shown in table 4. There are some institutions that lead the scientific production such as the University of Bucharest (5.6%), Institut Teknologi Bandung (3.0%) and Bina Nusantara University (2.0%), the latter in Indonesia, one of the countries where the study of cultural and creative industries has been quite relevant according to the existing literature.

Frecuency	Porcentaje	Percentage valid	Cumulative percentage
1	59	67.0	67.0
2	23	26.1	93.2
3	6	6.8	100.0
Total	88	100.0	100.0

**Table 5** Number of institutions  
Source: Own elaboration

### Countries

Finally, with regard to the countries of origin of the research found, Spain is in first place (15.8%), followed by Indonesia (12.6%) and the United Kingdom (7.1%). There were also 5 articles from Mexico, mainly from Mexico City and Sinaloa.

### Discussion and conclusions

The creative and cultural industries represent a broad field of study considering their possible multidisciplinary approach, i.e. they can be studied from different perspectives and criteria, in addition to the economic one. Although the boom in the subject seems to be diminishing at present, it has not ceased to be productive in any of the years analysed and, in the particular case of Mexico, the scarce literature focused on the country is an opportunity for research, taking as a guideline European and Asian cases, where the available literature is more advanced. As far as authors are concerned, although the majority of researchers are men, the percentage of women is quite representative and this may mean that there is not such a large bias in terms of authorship.

Another advantage is that most of the articles are open access, which allows the knowledge to be cited and used in future and complementary studies.

## References

- Boccella, N. y Salerno, I. (2016). Creative Economy, Cultural Industries and Local Development. *Procedia–Social and Behavioral Sciences*, (223), 291-296. <https://doi.org/10.1016/j.sbspro.2016.05.370>
- Castañeda, E. y Garduño, B. (2017). Mapa de las industrias creativas en México. *Proyección para CENTRO. Economía creativa* (7), 118-166. Retrieved July 10, 2020 from: <https://dialnet.unirioja.es/descarga/articulo/6063066.pdf>
- Daubaraitė, U. y Startienė, G. (2015). Creative industries impact on national economy in regard to subsectors. *Procedia - Social and Behavioral Sciences*, 213, 119-124. <https://doi.org/10.1016/j.sbspro.2015.11.415>
- Kloudova, J. y Chwaszcz, O. (2014). The analysis of the creative industry linked in connection with the economic development. *E a M: Ekonomie a Management* 17 (1), 32-42. <https://doi.org/10.15240/tul/001/2014-1-003>
- Mon, L. (2012). Industrias Creativas de Diseño de Indumentaria de Autor. Diagnóstico y desafíos a 10 años del surgimiento del fenómeno en Argentina. *Cuadernos del Centro de Estudios en Diseño y Comunicación* (42), 19-34. <https://doi.org/10.18682/cdc.v42i42.1422>
- Navarro-Beltrá, M. y Martínez-Polo, J. (2020). ESTUDIO BIBLIOMÉTRICO SOBRE REPUTACIÓN DIGITAL Y ECONOMÍA COLABORATIVA (2004-2017). *Revista de Comunicación de la SEECI*, (51), 83-107. <https://www.seeci.net/revista/index.php/seeci/article/view/596>
- Naylor, R.; Todd, J., Moretto, M., y Traverso, R., (2021) Las industrias culturales y creativas frente a la COVID-19 Panorama del impacto económico. UNESCO. Francia. [https://unesdoc.unesco.org/ark:/48223/pf0000377863\\_spa/PDF/377863spa.pdf.multi](https://unesdoc.unesco.org/ark:/48223/pf0000377863_spa/PDF/377863spa.pdf.multi)
- Ross Maryunani, S. y Raafaldini Mirzanti, I. (2015). The Development of Entrepreneurship in Creative Industries with Reference to Bandung as a Creative City. *Procedia – Social and Behavioral Sciences*, (20), 387-394. <https://doi.org/10.1016/j.sbspro.2015.01.324>
- Skavronska, I. (2017). Creative industries in Ukraine: Analysis and prospects of the development. *Economics and Sociology* 10 (2), 87-106. <https://doi.org/10.14254/2071-789X.2017/10-2/7>
- Ugarte, O., Arteta, E., De Diego, N. y San Millán, B. (2018). Hacia dónde dirigir las industrias culturales y creativas. Breve reflexión situada. *Príncipe de Viana* 79 (270), 119-133. <https://academic.e.unavarra.es/handle/2454/35096>
- Valdivia, M. (2014). Presencia e impacto espacial de los sectores creativos en las zonas metropolitanas de México. *Estudios Fronterizos*, 15(30), 215-259. [http://www.scielo.org.mx/scielo.php?script=sci\\_arttext&pid=S0187-69612014000200008](http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0187-69612014000200008).

## Bibliometric analysis for the determination of fields of opportunity for new technological trends: augmented reality as quality control

### Análisis bibliométrico para la determinación de campos de oportunidad de nuevas Tendencias Tecnológicas: La realidad aumentada como control de calidad

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#### Abstract

With the emergence of industry 4.0, innovation was made in terms of emerging technologies, one of them is Augmented Reality as a tool that manages to enhance the new generation of automated factories. This leads to a use by operators or any type of personnel who need interaction with specific information such as: product data sheets, instructions for maintenance procedures, assembly, manufacturing, quality control forms etc. just to mention a few of the applications. They can be handled efficiently and amplifying the degree of ease of these processes by applying AR. Therefore this is the reason why this research is carried out taking into account different environments, the objective is to provide an overview in which fields of opportunity or trends are identified on the use of this pillar of i4.0 within the quality control process, with the intention of showing approaches that motivate scientific research, to achieve this goal, a bibliometric analysis was applied to a database obtained in Scopus, using the R software, with which authors, research topics, journals of interest, keywords, scientific production by year or country were identified. With the intention of finding the most significant information, so the results obtained show 5 potential areas where AR can play an important role within the quality control process demonstrating its suitability to improve processes.

**Augmented reality, Quality assurance, Bibliometric analysis, I 4.0, Operational efficiency**

#### Resumen

Con el surgimiento de la industria 4.0, se innovó en cuanto a tecnologías emergentes, una de ellas es la Realidad Aumentada como herramienta que logra potenciar la nueva generación de fábricas automatizadas. Esto conlleva a un uso por parte de operarios o cualquier tipo de personal que necesite interactuar con información específica como: fichas técnicas de producto, instrucciones de procedimientos de mantenimiento, montaje, fabricación, formularios de control de calidad, etc. por mencionar algunas de las aplicaciones. Estas pueden ser manejadas eficientemente y ampliando el grado de facilidad de estos procesos mediante la aplicación de la RA. Por lo tanto esta es la razón por la cual se realiza esta investigación tomando en cuenta diferentes entornos, el objetivo es proporcionar un panorama en el cual se identifiquen campos de oportunidad o tendencias sobre el uso de este pilar de i4.0 dentro del proceso de control de calidad, con la intención de mostrar enfoques que motiven la investigación científica, para lograr este objetivo se aplicó un análisis bibliométrico a una base de datos obtenida en Scopus, utilizando el software R, con el cual se identificaron autores, temas de investigación, revistas de interés, palabras clave, producción científica por año o país. Con la intención de encontrar la información más significativa, así los resultados obtenidos muestran 5 áreas potenciales donde la RA puede jugar un papel importante dentro del proceso de control de calidad demostrando su idoneidad para mejorar los procesos.

**Realidad aumentada, Control de calidad, Análisis bibliométrico, I 4.0, Eficiencia operativa**

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## Introduction

Currently industry 4.0 has allowed the generation of benefits or improvements for the manufacture of products or the offer of services that are supported by these technologies, these changes are produced quickly, leading to greater requirements of technological knowledge by workers, increasing the degree of complexity of the task. This leads to systems that intensively adopt enabling technologies such as Augmented Reality and virtual reality to reduce these burdens for operators Ho, P., Albajez, J., A., Santolaria, J., & Yagüe-Fabra, J., A. (2022).

When mentioning the technologies that are used within industry 4.0 it can be concluded that there are mature tools, but some others are still under development by manufacturers or academics, where their application is sought in industrial environments a clear example is the Augmented Reality (AR) because it was not until the end of the 90's when it was finally driven by academics and government industry. German. Since then, it has been proposed for use in different stages of manufacturing, such as in assembly processes, creating solutions for the design phases or in quality controls Fernandez, T., M., Fraga, P., Suarez, M., & Vilar, M., (2018).

Augmented Reality is constantly adapting within key companies such as General Electrics, Airbus and Boeing Serván, Mas, Menéndez, & Ríos (2012). As an innovative tool. Used to advance the quality of products and processes as well as reduce error rates. Therefore, AR studies have emerged in the quality sector shown potential results in improving human performance in technical quality control tasks, as well as within TQM achieving autonomy within decision-making by operators. There are currently limited examples of concrete implementation of AR in the quality sector.

Therefore, the objective for this research is to carry out a systemic review of the state of the art of AR in terms of technology used focusing on the context of quality. It is about preparing for the digital transformation of Industry 4.0, which also entails the change in the quality sector, and the adaptation of AR for such control. Research was conducted on the state of AR-based manufacturing applications at plant level in the context of Industry 4.0 to give a holistic view on future challenges.

The research is structured in four sections. Introduction in which the Augmented Reality project is presented as quality control continued by the Systematic Review of the Literature, while the third section describes the methodology applied for the development of RSL. Followed by the results to provide a holistic view on AR utilization in general and AR-based quality control in particular. Ending with the conclusion that proposes trends for future research work.

## Literature review

Within this section presents a panorama in which you can visualize the different applications of Augmented Reality because the focus of this article focuses on a bibliometric analysis of this technology as quality control, because its use is currently becoming widespread thanks to the great flexibility of this tool.

It can be said that AR is an enhancer for users, thanks to the ease of presenting real-time information embedded in reality, thus obtaining help in the processes of products or services. This indicates that there are different ways to apply augmented reality, therefore the literature review will be grouped into 3 groups, which are: 1) Industrial applications, 2) The use of AR in education and 3) Application of Augmented Reality in the medical area.

### 1) Industrial applications

Augmented reality is a technology derived from industry 4.0 which makes it a key tool for increasing operational efficiency, empowering the next generation of factories. Helping operators who need to interact with critical information, but easily managed if AR is used, therefore Fernandez, Fraga, Suarez & Vilar (2018) demonstrate the viability and benefits obtained in conventional companies.

The validation and testing that are necessary to ensure its quality continue to advance and incorporate new technologies that over time gain importance guaranteeing safety along with quality. For this reason, simulations were created that propose a new framework on augmented reality that takes advantage of the physical environment such as digital, for a new testing methodology that aims to be a bridge between tests in a digital environment and tests in the real world, from a perception of control, in realistic conditions. Genevois, Horel, Renzaglia & laugier (2022). Presenting the data, improving the process with virtual information.

The authors Shafique, Khawaja, Sabir, Qazi & Mustaqim (2020) present the concept of the internet of things, conducting a review of the literature, obtaining as a result the emerging scenario for 5G technology, using cellular networks as a key to the wide application of AR, creating discussions about the changes in the implementation that 5G can have on the high flow of data and its transit on platforms known as clouds. Since currently this type of online services are on the rise thanks to their growing popularity due to the possibility of having an internet connection from anywhere this gives Augmented Reality a capacity to be used practically anywhere.

Lora, Sotoca & Chover (2022) show a theoretical framework, where users' perceptions can be found regarding the quality of the application of augmented reality through digital embeddings in physical environments, compared to the exposure of the same concepts through a conventional video. For this it is necessary to emphasize the importance for users to be able to visualize graphic information embedded on physical objects and an electronic medium capable of displaying information in real time, the experiments carried out delivered as results that the integration of the product in the environment as well as its spatial presence in users, generated a positive effect, within the users since they determined that the information presented is useful.

Cinematography and other digital content creators have innovated by integrating three-dimensional (3D) technology. The applications of Augmented Reality are aware of the advantages, possibilities and new means of expression for this technology.

The development of electronic and information technologies as indicated (Perek, Mielczarek & Makowski 2022) allows to achieve a better quality of 3D image recorded along with many possibilities for its correction. Therefore, it is necessary to carry out a search that allows to identify typical errors of stereoscopic vision related to the depth of image during a recording. Therefore, an independent and non-invasive system is presented that supports filming in the process of calibration of cameras, as well as the analysis of 3D depth, seeking to increase the quality of the materials created for use within Augmented Reality.

The research carried out by Li, Tsai, Lee (2022) state that the investigation of the visual threshold of parasitic light for three types of VR HMD devices for a virtual reality screen, proposes a qualitative model that demonstrates its feasibility and effectiveness, so the effectiveness of the model was 90%, demonstrating its suitability to be used in different applications based on visual perception and that serves as a basis for the design of future HMD optical systems and quality control. Therefore managing to become a critical indicator of image quality applicable for the design of Virtual Reality or Augmented Reality content.

## 2) The use of AR in education.

Digital tools are beginning to be incorporated into teaching, seeking to improve student performance. Finding Augmented Reality with a tool capable of being incorporated into the classroom, managing to provoke a revolution in the way of learning the subjects to be studied, generating motivation by applying this technology as a creative resource and taking it as a means of presenting information. The use of this technology promotes greater motivation aimed at study, increasing performance towards learning topics. Marín, Cabero & Gallego (2018).

In recent decades, there has been an evolution of technological applications that have managed to develop new forms of applications with the intention of addressing learning through Augmented Reality, this technology offers a new educational approach that helps students develop critical skills and deeper understanding of the concepts underlying scientific research.

The AR manages to enrich the reporting of learning opportunities helping to face the challenge of science for all Lazoudis & Agogi (2011) created the project "Science Center To Go" whose main objective is the presentation of an initiative in science teaching, in educational environments, formal and informal with the intention of facilitating at the same time that it measures the benefits of the exposure of educational material through said technology correctly focused on your compression level.

The degree of acceptance of a learning approach based on Augmented Reality, based on the use of the Science Center To Go system, created by Larsen, Buchholz, brodda, Bogner (2011) focuses on a qualitative evaluation centered on the teacher taking into account the student along with the degree of technical acceptance as well as the pedagogical effectiveness of the system, indicating that acceptance is high in general and that its pedagogical effectiveness is positively valued. Showing that meaningful system evaluation in a real school setting demands a large measure of prototypes with excellent robustness to achieve significant reliability.

On the other hand, with the arrival of the Covid-19 pandemic, visits to places of interest were highly restricted, making the tasks of engineering students almost impossible to be fulfilled, Sivanesan, Lu Ng, Xir Lim, Kai Tan, Yew, Goh (2021) suggest a remedy for the problems that students commonly face, using Augmented Reality as a tool, of interaction that helps solve problems in real time through information embedded in reality through digital resources. Through the analysis of the work sites measuring the effectiveness of the tasks, achieving encouraging results that indicate a significant improvement, concluding that there is room for its implementation and innovation in engineering teaching processes.

The pandemic that began in 2021, caused distance learning to be denoted as critical since it faced various application problems, because it was necessary to find a balance between high quality education and its participation in practical learning Villanueva, Zhu, Liu, Du, Huang, Peppler, Ramani (2021) present a robotics toolkit called RobotAR, that seeks to be incorporated as a query application for the creation of Augmented Reality makerspaces.

This software behaves like a voice assistant that can be incorporated for a teleconsultation. Achieving a better concentration in the areas of interest within the workspace helping the student to solve problems.

Therefore, an evaluation was carried out about the use of augmented reality within the activities carried out within study centers, with the intention of improving the educational service Egaji, Ashar & Griffiths (2021). Showing statistically that there are 5 fundamental factors for obtaining an increase in the absorption of knowledge, therefore it is very important to create activities and plans that help a good implementation of Augmented Reality in education, because it is a tool capable of motivating the student by improving their productivity.

### 3) Augmented Reality application in the medical field

Augmented Reality is positioned as a disruptive tool capable of enhancing medical processes by increasing their effectiveness, therefore the authors Ho, Albajez, santolaria & Yagüe-Fabra (2022) through a systematic review of the literature managed to generate an analysis with which they managed to observe that the current trend demonstrates a low use of Augmented Reality in quality control processes in the medical area, Therefore, this creates a field of opportunity for the creation of new methodologies to achieve a development that helps solve problems.

The role of technology for 3d reconstruction within the field of medicine is booming, due to its rapid implementation in different areas such as esophagogastric, therefore Robb, Scrimgeour, Boshier, Przedlacka, Balyasnikova, Brown, Bello & Kontovounisios (2022) highlight the gaps in the literature or the implications for future research. Through the application of a review of scientific articles which aims to create a visualization of trends and fields of opportunity within the study area, the authors conclude by saying that the information collected is insufficient, which is why they mention that the study for the application of 3d reconstruction in esophagogastric, is a field of opportunity since there is very little information which should motivate the generation of new knowledge.

Currently, devices capable of displaying Augmented and Virtual Reality are implemented in research with the intention of being applied in a wide range of medical uses. There are significant gaps in the evaluation of such devices as well as the difficulty of a regulatory assessment. Therefore the authors (Beams etc. 2022). They address these gaps to demonstrate safety along with the effectiveness of the devices, by describing technical aspects. In order to highlight current efforts in communities and illustrate the connections between evaluation challenges and the intended uses of Augmented Reality devices in the medical area.

Medical techniques such as intubation today are more important than before, therefore it is important to emphasize the importance of the domain and the challenge it presents for the intubation process. Where a group was properly trained by means of RA, where the authors Imach, Kolbel, Bohmer, Kiepke & Ahnert (2022) highlight the importance of training since a significant increase in the quality of the operation was demonstrated. Demonstrated that the combination of Reality Increases in combination with medicine is able to show benefits in technical results which great greater efficiency on the part of medical personnel.

Therefore, computer-aided solutions are currently changing surgical practices on an ongoing basis. As an example Jud, Fotouhi, Andronic, Aichmarir, Osgoog, Navad & Farshad (2020). They mention that AR is a disruptive technological tool capable of innovating in surgical techniques, while substantially increasing its use in this area. Therefore the intention to find the state of knowledge and application in orthopedic surgery is of interest due to its possible uses as an instrument for training or future surgical education.

Another AR application seeks to reduce the chances of falling in an elderly person, through randomized controlled training which will evaluate the effects of training through augmented and virtual reality. For this purpose, groups were recruited with the intention of evaluating the effects of the intervention in people with a variety of motor and cognitive deficits. Authors Mirealman, Rochester, Reelick, Nieuwhof, Pelosin, Abbruzzese, Dockx, Nieuwboer & Hausdorff (2013) concluded that the intervention that combines training with such technology reduces the risk of falls by improving mobility along with cognitive function.

Therefore, it can be shown that AR in rehabilitation is a treatment that was established for patients with movement dysfunction, which currently introduces 2 recent technologies, which are virtual reality and augmented reality with the intention of using them in this field, for which the authors Heffrnan, Abdelmalek & Nunez (2021) review the evidence of efficacy of rehabilitation administered by the 2 technologies mentioned above in patients with peripheral vestibular disorders.

Therefore, thanks to the review of the aforementioned literature, it was possible to create Table 1, which contains concepts grouped by author with the intention of generating a panorama in which the benefits or uses of AR can be identified as part of the process that seeks to increase the level of quality, in different areas of application.

Author	Conceptualization
Perek, Mielczarek & Makowski (2022)	The development of electronic and information technologies allows to achieve a better quality of recorded 3D image along with many possibilities for its correction.
(Lora, Sotoca & Rain 2022)	An application was developed for the exhibition and sale of ceramic molds.
Zhang, Omrani, Yadav & Fjeld (2021).	Creation of time-reversing imaging algorithm, post-image segmentation and volumetric visualization module.
(Beams etc. 2022)	To highlight current efforts in communities and illustrate the connections between evaluation challenges and the intended uses of medical augmented reality devices. We concluded that more research is needed to evaluate the safety and efficacy of such devices in all use cases.
Jud, Fotouhi, Andronic, Aichmarir, Osgoog, Navad & Farshad (2020).	provides a summary of the current state of knowledge and research of augmented reality in orthopedic surgery presented in the literature, and a discussion presenting the keys to the observations necessary for the seamless integration of Augmented Reality into future surgical practice
Lazoudis & Agogi (2011)	I created the project "Science Center To Go" whose main objective is the presentation of an augmented reality technology initiative in science education
Genevois, Horel, Renzaglia & laugier (2022).	Simulations were created that propose a new framework on augmented reality that leverages the physical and digital environment, for a new testing methodology that aims to be a bridge between looping vehicle testing and real-world testing.
Larsen, Buchholz, brosd, Bogner (2011).	Research covers the degree of acceptance with a learning approach vased in augmented reality using Science Center To Go, Larsen, Buchholz, brosd, Bogner (2011). Focusing on a qualitative evaluation centered on the teacher and the student along with the degree of technical acceptance as well as the pedagogical effectiveness of the system.

**Table 1** Concepts by author

Source: Own elaboration

Therefore, the wide variety of applications of Augmented Reality can be visualized within industrial, medical or academic processes, in order to increase its quality, since this tool is used as a control capable of being decisive with respect to quality that through information embedded in reality provides truthful information in real time helping the user to make efficient decisions, therefore, the use of AR is important for the improvement of the skills of human resources, as a disruptive tool that seeks to increase efficiency.

Through an improvement in learning, by providing easy-to-use didactic material with the intention of motivating learning and training, which is why it is considered as a new methodology capable of increasing knowledge. This means that it is not only used as a quality control tool, but also as a method that manages to improve teaching techniques or production processes.

## Methodology

Within the section called methodology, we proceeded to perform a bibliometric analysis of the topic Augmented Reality as Quality Control, after which trends were identified, thanks to the most cited documents, as well as the main authors on the subject, as well as the journals with greater importance by quantity of scientific production, making a focus on documents called scientific articles, of relevant authors, within the area of interest. The intention of bibliometric analysis is to provide data related to the research topic, seeking relevance, important institutions as well as groups of researchers.

A database obtained from Scopus was used, validating data correctly, such as the correction of spelling mistakes, elimination of blank spaces, taking into account initials that allow a standardized analysis when performing a search within Scopus. Through the use of images, graphs or tables, we proceeded to show the relevant results found after the bibliographic analysis.

Analyzing the information obtained from the database through the R software, which is a computer program that allows you to take a CSV file, and obtain relevant information that characterizes the same database, this computer program is able to display information such as authors, organizations, search range, number of citations, amount of scientific production per author, Production by country etc. Information that helps to perform an optimized delimitation that allows to identify fields of opportunity.

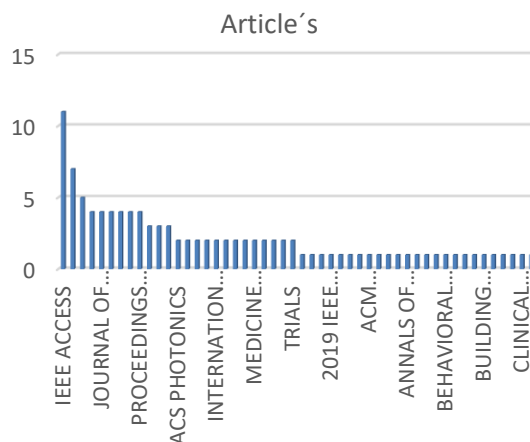
The following keywords were used: Augmented reality, Industry 4.0 and Quality control for the search of information in title, abstract or keywords used by the author, with a search period of 2 decades between 2002 and 2022 with a total of 203 results. The starting year taken was 2002 since it seeks to cover from the most cited documents that can be from the oldest to the most current that can touch on trending topics. Looking for scientific articles of interest and with the characteristic of being able to be cited.

**Result**

Main database information	
Timespan	2002:2022
Sources (Journals, Books, etc)	146
Documents	203
Average years from publication	3.57
Average citations per documents	14.1
Average citations per year per doc	3.362
References	9632
Document types	
article	116
conference paper	65
editorial	2
letter	1
review	19
Document contents	
Keywords Plus (ID)	2165
Author's Keywords (DE)	717
Authors	
Authors	995
Author Appearances	1033
Authors of single-authored documents	4
Authors of multi-authored documents	991
AUTHORS COLLABORATION	
Single-authored documents	4
Documents per Author	0.204
Authors per Document	4.9
Co-Authors per Documents	5.09
Collaboration Index	4.98

**Table 1** Database characteristics  
Source: Own elaboration based on information obtained through R

A bibliometric analysis was carried out, using a database obtained through Scopus, with a total of 203 documents, with an average of documents published per year of 3.57, at the same time it is important to note that the database is composed of 116 articles, 65 conference documents, 2 editorials, 1 letter and 18 reviews, in the same way it can be observed that the total of authors participating in the database was 995.



**Graphic 1** Relevant sources of information by number of articles published  
Source: Own elaboration based on information obtained through R

Within graph 1 the behavior of the main scientific journals with respect to their production is appreciated, which is within the range of 2002 to 2022, this delimitation helps to identify relevant sources of information for research, this means that these journals were the ones that represented the main interest to carry out the bibliographic review. Therefore the 6 most important sources of information are presented.

- Ieee access
- Applied sciences (switzerland)
- Journal of healthcare engineering
- Journal of medical internet research
- Journal of physics: conference series
- Cirp proceeded

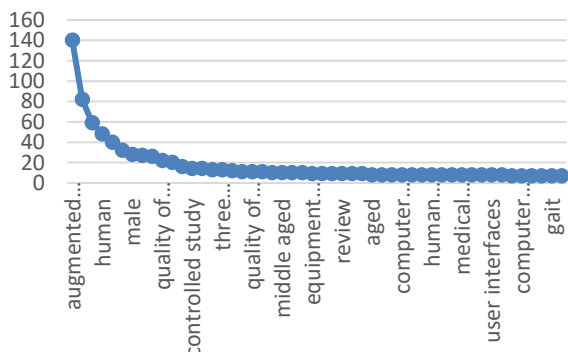
**Table 2**

Therefore, from the third place, a decrease in production can be seen because it is reduced from 4 items to only 1. Therefore, we focus on the bibliometric review of the top 6.



This information is of utmost importance because it helped the research with the delimitation of the sources of research, focusing on the most significant with the intention of giving weight to the article through the analysis of the main sources of information with the intention of identifying fields of opportunity.

Occurrence of Keywords Plus

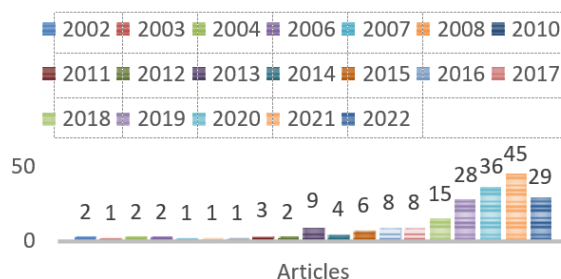


**Graphic 2** Occurrence of Keywords plus  
Source: Own elaboration based on information obtained through R.

The use of Keywords plus is a tool that helps us with the search for information, because it allows us to focus on topics related to the articles published by the authors, at the same time that we can see what is the main trend of research within the database.

When performing the analysis based on the results obtained by R, it can be deduced that the topic "augmented reality" is positioned as the most used term, although the results suggest complementing future research with the term "virtual reality" because these 2 terms have the highest use, while in third place is the term "quality control", This indicates that the authors are relating the terms "augmented reality and virtual reality" as a disruptive instrument capable of being used as a tool with the aim of increasing quality controls, due to the benefits of its implementation. The focus of inquiry within the top 3 is growing and with an important relationship to the main research topic, which shows the scientific interest in the dissemination and development of currents of thought.

## PRODUCTION ANNUAL SCIENTIFIC

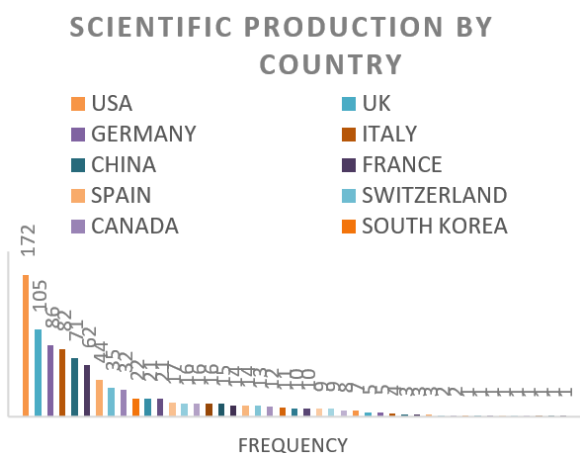


**Graphic 3** Annual scientific production  
Source: Own elaboration based on information obtained through R

The time range for research was from 2002 to 2022, this indicates that the boom in computing and electronics that began in the 2000s, encouraged the development of the research topic "Augmented Reality as Quality Control", perhaps not with this name, but with related topics, since computing and the adoption of ICTs with the advance of time gesture a prosperous environment for use of new technologies, within the area of quality control, which is of utmost importance since with the arrival of industry 4.0 technologies such as AR and VR are taken to add to the creation of value.

In 2013 it can be seen that a significant increase begins within scientific production, with a total of 9 articles published, from that year and within the following decade the number of publications increased to a maximum of 45 disclosures in 2021, this indicates that there is an exponential growth, which gives us the green light for the investigation of trends, which indicates that it is ideal to enter this field of opportunity, to disseminate relevant information.

Being confirmed by the section of references in which it is appreciated that the articles used for the present investigation are within the range of years mentioned above, due to the great technological advance presented in the last decade due to the adoption of new technologies such as mobile devices which gave the AR a low-cost means that has managed to massify in society which gives A platform capable of enhancing such technology by eliminating the need for specific technologies for its implementation.



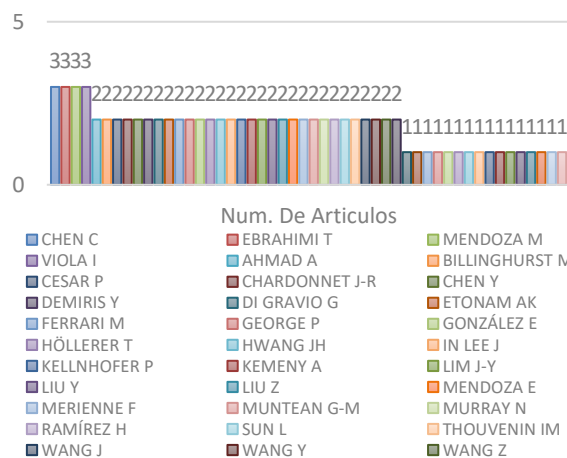
**Graphic 4** Scientific production by country  
 Source: Own elaboration based on information obtained through R

A useful instrument that supports the approach of the search of literature for research, is the review of scientific production by country, shown in graph 5, because it shows us the contribution, managing to visualize the behavior and geographical position of the exponents, with the intention of immersing us in a search focused on the main actors of interest, forming an exploration that allows to find fields of opportunity, because each country has an approach adapted to its own needs.

Within the interpretation of graph 5, it can be seen how the United States is positioned as the largest producer of scientific literature, due to its high rate of industrialization, this causes it to have a high technological degree for the use of new technologies in quality controls, on the other hand it can be seen that the representation of the European Union has 3 representatives to the United Kingdom followed by Germany and Italy, These countries are important exhibitors in the field of Industry 4.0 which is reflected in their scientific production.

On the other hand, China ranks fifth, positioning itself as the only Asian country within the top 7, which shows that China's broad and rapid economic growth is also reflected in its scientific production, which despite being located in fifth place, is positioned as a country of interest for possible future studies. On the other hand, France and Spain occupy the 6th and 7th place respectively, remembering that the European countries mentioned within the top 7 are the main exponents within the area of manufacturing in the European continent through technological innovation because they lead in the implementation of I4.0 worldwide.

Therefore, the research focuses on the scientific production of the top 7, because they are the main countries by number of publications, this indicates that the delimitation for the search for trends focused on the main actors worldwide, found within the Scopus database.



**Graphic 5** Most relevant authors by published articles  
 Source: Own elaboration based on information obtained through R

In the research, through the use of the information shown in graph 6, it is possible to appreciate the maximum and minimum production by each author, thanks to the inquiry it can be interpreted which authors are interesting to make a review of their production, with the intention of scrutinizing trends or works that can provide relevant information due to the wide range of articles.

When focusing on the first 4 positions, we find Chen, Ebrahimi, Mendoza and Viola, it is appreciated that there is a variety with respect to the authors, when conducting a review of the scientific production, it can be seen that Mendoza and Chen are positioned as the 2 authors who within their scientific production take the theme of Augmented Reality as a quality tool either within processes with the intention of increasing productivity manufacturing or as a way to increase the efficiency of lean tools.



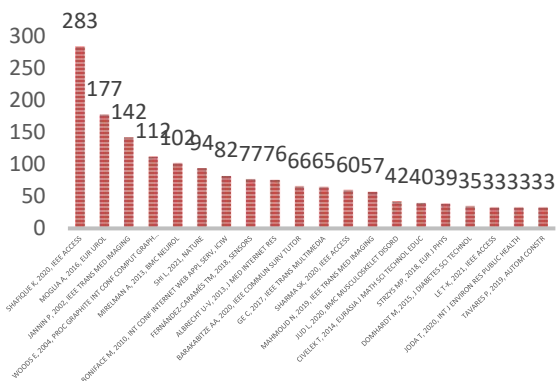
While Ebrahimi and Viola, focus on increasing the quality of the images used by Augmented Reality, in order to optimize the information displayed, along with the way in which this technology interacts with it, offering an improved level of immersion. This indicates that there are trends that can cause significant scientific production, because even one of the articles in which Chen participated is focused on the medical area, this shows us that the range of applications can be very extensive since it is an innovative tool capable of enhancing knowledge in different areas of application.

This helps to provide the research with an approach that could be said to be diverse by having information generated in different geographical points, this helps to identify trends or the way in which the authors approach the subject of study.

This technology is capable of offering new ways of performing tests within dense, safe, economical and reconfigurable environments, demonstrating that the methods are capable of preserving real data by increasing them with consistent virtual information according to Genevois, Baptiste, Renzaglia & Laugier (2022), this gives an innovative advantage with the ability to increase the quality of the processes, Through the conjunction of technologies seeking to show data in real time that help the operator in their performance. Future developments include the ability to increase feedback from critical scenarios both in industry and everyday life.

Due to the RSL and the analysis of the current development of AR technology, it was obtained as a result the potential research areas on the topic of applied AR in the quality sector in the context of industry 4.0 could be one of the following topics:

**MOST CITED ARTICLES**



**Graphic 6** Most cited articles  
Source: Based on R

**Conclusions**

Augmented reality is a very useful technological tool for the industry, due to the tendency to optimize or analyze the needs of each organization achieving a dynamic adaptation to new forms of quality control, therefore the authors define that due to the adoption of new emerging technologies currently used in industry 4.0 Fernandez, Fraga, Suarez & Vilar (2018) AR will be able to boost efficiency through innovative methods.

1. Within the transformation of traditional quality Lean tools into a virtual quality tool by identifying and implementing AR technology when feasible.
2. Integration of Augmented Reality in the help for manual metrology activities where its operational suitability is demonstrated within a process as well as the prevention of human errors, reduce configuration time, guarantee the accuracy of metrology data, as well as in assembly processes.
3. Within the standardization of the representation of knowledge relevant to quality or information for data formats, making AR systems compatible with manufacturing information systems.
4. During the development for the adaptation of solutions based on Augmented Reality in the quality sector following the international design focused on ISO standards, closing the gap between industrial and academic implementations. In addition, this human-centered model could also drive the adoption of AR technology not only for the quality sector, but also for manufacturing in general or services, even reaching the medical area.

For the integration of AR solutions with other enabling technologies of Industry 4.0, due to the need to obtain information in real time, which helps streamline production processes, which can range from the area of engineering, education, medicine or even in everyday life, this just to mention some of the areas where it could work.

## References

- Beams, R., Brown, · Cheng, W., C., Joyner, J., S., Kim, A., S., Kontson, K., Dimitri Amiras, D., Baeuerle, T., Greenleaf, W., Grossmann, R., J., Gupta, A., Hamilton, C., Hua, H., Huynh, T., T., Leuze, C., Murthi S., B., Pencze, J.,, Silva, J., Spiegel, B., Varshney, A., & Badano, A. (2022). Evaluation Challenges for the Application of Extended Reality Devices in Medicine. *Journal of Digital Imaging*. <https://doi.org/10.1007/s10278-022-00622-x>
- Egaji, O., A., Asghar, I., & Griffiths, M., G. (2021). An augmented reality-based system for improving quality of services operations: a study of educational institutes, *Emerald*. 330-354. DOI 10.1108/TQM-07-2021-0218
- Fernandez, T., M., Fraga, P., Suarez, M., & Vilar, M., (2018). A Fog Computing and Cloudlet Based Augmented Reality System for the Industry 4.0 Shipyard. *Sensors* 2018, 18, 1798; doi: 10.3390/s18061798
- Genevois, T., Horel, J., B., Renzaglia, A., & Laugier, C. (2022). Augmented Reality on LiDAR data: Going beyond Vehicle-in-the-Loop for Automotive Software Validation. <https://doi.org/10.1109/IV51971.2022.982735>
- Genevois, T., Horel, J., B., Renzaglia, A., & Laugier, C. (2022). Augmented Reality on LiDAR data: Going beyond Vehicle-in-the-Loop for Automotive Software Validation. <https://doi.org/10.1109/IV51971.2022.982735>
- Heffrnan, A., Abdelmalek M., & Nunez D. (2021). Virtual and augmented reality in the vestibular rehabilitation of peripheral vestibular disorders: systematic review and meta-analysis. <https://doi.org/10.1038/s41598-021-97370-9>
- Ho, P., Albajez, J., A., Santolaria, J., & Yagüe-Fabra, J., A. (2022). Study of Augmented Reality Based Manufacturing for Further Integration of Quality Control 4.0: A Systematic Literature Review. *Appl. Sci.* 2022, 12,1961. <https://doi.org/10.3390/>
- Imach, S., Kolbel, B., Bohmer, A., Kiepke D., & Ahnert, T., (2022). Re-creating reality: validation of fresh frozen full cadaver airway training with videolaryngoscopy and bougie FIRST strategy. *Scandinavian journal of trauma, resuscitation and emergency medicine*. <https://doi.org/10.1186/s13049-022-01006-4>
- Jud, L., Fotouhi, J., Andronic, O., Aichmarir, A., Osgoog, G., Navad, N., & Farshad, M. (2020). Applicability of augmented reality in orthopedic surgery – A systematic review. *Jud et al. BMC Musculoskeletal Disorders* 21:103 <https://doi.org/10.1186/s12891-020-3110-2>
- Larsen, Y., C., Buchholz, H., Brosda, C., & Bogner F., X. (2011). Evaluation of a portable and interactive augmented reality learning system by teachers and students. *Reality in Education*.
- Lazoudis, A., & Agogi, E., (2011). The “Science Center To Go” Project. *Augmented Reality in Education*
- Li, H.-C.; Tsai, M.-C.; Lee, T.-X. A Stray Light Detection Model for VR Head- ounted Display Based on Visual Perception. *Appl. Sci.* 2022, 12, 6311. [ttps://doi.org/10.3390/app12136311](https://doi.org/10.3390/app12136311)
- Lora, M., C., Sotoca, J., M., & Chover. M. (2022). Improved perception of ceramic molds through augmented reality. *Multimedia Tools and Applications*. <https://doi.org/10.1007/s11042-022-13168-5>
- Marín díaz, V., Cabero almenara, J., & Gallego Pérez, O. M. (2018). Motivation and augmented reality: students as consumers and producers of learning objects. 47, 337–346. <https://doi.org/https://doi.org/10.17811/rif.47.3.2018.337-346>
- Mirealman, Rochester, Reelick, Nieuwhof, Pelosin, Abbruzzese, Dockx, Nieuwboer and Hausdorff., (2013). treadmill training program augmented by virtual reality to decrease fall risk in older adults: study design of a randomized controlled trial. *BMC neurology*.

Perek, P., Mielczarek, A., & Makowski, D. (2022). High-Performance Image Acquisition and Processing for Stereoscopic Diagnostic Systems with the Application of Graphical Processing Units. <https://doi.org/10.3390/s22020471>

Robb, H., Scrimgeour, G., Boshier, P., Przedlacka, A., Balyasnikova, S., Brown, G., Bello, F., & Kontovounisios, C., (2022). The current and possible future role of 3D modelling within oesophagogastric surgery: a scoping review. *Surgical endoscopy*. <https://doi.org/10.1007/s00464-022-09176-z>

Serván, J., Mas, F., Menéndez, J.L., & Ríos, J., (2012). Using Augmented Reality in AIRBUS A400M Shop Floor Assembly Work Instructions. *AIP 2012*, 1431, 633–640.

Shafique, K., Khawaja, B., A., Sabir, F., Qazi, S., & Mustaqim, M., (2020). Internet of Things (IoT) for Next-Generation Smart Systems: A Review of Current Challenges, Future Trends and Prospects for Emerging 5G-IoT Scenarios. *DIO: 109/ACCESS.2020.2970118*

Sivanesan, V., Lu Ng, Z., Xir Lim, T., Kai Tan, H., Yew, K., Goh, W., (2021). The Use of Augmented Reality in Collaboration Within the Construction Industry. *Journal of Physics: Conference Series*. doi:10.1088/1742-6596/2120/1/012032

Villanueva, A., Zhu, Z., Liu, Z., Du, X., Huang, J., Pepler, K., Ramani, K., (2021). RobotAR: An Augmented Reality Compatible Teleconsulting Robotics Toolkit for Augmented Makerspace Experiences. In *CHI Conference on Human Factors in Computing Systems*. <https://doi.org/10.1145/3411764.3445726>

Zhang, Y., Omrani, A., Yadav, R., & Fjeld, M. (2021). Supporting Visualization Analysis in Industrial Process Tomography by Using Augmented Reality—A Case Study of an Industrial Microwave Drying System. *Sensors* 2021, 21, 6515. <https://doi.org/10.3390/s21196515>

Fernández. T, Mirandas F, Fernández V, Méndez G. (2022). Analysis and simulation of a tibial prosthesis. <https://doi.org/10.46932/sfjdv3n4-033>

Fernández. T, Mirandas F, Fernández V, Méndez G. (2022). Design and simulation of control of a system of ventilation assisted by PLC and weintek screen. <https://doi.org/10.46932/sfjdv3n4-034>

## Approaches to the financial evaluation of the “El Ahogado” wastewater treatment plant in Jalisco, Mexico

### Aproximaciones a la evaluación financiera de la planta de tratamiento de aguas residuales “El Ahogado” en Jalisco, México

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#### Abstract

**Purpose:** To generate financial feasibility indicators for the “El Ahogado” wastewater treatment plant project in Jalisco, Mexico, as an integral part of the water sanitation system in the Guadalajara Metropolitan Area (AMG). **Methodology:** Model of Public-Private Partnerships (PPP) for the development of social infrastructure works. A research object is adapted to a retrospective case study for its current application in Mexico. The financial feasibility analysis includes an evaluation of the financial costs regarding the revenues and subsidies delivered to the developer periodically and those received for water recovery per month. **Contribution:** This study allows us to conclude that for the financial conditions for the development or private capital in the “El Ahogado” treatment plant project, it was not financially viable given the maintenance and operation costs required in this infrastructure.

**Wastewater treatment plants, Public-Private partnership, Financial viability**

#### Resumen

**Objetivo:** Generar indicadores de factibilidad financiera para el proyecto de la planta de tratamiento de aguas residuales “El Ahogado” en Jalisco, México, como parte integral del sistema de agua potable de la Zona Metropolitana de Guadalajara (AMG). **Metodología:** Modelo de Asociaciones Público Privadas (APP) para el desarrollo de obras de infraestructura social. Se adapta un objeto de investigación a un estudio de caso retrospectivo para su aplicación actual en México. El análisis de factibilidad financiera incluye una evaluación de los costos financieros en cuanto a los ingresos y subsidios entregados al desarrollador periódicamente y los recibidos por recuperación de agua por mes. **Contribución:** Este estudio permite concluir que por las condiciones financieras para el desarrollo o capital privado en el proyecto de la planta de tratamiento “El Ahogado”, no era viable financieramente dados los costos de mantenimiento y operación que requiere esta infraestructura.

**Plantas de tratamiento de aguas residuales, Asociación público-privada, Viabilidad financiera**

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## Introduction

The conservation of natural water sources is an issue that concerns humanity in general. Rivera, Chávez, and Salinas (2018) point out that natural resources have suffered great impacts; among them water, this liquid has suffered an increase in demand due to population growth, generating pollution due to the discharge of garbage and waste to natural sources such as rivers, lakes, seas, a problem that has been getting worse over the years. In the international sphere, McGillivray (2008) comments that the United Kingdom, through the United Kingdom Department for International Development (DFID), demonstrates its experience in private investment projects for the development of infrastructure, mainly in poor countries. In the case of the Water and Sanitation Program (WSP), electricity, telecommunications, and transport programs in 2003, the Global Association for Results-Based Aid (GPOBA), formed by the World Bank with the support of the United Kingdom United, considers that delegating responsibility for the provision of public services to a private company or Non-Governmental Organization NGO is an effective strategy for financing or if it is justifiable to apply subsidies based on results, especially to low-income users.

Unfortunately, the economic issue is not addressed with much research in this regard since there is no consensus to evaluate the projects, high costs, limitations, and obstacles that they present (Senante, Sancho, and Garrido 2010). The collection of a fee that guarantees the management of wastewater treatment to the users allows the use of public resources for other purposes, guaranteeing optimal service and generating awareness of rational consumption among users (Moral-Pajares, Gallego Valero, and Román-Sánchez 2019). For their part, Lindtner, Schaar, and Kroiss (2008) pointed out that wastewater treatment plants in Australia are publicly owned and operated by the public sector and private companies.

Debaere and Kapral (2021) address the problems that several countries in the world are experiencing due to water scarcity. For countries with strong economies, the participation of private investment in their different financing schemes (Public Private Partnership - PPP) can be a good strategy to solve water problems, taking advantage of their experience, a calculation more in line with user prices to guarantee the works and innovation that they have been developing due to market competition. The United Nations, addressing the challenge of the water problem to guarantee its availability and sanitation, implements it in its agenda as the Sustainable Development Goal 6 (SDG6), focused mainly on low-income and developing countries, since 61% of the world's population does not have sanitation services. Africa is no exception, and the struggle to provide this service. Ghana approved in 2010 under the supervision of the Government; the polluter pays policy, in addition to this, the public sector, to positively improve sanitation services, should review the implementation of PPPs as a financial alternative to this problem (Tanoh, Nikiema, Asiedu, Jayathilake, and Cofie, 2022).

Van Dijk, Etajak, Mwalwega, and Ssempebwa (2014) comment that among some of the obstacles that exist to offer a better sanitation service to the most unprotected communities, a better financing scheme and a mechanism to generate income can be highlighted for the support of the projects undertaken. The industrial sector is the one that pollutes the most and uses the water resource the most. Industrialized countries produce approximately 80% of hazardous substances and 70% in developing countries, which directly dump the waste into their natural water sources (Rodríguez, Letón, Rosal, Dorado, Villar, and Sanz, 2006).

The European Court of Auditors (2018), in a press release, reported that after auditing several PPPs, the deficiencies are notorious as there is no balanced relationship between quality and price with respect to ineffective and unnecessary expenses recorded, lack of transparency in The percentage of risk distribution, which makes some contracts under this PPP scheme a non-viable option to promote public infrastructure works as a response to social problems.

To date, the financial and economic viability of the Wastewater Treatment Plant (WWTP) in Mexico is officially unknown. In this regard, there is no official evidence that shows this situation and reality in the states; Also, there is misinformation transparency and disconnection between studies of financial viability and the social value generated by WWTPs and for which they were promoted and approved in developing countries. Waste is dumped into natural water sources near the urban sprawl, especially rivers, lakes, seas, underground streams, even wasting this resource for drinking water supply, communication as a means of transport, and power generation (Espigares-García, Gálvez, and Lopez, 1986).

The objective of this document was to generate financial viability indicators for the "El Ahogado" WWTP project from the point of view of the developer's investment as an integral part of the water sanitation system in the AMG. Financial viability will be the ratio of financial benefits to financial costs, based on formulas used in a study to analyze financial viability for decentralized sewage treatment plants in Beijing selected because this article focuses on determining whether decision-making for the developer is financially viable and, therefore, its permanence and final results to achieve the objectives proposed by the public sector in the construction, maintenance and operation of the WWTPs object study. Liang and van Dijk (2010) establish that the financial viability of the project will be determined by the relationship between the financial benefits and the financial costs because if the results are less than 1 (one) the investment is not viable, but if on the contrary is greater than one (1), it can be concluded that the work is feasible for its realization and operation.

According to Ordoñez and Losada (2015) point out that water issues have been on the Cooperation for Development Agenda permanently, even several international organizations promote drinking water and sanitation projects from their conceptualization, financing, processes, collection of documented experiences and publications referring to research and manuals on the subject.

For Lahera-Ramón (2010), developing countries such as Mexico must return the water that is used in optimal conditions and after treatment so as not to stop its hydrological cycle, and even they are issues that have not been resolved in part due to the population size, technology, economy, and regulatory policies that have not allowed these projects to be consolidated.

### **Mexican legislation and institutional**

Article 27 of the Constitution of the United Mexican States states that the waters are national and not of the states or individuals; everything originates there, so for this, they defined the national water law that regulates how to manage water in the country, and Jalisco in congruence with the regulatory framework and to regulate the administration of waters in the jurisdiction of the state of Jalisco, the Water Law for the State of Jalisco and its Municipalities was approved, with decree 21804/LVII/06 and published in the Official Newspaper "El Estado de Jalisco" (Congress of the State of Jalisco 2007). This law establishes the regulations and regulatory bases whose activity is to attend to social welfare in terms of water for all state and municipal entities; construction, conservation, expansion of hydraulic infrastructure; administrative cooperation between entities; the provision of drinking water, sewage, sanitation, and wastewater reuse services in the State of Jalisco, delegating responsibility to the municipalities; fees, among others. Regulation of the Water Law for the State of Jalisco and its Municipalities (2009) (Government of the State of Jalisco 2009).

The State Commission for Water and Sanitation (2003) addressed the situation regarding the contamination of natural water sources located in the AMG, mainly in the "El Ahogado" Basin, the Santiago and Verde Rivers, as a result of untreated water spills, to which the Government of the State of Jalisco, with the support of the State Water and Sanitation Commission (CEAS), the National Water Commission (CNA), they promote sustainable alternatives for the environment, protection of the environment, prevention of public health problems and economic engine for projects.

In the "El Ahogado" and "Agua Prieta" WWTP project, the public sector contemplated the participation of private capital in a financing scheme of a Public-Private Partnership in which the Federation through the National Infrastructure Fund (FONADIN) contributes a part of the required investment (49%), while the state is responsible for the difference in missing resources to achieve them. Garrick, De Stefano, Turley, Jorgensen, Aguilar-Barajas, Schriener, ... and Horne (2019) mention that some policies maintain that the administration of public services locally is positive, since the needs are adjusted to the interests of the population, in addition, accountability directly to citizens grows (Herrera, 2014). Mexico registered in 1998 the origin of fiscal decentralization, generating in the thirty-two states. In the legal framework of Mexico, water is a resource for all its inhabitants; that is, it is a public resource and is under the direction of the National Water Commission (CONAGUA), and the reuse of water is regulated. The policies that govern the recovery of water to take advantage of it, for example, in irrigation, make the mandatory administrative costs too high for its use (Mendoza-Espinosa, Burgess, Daesslé, and Villada-Canela, 2019).

In 1992, the WWTPs were the first projects to become concessions in Mexico, a project of the Government of the State of Mexico through the Secretariat of Urban Development and Public Works (SEDOP) (World Bank 2006). Municipalities are responsible for providing drinking water, sewage, and sanitation services, according to article 115 of the Mexican Constitution (Bravo, Castro, and Gutiérrez 2011). Regarding the tariff, issue to demonstrate the financial sustainability of the projects. The National Water Commission (CONAGUA, 2007) points out that there are different models for the rate structure with representative models at the international level and in practice at the national level, which seeks to improve the rate-setting for users; and for the calculation of the rate, the total of the costs that integrate it must be considered "technical, financial and social criteria; these are reflected in the fixed and variable costs" (CONAGUA, 2007, p. 7).

For the particular case of the state of Jalisco, it was determined that the state participation would be covered with resources from private participation through the municipalities of the AMG, which are organized in the Intermunicipal Drinking Water and Sewerage System (SIAPA) for the municipalities of Guadalajara, Zapopan, San Pedro Tlaquepaque, and El Salto; Potable Water, Sewerage and Sanitation System (SIAT), for Tlajomulco de Zúñiga; and finally the El Salto Municipal Potable Water and Sewage System (SIMAPES) for the municipality of El Salto. It has the financial support of the Government of the State of Jalisco, through the State Water Commission of Jalisco (CEA) in the course of the service operation of the work carried out. This situation allows a financing alternative in the face of the lack of economic resources of some of the parties to conclude works of relevance for social benefit.

The results after years of starting these projects have discouraging comments and results, so this document aims to focus its attention on the "El Ahogado" WWTP and review the financial viability for the developer in the face of this million-dollar investment at the initiative of the Government of Mexico, with the projection of monthly income, subsidies regarding the programmed expenses for its operation agreed in the ruling of the Public Tender No. 43111001-046-08 (CEA, 2008), important in this analysis since these must guarantee and demand an optimal result the developer as a member of the private sector in the financial model of the Public-Private Partnership (PPP).

The guarantee of solving public service problems must be contemplated before the start of the projects since these represent a true social impact and hope for problems that afflict several communities. Throughout the document, both treatment plants will be mentioned because they are complementary, and their entire infrastructure forms the integral system of treated water for the AMG.

Anda-Sánchez (2017) points out that the WWTPs mostly used in the municipalities of Mexico consist of conventional or centralized technologies, which demand large amounts of energy, markedly increasing maintenance and operation costs. Unfortunately, when they present failures, they directly impact the communities with sewage flooding. The investment, maintenance, and operating costs are not viable for low-income sectors of the country, as this becomes an unsustainable long-term financial burden for the users or beneficiaries of these populations. Mexico should consider new technologies as an alternative to this problem, such as decentralized wastewater treatment systems (cost reduction, adaptation to the environment for its construction, etc.). On the other hand, the “El Ahogado” WWTP is projected to serve 20% of the AMG, while the “Agua Prieta” WWTP 80%, in order to integrate the wastewater treatment system of the AMG urban area.

Due to the contamination of the Santiago River by residual discharges from the AMG, the construction of the “Agua Prieta” and “El Ahogado” WWTPs was promoted with the support of federal, state, municipal, and private sector resources. The lack of budget at the three levels of Government in Mexico (federal, state, municipal) once again allows the participation of the private sector in investments that promote development in different sectors. These two-infrastructure works form the purification or treated water system, with a projection of sewage treatment of 89% in the AMG. For both WWTPs, the financing model is under the PPP scheme and with a DBOT contract (design, construction, operation, and transfer), with the long-term operation. The sources of investment and characteristics of the projects are illustrated in table 1. Regarding the construction of the sewage system and the collectors, they are carried out by the companies with the best economic and technical proposals under the regime of the Public Works Law, absorbed in its entirety with public resources.

Comprehensive Sanitation Project for the Guadalajara Metropolitan Area			
Details	Public sector	Private sector	
Investment	Sewerage and collectors "Agua Prieta and El Ahogado"	Treatment Plants - PPP Scheme (DBOT) 20 years	
	Construction of: sewerage network 615 km collector system 203 km pumping station San Gaspar collector tunnel San Martín collector	"Dark Water" 8.50 m <sup>3</sup> /s 80% treated water	"The Drowned" 2.25 m <sup>3</sup> /s 20% treated water
Tender and Trust		2009 – 2012	2008 – 2009
Expenditure Budget of the Federation (PEF)	USD 88.61 million		
Jalisco state	USD 88.61 million		
National Infrastructure Fund Trust (FONADIN) non-refundable.		USD 45.52 million	USD 19.71 million
Private investment		USD 79.58 million	USD 21.53 million
Subtotal	\$177.23	USD 125.09 million	USD 41.24 million
Total investment without VAT	USD 343.56 million		

**Table 1** Characteristics of the Comprehensive Sanitation Project of the AMG

Source: National Water Commission (CONAGUA, 2012) Strategic Projects for drinking water, drainage and sanitation. National Infrastructure Program 2007-2012. De la Pena et al. (2013). own adaptation  
The dollar exchange rate used corresponds to \$20.8266 MN MX on March 15, 2022. <https://www.banxico.org.mx/tipcamb/main.do?page=tip&idioma=sp>



The objective of the "Agua Prieta" WWTP project is to provide and take advantage of the reuse of treated water for the generation of electricity for the benefit of the Federal Electricity Commission (CFE), Valentín Gómez Farías hydroelectric plant. Finally, once the treated water is reused, the discharges will be deposited in the Santiago River. For this work, wastewater discharges from the Atemajac Basin (Osorio, San Andrés, and San Gaspar sub-basins) are contemplated, which pass through the Tunnel - San Gaspar - Atemajac to reach the "Agua Prieta" WWTP, treating 80% of the wastewater from the AMG. (State Water Commission - Jalisco, 2012).

The distribution of capital, according to reports from El Informador (2009), estimates that for the construction of the "El Ahogado" WWTP in Jalisco, Mexico, could have reached a cost of approximately 43.22 million dollars, made up of the participation of FONADIN with capital up to 19.70 million dollars in lost funds (49%), and on the other hand, the participation of private capital, of 25% with risk capital and the rest with a loan at the end of the total project. The recovery of 51% of the developer's investment would be generated at the time of the concession through the payments that the Government of the State of Jalisco would make monthly once this work begins operations.

The financial benefits for the PTAR project will be the monthly payments and subsidies that the CEA makes to the investor or developer agreed upon in the resolution of the public Tender No. 43111001-046-08 (public access at the State Water Commission - Jalisco, 2008). The financial costs will be integrated with the total cost of the investment, maintenance costs, and initial operation. See table 2.

Operation Period		Monthly payments at constant prices from September 30, from 2008.				
Year	Month	investment fee	Fee for fixed costs of operation and maintenance	Fee for variable costs of operation and maintenance	Consideration per month	Total project payments
		T1=TIC + T1R	T2	T3		
3 to 19	31 to 222	\$248.22 million	\$97.04	\$85.44	\$430.70 million	USD 82.69 million
19 to 20	223 to 240	\$102.20 million	\$97.04	\$85.44	\$284.68 million	USD 5,124.40 MD
Total of the National Public Bidding project 43111001-046-08 Data in millions of dollars MDD						\$87,820.55 MD

**Table 2** Characteristics of the AMG wastewater treatment plants

Source: Own elaboration based on the Public Tender ruling and information collected from the State Water Commission - Jalisco (2008); National Water Commission (CONAGUA, 2012). Data obtained in field interviews.

Note: Values are given at current prices. Operation Period

Monthly payments at constant prices from September 30, From 2008. Conversion to dollar price.

Projection of monthly payments per rate for the "El Ahogado" treatment plant

Given the results obtained with the data worked, those perceived by the AMG community, it will be supported with references and studies that prove them since this work has been in force for more than ten (10) years. Since the proposal of the project for the PTAR "El Ahogado" to solve the wastewater problem for the benefit of the Metropolitan Area of Guadalajara (ZMG) or also known as the Metropolitan Area of Guadalajara (AMG), several changes have been recorded from its structure of initial financing, as government participation, to finally intervene the private sector in the PPP scheme.

The "Agua Prieta" WWTP was built with federal resources from the National Infrastructure Fund (FONADIN) and private resources. This project is expected to benefit 3.5 million inhabitants; this project is the third-largest in Latin America and the largest plant in Mexico; the cost per cubic meter for water treatment is 98 cents, registering as the lowest in the country, with a capacity of 8,500 liters per second; and the PTAR "El Ahogado" with its 2,200 liters per second, will cover the sanitation of around 98% of the residual or black water produced by the ZMG (Government of the State of Jalisco 2014).

## Methodology

From the methodological point of view, the criterion of adapting a research object to a retrospective case study for its current application in Mexico is assumed. In the internal order, the methodology is translated into an analysis of financial viability that includes an evaluation of the financial costs that is integrated with the financial benefits (the initial investment, operation, and maintenance costs) with respect to the financial benefit that would be integrated by the income and possible subsidies delivered to the developer periodically (generated by the payment of the users of the different municipalities that participated in the WWTP project, with the "Contribution of sanitation plants" tax with their respective percentages of participation, subsidies) and that received for water recovery per month. Although the reality is different, since the responsibility is assumed by the SIAPA before the developer, this study will be based on the monthly payments agreed in the public tender, which was published by public sector entities with open access and the one collected in Fieldwork.

The relationship between these two factors will determine the viability (if the ratio is greater than 1, it is viable; otherwise, good financial planning was not done). The formulas used to obtain the results are referenced from a study in Beijing on decentralized wastewater treatment plants to understand the regular performance obtained with respect to expected expectations. For the evolution of financial analysis, the relationship between financial costs and benefits will be taken into account, which is calculated with next formulas (3 and 5), source: Liag & Dijk (2010).

$$V_I = V_B + V_M + V_P \quad (1)$$

$$V_{O\&M} = \sum_{t=1}^n \frac{V_t}{(1+r)^t} \quad (2)$$

$$FC_{PV} = V_I + V_{O\&M} \quad (3)$$

$$FB_{PV} = \sum_{t=1}^n \frac{FB_{r(t)}}{(1+r)^t} + \sum_{t=1}^n \frac{FB_{s1(t)}}{(1+r)^t} + FB_{s2} \quad (4)$$

$$R_{FB/FC} = \frac{FB_{PV}}{FC_{PV}} \quad (5)$$

Where:

$V_I$ : Initial investment (land, electrical and mechanical material, pipes, building construction material, etc.).

$V_{O\&M}$ : initial operation and maintenance costs

$t$ : time in which the investment was developed.

$r$ : discount rate  $\rho$

$n$ : number of years of the concession

$V_t$ = operation and maintenance expenses of year  $t$

$FC_{PV}$ : Financial cost (total investment and maintenance costs and initial operation)

$FB_{PV}$ : Financial benefits

$FB_{r(t)}$ : Income in year  $t$ .

$FB_{s1(t)}$ : Subsidies in year  $t$

$FB_{s2}$ : Initial investment subsidies

$R_{FB/FC}$ : Relationship between financial benefit and financial cost.

For this investment, three rates are agreed upon, classified as follows: T1 investment rate, T2 rate for fixed costs of operation and maintenance, and T3 rate for variable costs of operation and maintenance, which make up the total consideration for the project, listed in table 2.

## Results

To achieve the collection of this information, officially published sources with free access were sought, mainly issued by the State Water Commission of Jalisco (CEA), the State Government, SIAPA, CONAGUA, newspapers, magazines located in databases and the Internet, government reports, among others, and as fieldwork, an interview was conducted with government officials from the state of Jalisco. The results obtained show that the financial viability for this project is zero (0.00162366).

These reinforce information issued by the CEA itself, institutions, researchers, and even various government entities, where the monthly payments agreed in the Public Tender rose considerably in the face of maintenance and operation costs.

The information was converted to real prices based on the National Consumer Price Index (INPC) (financial costs, income to the developer, and investments) to determine the financial viability of the “El Ahogado” WWTP. As of November 2009, the initial investment, maintenance, and operation costs were deflated. For its part, revenues to the developer were deflated as of 2012, which is when the commitment begins until 2029. However, as of 2022, an increase in inflation (INPC) is projected based on the increase in the average registered year in 2021. The results obtained are generated based on the information listed in table 3.

Formulas details	Without vat
V1: Initial investment (land, electrical material, pipes, construction material, etc.)	\$19,350,466.43
VO&M: initial operating and maintenance costs	\$5,477,484.51
t: time in which the investment was developed	2.5
r: discount rate	12
n: number of years of the concession	20 years
Vt= operation and maintenance expenses of year t	\$31,661,176.03
FBr(t): Income in year t.	\$42,128,430.21
FBs1(t): Subsidies in year t	\$0
FBs2: Initial investment subsidies	\$0

**Table 3** Information for the calculation of formulas  
 Source: State Water Commission - Jalisco (2003). Data obtained in field interviews. Minutes of the Public Tender decision and information collected from the Jalisco State Water Commission – CEA. (2008). Deflated data (real own prices obtained) based on the National Consumer Price Index INPC. Base = 100 second fortnight of July 2018

The results obtained are the following:

$$FB_{PV} = \text{USD } 1,714.28$$

$$R_{FB/FC} = 0.00162366$$

Given that the final relationship between financial benefits and financial costs is less than one, it is concluded that it is not financially viable from the developer's point of view, which allows reinforcing the results with literature that addresses comments against expectations. Expected before this millionaire infrastructure work in the AMG. Construction of the “El Ahogado” WWTP began in 2012 to complete the sanitation of wastewater from the AMG on a par with the “Agua Prieta” WWTP, but the proposed objectives have not been achieved due to the lack of pipelines to handle the municipal discharges from Tlajomulco since the wastewater from this municipality falls directly into the Santiago River, notoriously affecting this water resource of the state for the development of important economic activities in this region (Government of the State of Jalisco 2019).

Contrary to the amounts reported in the final decision of the Public Tender No. 43111001-046-08 (State Water Commission - Jalisco, 2008), which amount to USD 430,709.09 thousand dollars per month, Anda-Sánchez (2017), addresses the high maintenance and operation costs for the “El Ahogado” WWTP, where monthly it is for USD 1,632 thousand dollars, becoming a long-term and non-viable debt for developing countries.

Some exercises were carried out to understand that in the absence of subsidies from the beginning of the investment and in the years granted to the developer, the relationship becomes negative; On the contrary, if these are present during the initial investment and in the concession years, the relationship is positive, yielding a result greater than 1. But this analysis can be supported if the monthly payments reported and agreed in the accepted public tender have been fulfilled, in contrast, with the results shown in the information collected.

Meléndez (2020) comments that the “El Ahogado” WWTP is overflowing because it is working at 110% of its capacity; it is attributed to the increase in population but adds the same CEA that the “Agua Prieta” WWTP is not working at its capacity maximum after three years of operation since it is only at 56% of its capacity.

This confirms that the project of the two largest treatment plants is not complying with the attention to the pollution problem, a statement issued by the Greenpeace organization according to a November 2016 report, since in their studies they found highly toxic, unregulated chemicals by Mexican Law, they also conclude that these plants will not solve the problem, since they only treat domestic water and were not designed for industrial discharges.

Covarrubias and Lozano (2012), in their article "The plant of "El Ahogado", the last fiasco of Calderón," strongly evidence how political interests are more relevant than social welfare problems. This is demonstrated by the million-dollar approval of the PTAR "El Ahogado" to attend to the sanitation of the Santiago River, where the norms of NOM 001-SEMARNAT-1996 are not fulfilled in 87% to 94% by the industries located mainly in the municipality from El Salto, precisely where the "El Ahogado" dam is. The high levels of substances were found to violate the provisions of the Federal Water Rights Law 2009 (Secretariat of Environment and Natural Resources 2009). Between El Salto and Juanacatlán, the mortality rate from 2007 to 2010 increased due to diarrhea, gastroenteritis, malignant tumors, leukemia, cancer, hypertensive kidney diseases, among others, according to the National Health Information System (Sinai). On the other hand, the problem is exacerbated by irresponsible administrations such as the PRI and the PAN, where an average of 23 housing developments were authorized a decade ago. In an interview with the Greenpeace organization, the Mexican legislation for the regulation of the environment is obsolete, and they are free for the industry. He concludes that those who pollute are the industries that cause the contamination, such as the case of non-phenol, since there is no technology in the world to clean this substance, so its implementation should be prohibited.

It is concluded that the project was not analyzed from the beginning because these plants were only going to attend to domestic water discharges, so the real beneficiaries are the developers in the face of the millionaire charges, as researchers from the Western Institute of Technology and Higher Studies (ITESO) (Covarrubias and Lozano, 2012), they already knew that these WWTPs were not going to solve the problem because they did not address the real problem by applying the technology required to attend to the water discharged by the industries.

In more recent information, Beret (2020) reports that the "Agua Prieta" WWTP is underutilized according to the report of the 2014-2018 Institutional Plan of SIAPA (National Water Commission (CONAGUA, 2016), in the absence of collectors, highlighting that the capacity of the project proposal of 8.5 m<sup>3</sup>/s, only 5.4 m<sup>3</sup>/s are working on average. The promise of the state government to treat up to 89% of the AMG has not been fulfilled because the results in 2019 are 51. Given this situation, SIAPA, from the Tariff Commission, published that, for the wastewater treatment activity, the monthly fee will be between USD 0.03 cents and up to USD 0.50 dollars.

Meléndez (2020), according to reports requested for transparency, the CEA informs that due to the new investment in the infrastructure of another 13 treatment plants within the state with an estimated USD 28.81 million dollars will partially solve the contamination problem by managing to go from 65% to 70% of sanitation of the domestic waters that fall into the Santiago River. The questioning that is made in this report to the Government is towards the wrong solutions that are being implemented to this problem; according to Cindy McCulligh, a scientist from the University of Zacatecas, points out that the eastern interceptor collector or tunnel that conducts wastewater from the AMG should be built to the "Agua Prieta" WWTP, which has been contemplated since 2013. The tunnel project has not even been put out to tender to date, but it is contemplated from the projection of the wastewater treatment system for the AMG specifically for the "Agua Prieta" WWTP project, so this sewage in part of industry and farmers are going directly to the Santiago River through the municipality of Tonalá when going down the ravine.

## Discussion and conclusions

The approach that was carried out in this study allows us to conclude that for the financial conditions for the development or private capital in the “El Ahogado” treatment plant project, it was not financially viable given the maintenance and operation costs required in this infrastructure. This is reinforced by the monthly payments that the Government of the State of Jalisco must currently make through CEA to the developer since they are notoriously higher than those proposed in the public tender.

These results strengthen the comments recorded in the literature and research against millionaire investments, which are approved without a guarantee against the proposed or promised results. In addition to this, it is once again demonstrated the lack of experience on the part of the public sector to carry out infrastructure works for social benefit without generating long-term indebtedness and making the provision of public services more expensive.

It has been shown in some studies that decentralized WWTPs can be an alternative to contaminating the state's water basins and water resources, but this would go against policies that protect companies and large monopolies already established in the AMG. If real estate developers, industrial complexes, shopping centers, and works that constantly generate waste or sanitary waste were approved to build their own WWTPs, in exchange for subsidies or discounts in their rates for the payment of services, the pollution of rivers and water sources could gradually recover. The literature review allows us to appreciate that the Mexican legislation to protect the environment is obsolete and leaves an open gap for the indiscriminate use of industries, for not typifying the use of chemical substances harmful to life and that their use should be prohibited not only in Mexico but in the whole world. Likewise, the permissiveness and negligence of governments at all levels, by not controlling wastewater discharges from chemical processes; the deception of the population for electoral purposes in many cases, by allowing million-dollar works that do not solve the pollution problem with technology aimed at industrial waste. To this must be added the indebtedness and long-term economic commitments to which citizens and future generations are exposed.

Although the results obtained in this investigation are relevant from the financial point of view, the operation of the WWTP requires continuing to analyze the cause of the problem to really solve the wastewater treatment. It is considered necessary to continue with the analysis to include the positive externalities, social, and economic impact to validate the legitimacy of the millionaire investments made by the governments. The experience that the development companies have should be evaluated for more objective purposes so as not to cast doubt on their results with significant investments from the public sector.

The Law of Public-Private Partnerships of January 12, 2012, states that the works under these contracts must be directed to social benefit and demonstrate the advantages of this financial scheme in comparison to other forms of financing, but in practice, it can be concluded that there is a lot of inconsistency when obtaining the results. This can be supported when submitting proposals in public tenders because in this case study, the technology to treat wastewater from the AMG did not address the real problem of contamination of the Santiago River due to not carrying out in-depth studies or because the important thing is to obtain the ruling in favor of the developer presenting the lowest proposal with very high expectations, but that in the inter-years of the concession the agreed payments increase substantially, without this guaranteeing the solution to the real problem. It is the bidders who submit proposals, initial investment costs, financial, maintenance and operation costs, delivery times for their operation, environmental impact studies, financial and social feasibility, among others, to achieve the objectives.

The issue of conserving water resources in the state, and very possibly in the country, has become an issue of proselytism, of permits to the industry, to real estate developers, to agribusiness industries, regardless of the cost of living and irreparable damage to the environment. The most viable solution that the Government sees in its different instances is to raise the tariffs for the use of water to the consumer, but the references mentioned here show that the problem is not the high tariffs, nor the subsidies, but rather the infrastructure in its total construction.

It is necessary to promote a change of vision for the public sector in the face of the responsibility to attend public services for the well-being of its inhabitants with public works that guarantee their purpose and where the private sector participates with the same interest, and even strictly regulating compliance and the payments agreed upon in public tenders. In addition, it is necessary to promote and typify the use of decentralized WWTPs, where they are adapted to developments and projects approved under national and international laws; that is, each developer must generate their own WWTPs and be responsible for the waste produced. Current investments with conventional WWTPs can only serve to treat residual or domestic waters due to their initial nature for projects. Without a doubt, it is extremely necessary to promote international laws that do not allow countries to deliberately choose the systems they consider suitable for treating wastewater, changing the view that water resources belong to all of humanity.

The recovery of natural sources such as rivers, lakes, dams, among others, are issues that today acquire relevance for developing countries, with the construction of an entire infrastructure for channeling wastewater to be treated in wastewater treatment plants. The responsibility to invest in these projects is of the governments to attend to this problem; however, the responsibility to cover the obligations for the use and exploitation of drinking water, as well as that which is wasted as organic waste from personal property, is undoubtedly of the citizens, the main characteristic of the services is that whoever uses them pays for them.

The criterion of financial viability for the developer is assumed based on the comprehensive sanitation project in the AMG. This research not only intends to throw a number to determine the financial viability based on the developer, but also contextualizes the value of water and the responsibility assumed by both private actors and the public sector for decision-making to make financial alliances, and with this, solve social or infrastructure problems in favor of national development. It is suggested to continue with studies that show the responsibility of the developers before the obligations acquired in the failures of the tenders against the results of the works and close the biases in indiscriminate payments and far from those accepted in said tenders.

## References

- Anda-Sánchez, J. de. (2017). Decentralized sanitation and sustainable reuse of municipal wastewater in Mexico. *Society and Environment*, 14, 119-143.
- Beret, M. (2020). Sanitation in Santiago lowest in six years. *El Informador*. <https://www.informador.mx/Saneamiento-del-Santiago-el-mas-bajo-en-seis-anos-1202002240001.html>
- Bravo, H. M., Castro, J. C., and Gutiérrez, M. Á. (2011). Evaluation of a fiscal policy to determine the optimal level of investment in drinking water, sewerage and sanitation services. *Gestión y Política Pública*, 20(1), 63-95.
- Congress of the State of Jalisco (2007). Water Law for the State of Jalisco and its Municipalities. Decree 21804/LVII/06 Y. [https://info.jalisco.gob.mx/sites/default/files/leyes/ley\\_del\\_agua\\_para\\_el\\_estado\\_y\\_sus\\_municipios.pdf](https://info.jalisco.gob.mx/sites/default/files/leyes/ley_del_agua_para_el_estado_y_sus_municipios.pdf).
- Covarrubias, J., and Lozano, A. G. (2012). The El Ahogado Plant, Calderón's latest fiasco. *Proceso magazine*. <https://www.proceso.com.mx/reportajes/2012/11/16/la-planta-de-el-ahogado-el-ultimo-fiasco-de-calderon-110892.html>
- De la Peña, M. E., Ducci, J., and Zamora, V. (2013). Wastewater treatment in Mexico. Technical Note IDB-TN-521, 12, 30. <https://publications.iadb.org/publications/spanish/document/Tratamiento-de-aguas-residuales-en-México.pdf>
- Debaere, P., and Kapral, A. (2021). The potential of the private sector in combating water scarcity: The economics. *Water Security*, 13, 100090.
- El Informador (2009). Arranca la construcción de la planta de tratamiento "El Ahogado." *Planta de Tratamiento "El Ahogado."* <https://www.informador.mx/Jalisco/Arranca-la-construccion-de-la-planta-de-tratamiento-El-Ahogado-20091109-0255.html>.
- Espigares-García, M., Gálvez, R., and López, J. A. P. (1986). Sanitary aspects of the study of water. University, Servicio de Publicaciones.
- MORENO-ORTIZ, Alba Lucia & VÁZQUEZ-ELORZA, Ariel. Approaches to the financial evaluation of the "El Ahogado" wastewater treatment plant in Jalisco, Mexico. *Journal-Economic Development Technological Chance and Growth*. 2022

- European Court of Auditors (2018). Auditors say EU public-private partnerships suffer from widespread weaknesses and limited benefits. Public-Private Partnerships. [https://www.eca.europa.eu/Lists/News/NEWS1803\\_20/INSR\\_PPP\\_ES.pdf](https://www.eca.europa.eu/Lists/News/NEWS1803_20/INSR_PPP_ES.pdf)
- Garrick, D., De Stefano, L., Turley, L., Jorgensen, I., Aguilar-Barajas, I., Schriener, B., Leao, R. de S., O'Donnell, E., and Horne, A. (2019). Dividing the water, sharing the benefits: lessons from rural to urban water reallocation.
- Government of the state of Jalisco (2009). Reglamento de la Ley del Agua para el Estado de Jalisco y sus Municipios. <https://info.jalisco.gob.mx/gobierno/documentos/9160>.
- Gobierno del estado de Jalisco. (2014). Agua Prieta, a historic work for Jalisco. Aguas Residuales Agua Prieta. <https://www.jalisco.gob.mx/es/prensa/noticias/14736>
- Government of the State of Jalisco. (2019). Plan Estatal de Gobernanza y Desarrollo de Jalisco 2018-2024. Vision 2030. Retrieved At: [https://Transparenciafiscal.Jalisco.Gob.Mx/Transparenciafiscal/Programatico\\_presupuestal/Plan-Estatal-de-Desarrollo](https://Transparenciafiscal.Jalisco.Gob.Mx/Transparenciafiscal/Programatico_presupuestal/Plan-Estatal-de-Desarrollo).
- Herrera, V. (2014). Does commercialization undermine the benefits of decentralization for local services provision? Evidence from Mexico's urban water and sanitation sector. *World Development*, 56, 16-31.
- Lahera-Ramón, V. (2010). Sustainable infrastructure: wastewater treatment plants. Quivera. *Journal of Territorial Studies*, 12(2), 58-69.
- Liang, X., and van Dijk, M. P. (2010). Financial and economic feasibility of decentralized wastewater reuse systems in Beijing. *Water Science and Technology*, 61(8), 1965-1973.
- Lindtner, S., Schaar, H., and Kroiss, H. (2008). Benchmarking of large municipal wastewater treatment plants treating over 100,000 PE in Austria. *Water Science and Technology*, 57(10), 1487-1493.
- Mcgillivray, G. (2008). The DFID public-private model. Working Papers (Fundación Carolina), 30, 55-63.
- Meléndez, V. (2020). Invierten 600 mdp en saneamiento del Santiago, pero apenas crecerá 5% tratamiento de aguas negras. *Udgtv News*.
- Mendoza-Espinosa, L. G., Burgess, J. E., Daesslé, L., and Villada-Canela, M. (2019). Reclaimed water for the irrigation of vineyards: Mexico and South Africa as case studies. *Sustainable Cities and Society*, 51, 101769.
- Moral-Pajares, E., Gallego Valero, L., and Román-Sánchez, I. M. (2019). Cost of urban wastewater treatment and ecotaxes: Evidence from municipalities in southern Europe. *Water*, 11(3), 423.
- National Water Commission (CONAGUA). (2007). Manual de Agua Potable, Alcantarillado y Saneamiento. Mexico.
- National Water Commission (CONAGUA). (2012). Strategic projects, drinking water, drainage and sanitation. Programa Nacional de Infraestructura 2007-2012. [https://www.cmic.org.mx/comisiones/Sectoriales/infraestructurahidraulica/presentaciones\\_2008/20-02-2012.pdf](https://www.cmic.org.mx/comisiones/Sectoriales/infraestructurahidraulica/presentaciones_2008/20-02-2012.pdf)
- National Water Commission (CONAGUA). (2016). Strategic projects, drinking water, drainage and sanitation. CONAGUA, National Infrastructure Program 2014-2018.
- Ordóñez, J., and Losada, C. (2015). Development of an interactive tool to facilitate the development of drinking water projects in low-income countries.
- Rivera, P., Chávez, R., and Salinas, F. R. (2018). Advances and limitations in wastewater treatment in the state of Zacatecas. *Tecnología y Ciencias Del Agua*, 9(1), 113-123.
- Rodríguez, A., Letón, P., Rosal, R., Dorado, M., Villar, S., and Sanz, J. M. (2006). Technology watch report. Advanced industrial wastewater treatment. CITME. <http://www.madrid.org/bvirtual/BVCM001696.pdf>

Secretaría de Medio Ambiente y Recursos Naturales (2009). Ley Federal de Derechos Disposiciones Aplicables en Materia de Aguas Nacionales. 2009. Federal Government of Mexico. [https://agua.org.mx/wp-content/uploads/2010/05/Ley\\_Federal\\_de\\_Derechos.pdf](https://agua.org.mx/wp-content/uploads/2010/05/Ley_Federal_de_Derechos.pdf)

Senante, M. M., Sancho, F. H., and Garrido, R. S. (2010). Economic feasibility of wastewater reuse: economic valuation of environmental benefits. *Annals of ASEPUMA*, 18, 45.

State Water Commission - Jalisco (2003). Manifestation of Environmental Impact particular modality hydraulic projects for the project: wastewater treatment plants of the Ahogado basin and its associated works. Government of the State of Jalisco. <http://sinat.semarnat.gob.mx/dgiraDocs/documentos/jal/estudios/2004/14JA2004HD012.pdf>

State Water Commission - Jalisco (2008). Wastewater treatment plant "El Ahogado." Public Tender No. 43111001-046-08. <http://info.ceajalisco.gob.mx/licitaciones/wp-content/uploads/Dictamen-de-Fallo-de-la-Licitación-Pública-No.-43111001-046-08.pdf>

State Water Commission - Jalisco (2012). Informe Planta de Tratamiento de Aguas Residuales Agua Prieta. Aguas Residuales Agua Prieta.

Tanoh, R., Nikiema, J., Asiedu, Z., Jayathilake, N., and Cofie, O. (2022). The contribution of tipping fees to the operation, maintenance, and management of fecal sludge treatment plants: The case of Ghana. *Journal of Environmental Management*, 303, 114125.

Van Dijk, M. P., Etajak, S., Mwalwega, B., and Ssempebwa, J. (2014). Financing sanitation and cost recovery in the slums of Dar es Salaam and Kampala. *Habitat International*, 43, 206-213.

World Bank (2006). Public-private Infrastructure Advisory Facility (PPIAF). 2006. In *Approaches to Private Participation in Water Services*. <https://www.gwp.org/globalassets/global/toolbox/references/approaches-to-private-participation-in-water-services-ibrdworld-bank-2006.pdf>.



## Automatic document classification: the role of interclass similarity

### Clasificación automática de documentos: el papel de la similitud entre clases

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#### Abstract

The continuous increase of information in digital format requires new methods and techniques to access, collect and organize these volumes of textual information. One of the most widely used techniques to organize information is the automatic classification of documents. Automatic text classification systems have a low efficiency when the classes are very similar, i.e. there is overlap between them, and in this case it is very important to be able to identify those attributes that allow us to separate one class from another. In this paper we present the relationship between overlap between classes and classification accuracy. A public corpus with four classes is used for the evaluation, and each class is further separated by positives and negatives. The results obtained from four subsets with different number of training instances are presented, for each case the similarity plots, the accuracy value and the confusion matrices obtained are presented. The results obtained are very illustrative and show that the higher the similarity between classes, the lower the classification accuracy.

**Supervised learning, Similarity coefficient, Automatic classification of opinions, Automatic classification of opinions**

#### Resumen

El incremento continuo de información en formato digital obliga a contar con nuevos métodos y técnicas para acceder, recopilar y organizar estos volúmenes de información textual. Una de las técnicas más utilizadas para organizar la información es la clasificación automática de documentos. Los sistemas de clasificación automáticos de textos tienen una baja eficiencia cuando las clases son muy parecidas, es decir existe traslape entre ellas, y en este caso es muy importante el poder identificar aquellos atributos que nos permiten separar una clase de otra. En este trabajo se presenta la relación que existe entre el traslape entre las clases y la precisión de clasificación. Para la evaluación se utiliza un corpus público con cuatro clases y cada clase además separados por positivos y negativos. Se presentan los resultados obtenidos de cuatro subconjuntos con diferente número de instancias de entrenamiento, para cada caso se presentan las gráficas de similitud, el valor de la precisión y las matrices de confusión obtenidas. Los resultados obtenidos son muy ilustrativos y permiten comprobar que, a mayor similitud entre las clases, menor precisión de clasificación.

**Aprendizaje supervisado, Coeficiente de similitud, Clasificación automática de opiniones**

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## Introduction

Supervised machine learning studies are gaining more importance recently due to the availability of an increasing number of electronic documents from different resources. Text classification can be defined as the task of automatically categorising a group of documents into one or more predefined classes. Therefore, the main goal of text classification is to enable users to extract information from textual resources and to deal with processes such as retrieval, classification and machine learning techniques to classify different patterns. In the text classification technique, an indispensable task is the preprocessing stage, where the data must be prepared to perform the classification task. Having computational tools to perform preprocessing tasks such as tokenisation of a text or the generation of graphs to visualise the similarity of documents would facilitate the classification work in the stages after preprocessing.

The problem of measuring similarity between documents and classes is not new in the state of the art, to date it is still an open research problem. When reviewing the most relevant works in the area we find for example the one reported in [1] where a measurement of similarity between words is proposed using the Jaccard coefficient, implemented in the programming language Prolog, and they conclude that the Jaccard similarity coefficient is adequate enough to be used in the measurement of word similarity, but without taking into account the similarity between sentences, which increases the similarity ratio. On the other hand, in [2] they propose five association measures in information retrieval from any encyclopaedia with a large number of documents in electronic format, such as Encyclopaedia Britannica or Wikipedia, the association measures are: Dice, Jaccard, overlap, simple matching and cosine coefficient.

Concerning text classification, in [3] they mention that texts and documents are unstructured datasets and that feature extraction and pre-processing are crucial steps for text classification applications. As part of this pre-processing they mention that data must be cleaned to omit unnecessary characters and features, in addition to tokenisation and stop word removal.

In the study reported in [4] they indicate that the measurement process in text similarity can be divided into text distance and text representation. Text distance can be divided into length distance, distribution distance and semantic distance; text representation is divided into string-based text, corpus-based text, single semantic text, multi-semantic text and graphical structure-based representation. Within string-based text similarity are the Sorensen - Dice and Jaccard coefficients. They conclude that these methods take into account the actual meaning of the text, however, they cannot be adapted to different domains and languages. The goal of supervised machine learning techniques for automatic text classification [5], is to determine whether or not a given document belongs to the given category by looking at the words or terms in that category. Among the most commonly used techniques are Naive-Bayes [6] and K-nearest-neighbours [7, 8].

Classification is considered as a form of supervised learning where, from input data and a training stage, class assignments (labels) are generated based on patterns that are separable, with a quantifiable accuracy. A previous step for the training of a classifier system consists of the transformation and preparation of the data that will form part of the training set, made up of a set of features that will be used as input to the system. Among the classifiers that have reported the highest accuracy are Naive-Bayes and Support Vector Machines (SVM). The Naive-Bayes classifier is the simplest instance of probabilistic classifiers, based on Bayes' theorem. From an input set, the classifier calculates the conditional probability that an element of that set belongs to one category or another, by calculating the ratio of the number of times the event occurs to the number of possible cases. SVMs consist of algorithms that represent predictive models for classifying a set of features through a linear function known as a hyperplane. In their implementation, 3 steps can be observed: a) feature selection; b) training and testing; c) evaluation. According to [9], SVMs achieve balanced performance and high accuracies, being ideal for tackling a variety of classification problems.

For accuracy estimation of a classification system, it is necessary to build the classification model. Firstly, the training set is constructed in order to implement it in the model; and secondly, a test set is used for the evaluation of the proposed classification model. The ratio of the labelled cases in the test set to the result obtained by applying the model will be the classification accuracy percentage. This ratio represents the number of correct predictions made by the classification system.

**Methodology**

In order to obtain the training set for the classifier system and to calculate the similarity between classes, a free corpus, available on the web, is used, which is described below.

*Dataset*

The dataset used consists of a corpus of text files with the comments of users of the Amazon online shop, concerning their experiences in the purchase of books, dvd's, electronics and kitchen items, separated into 2 categories (positive and negative) according to whether the purchase experience was positive or negative for each of the mentioned classes. Table 1 shows that the corpus consists of 9004 text files and how they are distributed in the different classes.

Category	Positives	Negatives	Total
Books	1037	1463	2500
Dvd	1394	1390	2784
Electronics	1015	949	1964
Kitchen	923	833	1756
			9004

**Table I** Distribution of the files in the corpus

As can be seen in table 1, there are not the same number of files for all categories, nor between positive and negative.

This set was used to carry out the evaluation of the system developed in this work. The purpose is firstly to test the similarity between the classes and secondly to test the intuitive idea that the higher the similarity, the lower the classification accuracy between them. Several sets were used to carry out the evaluation. Table 2 shows the balanced ensembles that were formed to carry out the evaluation of the methodology proposed in this paper.

The C100 class consists of 100 files of the positive category and 100 of the negative category; the C200 class consists of 200 files of each type and so on.

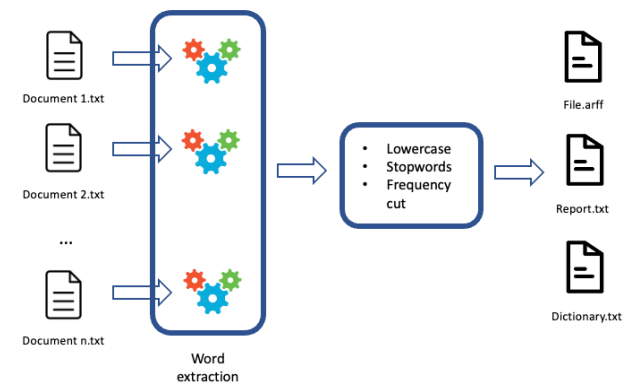
Class	Positives	Negatives	Archives
C100	100	100	1 - 100
C200	200	200	101 - 200
C400	400	400	201 - 400
C800	800	800	401 - 800

**Table 2** Distribution of files in classes

The purpose of this file distribution is to calculate the classification accuracy as the number of instances in each class increases and also to see what happens to classes that have overlap, i.e., are more similar.

*File generation*

A Python script was implemented in order to generate three files, as shown in figure 1: a file with extension .arff, to perform the classification calculations in the supervised learning software Weka; a text file called Report.txt, where the paths of the categories and the most frequent words extracted from the text files are indicated; and a text file called Dictionary, where all the words extracted from the text files are recorded along with their frequencies, as well as the total number of words extracted.



**Figure 1** File generation

For the generation of the ARFF file, each file of each class is taken and the extraction of words is carried out, eliminating empty spaces and special characters, as well as converting all the words to lower case to be stored in a temporary list. Subsequently, when all the words in the files have been captured, the unique values and their frequencies are found.

This data is then stored in a dataframe where the process of stop words elimination and frequency cutting (both options if required by the user) will continue. The resulting dataframe is used for the generation of ARFF, Report and Dictionary files.

In order to increase the functionality of the developed algorithm, the function of loading the file Report.txt has also been implemented, with the purpose of being a source file for the modification or generation of new ARFF files, allowing to reduce the number of words and to perform new word searches in the files that make up the corpus in other paths.

*Similarity measures*

For the calculation of the similarity between documents and the elaboration of the similarity graphs, the Jaccard and Sorensen-Dice coefficients were calculated, which are described below.

*Jaccard coefficient*

The Jaccard coefficient is one of the techniques used to measure lexical similarity. It is a numerical value between 0 and 1, which measures the similarity between two text documents (1=completely the same; 0=completely different) considering the words that both documents have in common. This coefficient considers all elements or attributes to be equally important. It can be seen as a measure of similarity over sets, as shown in the following equation:

$$j(A, B) = \frac{|A \cap B|}{|A \cup B|}$$

*Sorensen-dice coefficient*

The Sorensen-Dice coefficient is a similarity coefficient similar to the Jaccard coefficient which, likewise, its value is between 0 and 1, but unlike Jaccard, this coefficient considers the elements in common of a pair of sets to be of greater importance, as shown in the following equation:

$$s(A, B) = \frac{2|A \cap B|}{|A| + |B|}$$

These metrics are calculated in order to carry out the development of similarity plots, which are described in the following section.

*Similarity plots*

The general process that was implemented in the algorithm developed for the generation of the similarity plots is shown in figure 2. As can be seen, the Jaccard coefficient and the Dice coefficient were considered. It consists of taking each file and performing the tokenisation process, where the words that make up the text are separated, empty spaces and special characters are removed and converted to lowercase. These words are then stored in two lists to calculate the similarity coefficient and stored in a dataframe. When a file has been compared with the rest, a second file of the class is taken, and the process is repeated until all combinations are complete. The resulting data is used to make a scatter plot which will be the similarity plot for the selected class.

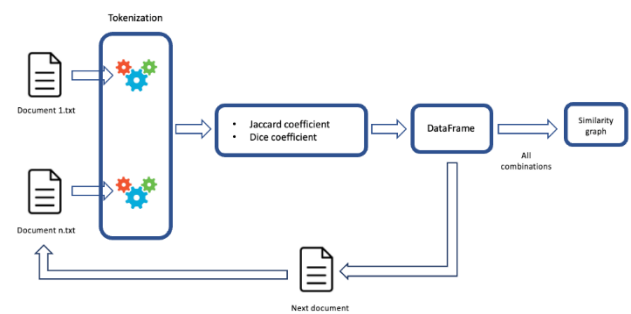


Figure 2 Generation of similarity plots

**Results**

For the evaluation of the developed algorithms, training and test sets taken from the positive feedback of each of the formed subsets (C200, C400, C600 and C800) were used. After tokenisation, the 1000 words with the highest frequencies were taken. The resulting training set was used with an 80-20 ratio (80% for training and 20% for testing).

Table 3 shows the results of performing the classification of these sets, using the previously described learning methods Naive Naves (NB) and Support Vector Machines (SVM). We can see how in both cases the accuracy increases as the number of training instances increases.

Cross-validation		
Class	NB	SVM
C100	78.9	76.4
C200	78.1	73.7
C400	80.3	80.5
C800	81	86

Table 3 Cross validation results

Similarly, table 4 presents the results obtained using the same learning methods, but now using the training and test set classification scenario. Unlike the previous scenario, in this case the training set is never seen by the test set, which makes it a more desirable scenario when there is a sufficiently large number of instances to be able to achieve efficient performance of an automatic classification system.

Training and testing		
Class	Bayes	SVM
C100	79.3	73.1
C200	74.3	77.3
C400	79.6	82.6
C800	81.5	86.3

Table 4 Training and testing

It can be observed, for most cases, that accuracy increases with increasing number of training instances. Now, it is time to ask what happens with the overlap between the classes, for which we will make use of the similarity plots for these same sets.

For the generation of the similarity plots, the Jaccard and Dice coefficients were calculated for the files with the positive comments contained in classes C100, C200, C400 and C800. The values of these coefficients are in the range of 0 to 1, where a value of 0 corresponds to a complete mismatch between the two files, while a value equal to 1 corresponds to the case where a file is compared with itself. According to the similarity plots generated, a higher value can be observed in the Dice coefficient, because this coefficient gives a higher importance to the elements in common, unlike the Jaccard coefficient, where all elements have the same importance. The graphs obtained for the sets under study are presented in figures 5 to 8.

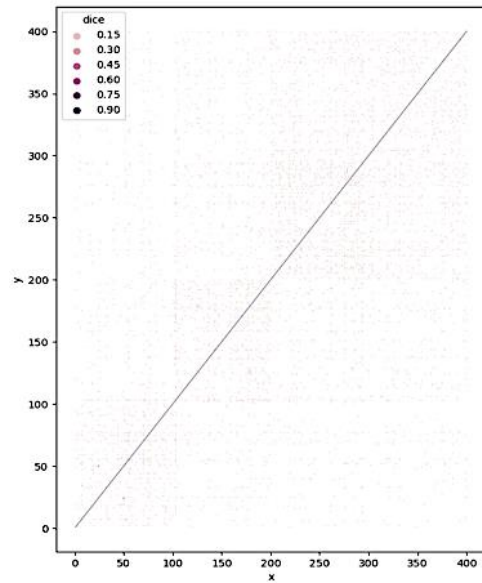


Figure 3 Similarity plots of the C100 class, positive

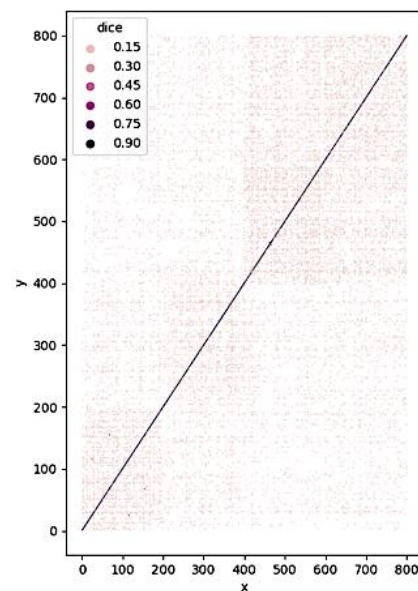


Figure 4 C200 class similarity plot, positive

In these graphs it can be seen that the number of points increases as the number of training instances also increases, this is because the vocabulary (number of words) is higher.



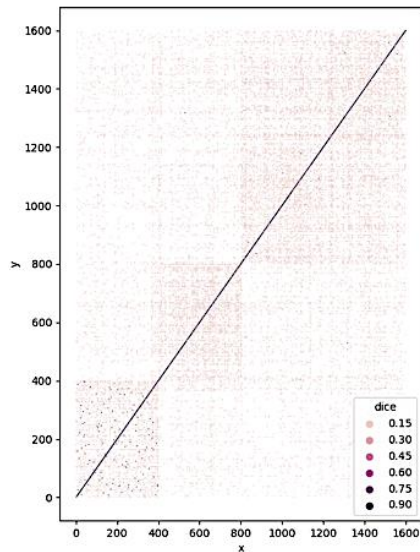


Figure 5 Similarity graph of class C400, positives

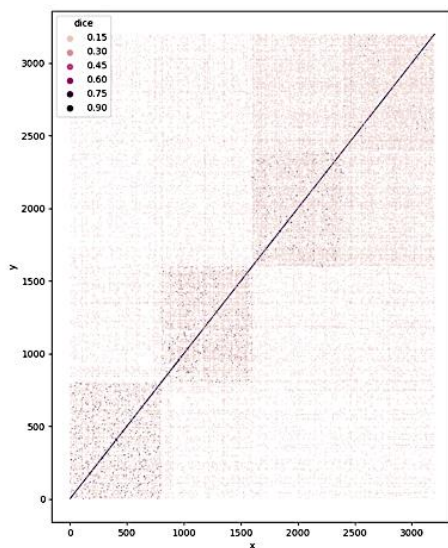


Figure 8 Class C800 similarity plot, positive

In the figures we can see how small tables are formed per class, this is because of the similarity between the language. For example, in figure 8, as described, there are 800 files for each class, that is 3200 files in total. We can observe a first frame from 0 to 799 (BOOKS), another from 800 to 1599 (DVD) and we observe between the last two classes (from files 1600 to 3199, corresponding to ELECTRONICS and KITCHEN) an overlap between these classes in all the similarity graphs, although in a more noticeable way from the set C200 onwards. Figure 9 shows the merging matrices for the set C200. The elements that are correctly classified are located on the main diagonal.

	Cross-validation				Training and testing			
	a	b	c	d	a	b	c	d
a=books	155	26	3	16	33	2	1	1
b=dvd	10	162	8	20	3	42	4	4
c=electronics	2	15	150	33	0	5	22	9
d=kitchen	2	15	32	151	0	2	21	21

Table 5 Confusion matrices for C200

The confusion matrices for the four sets under study and both classification scenarios are presented in Annex 1. We can see that, as expected, the classification system errs more between these two categories. For example, for Bayes, 33 files that were electronics were placed as kitchens and 32 that were kitchens were placed as electronics.

### Conclusion

According to the results presented, it is observed that the classification accuracy increases as the number of training instances increases. Of the classification algorithms used, Support Vector Machines showed higher accuracy value as the number of instances increases. It can also be seen from the results obtained that as there is overlap between the classes this causes confusion in the classification method.

### References

- [1] S. Niwattanakul, J. Singthongchai, E. Naenudorn, S. Wanapu. Using of Jaccard Coefficient for Keywords Similarity. Proceedings of the International MultiConference of Engineers and Computer Scientists 2013 Vol I, IMECS 2013, March 13 - 15, 2013.
- [2] S. Takale, S. Nandgaonkar. Measuring Semantic Similarity between Words Using Web Documents. International Journal of Advanced Computer Science and Applications, Vol. 1, No.4 October, 2010.
- [3] K. Kowsari, K. Meimandi, M. Heidarysafa, S. Mendu, L. Barnes, D. Brown. Text Classification Algorithms: A Survey. Information 2019, 10, 2019
- [4] J. Wang, Y. Dong. Measurement of Text Similarity: A Survey. Information 2020, 10, 2020.
- [5] A. Kadhim. Survey on supervised machine learning techniques for automatic text classification. Artificial Intelligence Review. 2019

- [6] A. Mohammad, T. Alwanda, O. Al-Momani. Arabic Text Categorization Using Support vector machine, Naïve Bayes and Neural Network. GSTF Journal on Computing (JOC) Volume 5, Issue 1; pp. 108-115. 2016.
- [7] S. Chen. K-Nearest Neighbor Algorithm Optimization in Text Categorization. IOP Conference Series: Earth and Environmental Science 108. 2018.
- [8] M. Azam, T. Ahmed, F. Sabah, M. Hussain. Feature Extraction based Text Classification using K-Nearest Neighbor Algorithm. IJCSNS International Journal of Computer Science and Network Security, VOL.18 No.12. 2018.
- [9] D. A. Pisner, D. M. Schnyer. Support vector machine. Machine Learning. 2020.

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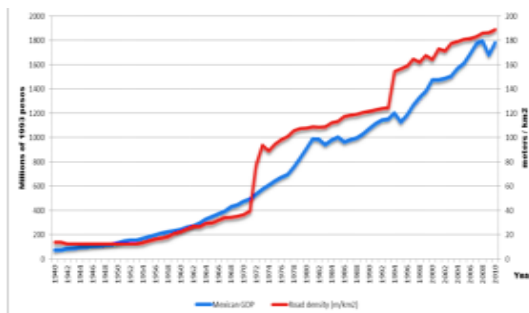
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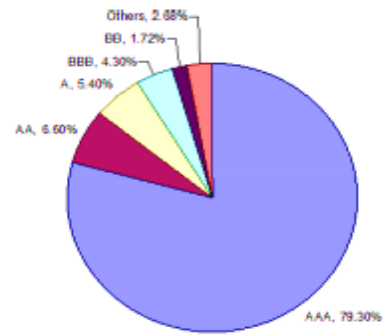
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C	Borrower may be in bankruptcy but is still paying its obligations
D	Borrower has defaulted on obligations and CRA believes that it will generally default on most or all obligations
<b>MOODY'S scale varies slightly</b>	
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