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Implementation of the ML-UPAEP methodology to predict the susceptibility of job automation in Mexico

Implementación de la metodología ML-UPAEP para predecir la susceptibilidad de automatización de los empleos en México

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Abstract

Objectives - The objective of this research concerns the development of a methodology to collect, process, and analyze data regarding the existing scenarios at the national level of the automation of labor occupations in Mexico due to the inclusion of some technological solution.

Methodology - Through the review and analysis of the literature available through the various databases, current knowledge of the situation in the short, medium, and long term is generated in the risk that people present of being replaced by carrying out some routine work activity and not cognitive.

Contribution - Generate knowledge and a challenge for other researchers focused on knowing the susceptibility of the automation of work occupations in various contexts of a political, economic, cultural, educational, age, and salary nature of people who perform some work activity.

Inclusion, Susceptibility, Methodology automation, Job computerizability, Occupations, Technological unemployment

Resumen

Objetivos – El objetivo de esta investigación concierne al desarrollo de una metodología, que permita recopilar, procesar y analizar datos referentes a los escenarios existentes a nivel nacional de la automatización de las ocupaciones laborales en México debido a la inclusión de alguna solución tecnológica.

Metodología – Mediante la revisión y análisis de la literatura disponible a través de las diversas bases de datos, se genera un conocimiento actual de la situación a corto, mediano y largo plazo en el riesgo que las personas presentan de ser reemplazadas por realizar alguna actividad laboral rutinaria y no cognitiva.

Contribución – Generar conocimiento y un desafío para los demás investigadores, enfocados en conocer la susceptibilidad de la automatización de las ocupaciones laborales en diversos contextos de índole político, económico, cultural, educativo, edad y salarial de las personas que desempeñan alguna actividad laboral.

Inclusión, Susceptibilidad, Automatización de metodologías, Informatización del trabajo, Ocupaciones, Desempleo tecnológico

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Introduction

The generational technological changes accompanied by strategies according to the needs of a society, a country, an organization, or simply a government and the dependence of these and people towards Information and Communication Technologies, show that several optimized activities of any the labor sector, using infrastructure and software applied in specific processes, but the continuity of professions or people at risk due to the computerization of jobs.

The term computerization was described in the research work carried out by Frey & Osborne (2013), its motivation was to be able to estimate the probability of computerization in 702 professions in the United States labor market through the implementation of Machine Learning techniques and a proposed methodology by them, allowing them to determine the work activities at risk of disappearing or the replacement of the people who perform them due to the automation of cognitive and manual tasks; as well as the routine or non-routine ones, predicting that 47% of the jobs presented a high risk of being computerized within the next ten years.

The World Economic Forum (WEF, 2020) revealed the trends of the organizations in its recent report, the majority (43%) plan to carry out the reduction of their staff by 6.4% of their total workforce due to technological implementations that will be carried out to distribute workloads between people and machines, reflecting a total of 85 million workers who will be replaced by smart technology in 2025. However, there is the possibility for people to be integrated into new functions, that is, they will be able to occupy positions or responsibilities with a higher level of difficulty in areas for solving problems that currently a machine or a robot can hardly perform. The activities that will be developed mainly by some type of technology within companies in 2025 are: information and data processing, technical and complex activities; as well as those work that involves a physical and manual effort, leaving greater participation in coordinating, developing, managing, advising, reasoning, making decisions, communicating, and interacting with people.

The inclusion of technologies in various edges of the labor markets worldwide is more common today, companies have chosen for several years to use technological solutions for the best use and optimization of their processes, an example of this has to do with the use of cloud computing, machine learning algorithms, the use of robots accompanied by implementations with Artificial Intelligence. In this research we show the studies that have been carried out in the world, to measure the susceptibility to the computerization of jobs or activities through the following questions:

- Q1: How susceptible are labor occupations to technological automation in Mexico?
- Q2: Do cognitive occupations present a greater risk of being technologically automated than routine occupations?
- Q3: Is there any relationship between economic level, educational level, and age for a labor occupation to present a greater risk of being technologically automated?

The research is organized as follows: first, the experiences in various countries are described, specifying the impacts of computerization on the labor market. Subsequently, a vision of labor automation in Mexico is presented. Finally, challenges in the workplace due to technological inclusions within organizations are specified.

The objective of this research is to analyze the main scientific contributions published on the computerization of jobs or activities in Mexico.

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The labor situation in Mexico

The 2030 Agenda for Sustainable Development of the United Nations integrates 17 Sustainable Development Goals to transform the financial, economic, and political systems of societies. The recent report on the Sustainable Development Goals reflects that before the global Pandemic -COVID-19- there was a lag in the commitments established for the year 2030, even a worrying figure was published concerning the projection of approximately 71 million people who during 2020 would be in extreme poverty. Goal 8: "Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all", reflected an adverse effect in the workplace for those who work informally, on their account, day laborers and vulnerable sectors in the face of atypical circumstances such as the Pandemic that affected Mexico at the beginning of 2020.

According to the Organization for Economic Cooperation and Development (OCDE), in its objective to coordinate the economic and social policies of its member countries; in which Mexico was included since May 18, 1994, in its 2019 economic study Mexico had one of the lowest levels of PIB (Gross Domestic Product, for its description in english) within the OCDE, due to a low growth rate resulting from the poor labor productivity.

The Bank of Mexico in its quarterly report (January - March 2021), refers to a slight improvement in the Mexican labor market despite the negative scenario between the end of 2020 and the beginning of 2021, that is, the Economically Active Population grew approximately two million people. Tertiary activities showed a decline in January 2021; Furthermore, regardless of the reactivation in the third month of the year, they continued to be below that registered in February with 1.9%.

In addition, the labor market in Mexico suffered significant deterioration, as shown in the Banco de Mexico report (BANXICO, 2021) published with figures for the first quarter of 2021. The document shows the month of November of the previous year as the starting point However, there was an improvement regardless of the national context experienced due to COVID-19.

The month of April 2021 registered a significant increase in the Economically Active Population with two million people, showing a recovery in comparison with the same month of the previous year, proof of this was the reduction in the percentage of the Non-Economically Active Population with 61.5% (12.3 million people).

According to the OCDE economic study (2019), Mexico will present an economic growth of approximately 5% by 2021 and a lower expectation for the year 2022 of 3.2%, this mainly due to the aftermath of the Pandemic that for one year affects us globally and that in a particular way in our context implies that poverty, inequality and the gender gap have a greater negative impact due to COVID-19; In addition, vaccination processes in the population to mitigate contagions will allow generating certainty in the economic sectors; as well as for those who are dedicated to formal activities and mainly for informal work.

According to the National Survey of Occupation and Employment (ENOE, 2021), for the second quarter of 2021 the National Institute of Statistics and Geography (INEGI) reported an increase of 10.7 million in the Economically Active Population, however, in a negative consequence of the Pandemic in April of the same year, the Non-Economically Active Population grew due to the 12 million people who sadly lost their jobs.

The information presented during August 2021 in the ENOE (2021), reflects the estimates concerning the occupation and unemployment of the Economically Active Population (see Figure 1) considering now from 15 years of age, appreciating the size and composition of the Population Economically Active and Non-Economically Active Population.

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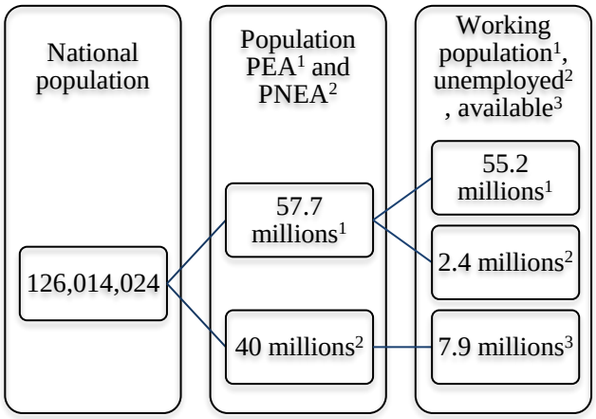

Figure 1 Workforce at the national level
Source: National Survey of Occupation and Employment (ENOEn), 2021. p.9

We appreciate that 45.8% of the population is currently an Economically Active Population and 31.7% does not have any occupation within the age range of 15 years and over; Therefore, a fundamental part of the research work has to do with estimating how many professionals per sector are at risk of losing their jobs due to the computerization of the processes and activities they carry out, quantifying the impact on the inclusion of technologies in Mexico.

The WEF (2020), reported that Mexico had a 26.9% vulnerability for jobs, in addition, the unemployment rate had a change between the years from 2019 to 2020, reflecting 2.7% and 3.3% (Q2) respectively. The adoption of technology according to the surveyed companies, indicated that the main solutions to be included in their organizations were the processing of text, images, and speech; as well as the internet of things, cloud computing, and the analysis of large volumes of data through Big Data with a percentage of 91%, in addition, electronic and digital commerce (86%), AI solutions (82%), computer and cryptographic security processes (78%), virtual reality (64%) and robots (60%) were part of their strategies and technological solutions.

Literature review

We can more frequently see the existence of robots performing routine activities; however, the great challenge will be that the digital and computational part accompanied by Artificial Intelligence can interact cognitively with people, that is, even that robots can feel emotions like a human being.

Hernández & Destinobles (2019) defined technology as that which does not generate a healthy way of living for people, on the other hand, Elliott (2018) in his work highlighted the importance of improving Artificial Intelligence techniques in computers, it's The study determined that there are differences between people and computers when it is necessary to carry out highly complex activities, to be more specific, those jobs that require a rational understanding in which only people can perform and, even more so when they have an of educational preparation superior to the elementary.

The literature allows us to visualize the panorama concerning the computerization of the activities that people previously carried out, it does not mean that they will necessarily lose their jobs "automation does not necessarily lead to job losses, even in the affected industry. When major industries are automated, their employment often increases rather than decreases" (Bessen, 2019, p.591; Jahn, 2017).

In this sense, Sako (2020) refers to the tasks that people perform within an organization, differentiating them from jobs, stating that routine activities involve automation to a greater degree compared to jobs that require a resolution capacity than robots do not have, therefore, jobs are not computerized (p.26). For this reason, Man & Man (2019) alluded that workers should invest in themselves, looking for training options to raise their problem-solving skills, acquiring new knowledge, cognitive and creative skills, using technological tools that allow them to obtain greater competitiveness within the organization and mitigate a replacement scenario due to the computerization of its activities, this coming from the AI that has more frequently taken on the routine tasks previously performed by people (Krakovsky, 2018; Nicholas & Sacco, 2018; Cummins, Yamashita, Millar & Sahoo, 2019; Shackleton, 2020; Aboal, López, Maurizio & Queraltó, 2021).

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It is important to highlight what was pointed out by Clarke (2019), its publication emphasizes the creation of the first international standard focused on Artificial Intelligence that has been accepted by all OECD member countries, showing a clear example of the benefits that in the future we will see for the inclusion of advanced technologies in societies, and that is undoubtedly associated with political and regulatory issues, unavoidable for their application in the labor sectors, denoting a maturity of the technologies and announcing to people that they are effective, reliable and that they reduce costs of operation.

The labor market and computerization

The work carried out by Frey & Osborne (2013) considered 702 occupations that were evaluated to indicate the degree of risk to be computerized, through their proposed methodology, the implementation of a Gaussian method algorithm, and a classification of occupations using information from O * NET (The Occupational Information Network, for its acronym in English) belonging to the Department of Labor of the United States of America (the USA, for its acronym in English), considered the possibility of visualizing an increase in the risk of jobs to be computerized including variables such as salaries and people's educational level.

Their conclusions showed that 47% of jobs in the USA are categorized as high risk to be computerized in the short, medium, or long term, in addition, they ratified that people with basic educational levels and a low economic perception significantly influence be revealed by some technological implementation or otherwise hinted at, are technologically displaced (Cebreros, Heffner-Rodríguez, Livas & Puggioni, 2020; Brandes, & Wattenhofer, 2016; Rodríguez, 2019) as has been happening over several decades and, for a few years increasing due to the technological ecosystems that have supplied the ideal conditions to potentiate the use of Artificial Intelligence solutions in various work environments.

Even Donald Trump -contender to the US presidency- in an international context statement, asserted that the decrease in jobs (approximately 7 million workers) in the North American industry had to do with various actions that Mexico and China were taking, However, it was the result of the technological innovations that the various factories had been carrying out to optimize production times (Wiseman, 2017), providing better service to the end customer.

In Mexico, Ghys, Cools, Acedo, & Wright (2021) outlined the future that our country would have with the inclusion of disruptive technologies, based on new technologies and advances in research that large organizations carry out, allows us to tell with an ideal ecosystem to promote and enhance the latest generation technological solutions. In this sense, the authors alluded through the survey carried out by the Boston Consulting Group that Mexico considered investing in technology for the automation of industrial processes through several companies, which would imply a representative decrease in the number of hired personnel and an increase in productivity.

Through Banco de México (BANXICO), the feasibility of an activity being technically computerized was considered, according to Cebreros, Heffner-Rodríguez, Livas, & Puggioni (2020), the formal labor market presents an important risk (57%) of suffering some type of technological automation, only, it is important to note that the previous percentage does not consider the informal work environment and if it is included it would lead us to a risk scenario of 65% of all jobs nationwide, to be technologically feasible to optimize according to the estimates made by Cebreros *et al.* (2020), who assert that age and educational level with certain characteristics influence to increase the probability of computerization of occupations, evidencing a concern of government organizations and private entities regarding the inclusion of technological solutions in the economy of Mexico and what this will represent for people who carry out activities in the formal and informal sectors of our work context.

Previously, Ramos & Carrasco (2019) had carried out a prospective investigation to visualize the future of jobs in the state of Nuevo León in Mexico, related to technological inclusions in Industry 4.0. Their methodological procedure was based on the application of the Delphi method, in addition, it allowed them to propose the elaboration of a policy that would add to the initiative of the Specialization Program in Industry 4.0 (PEI4.0), to reduce the negative effects on the workers as a result of computerization in the processes they carried out, offering them professional alternatives to improve their horizons in the educational aspect and experience within organizations, favoring their permanence by assigning new responsibilities that involve more complicated tasks.

The results are interesting, on the one hand, they indicate that the susceptibility for people to lose their jobs is higher than 50% due to the penetration of robots in their work areas; however, they also point out that there is a probability above 75% for the creation of new jobs, in which workers could develop skills that help them to adapt in less time to their new responsibilities by the year 2030.

In addition, we cannot ignore the concern generated by the fear of technological inclusion within industries, which specifically links a panorama of job dissatisfaction in people - who lack cognitive skills - due to the probability of being dispossessed. of their work tasks by robotization (Schwabe & Castellacci, 2020), for example, Doménech, García, Montañez & Neut (2018) asserted that 36% of the jobs in the industrial sector in Spain will be candidates for automation, likewise, Choi Mendizábal & Calero (2018), through an analysis that allowed them to have an overview of the progress in the Spanish labor market corresponding to a period from 2006 to 2016, using the National Institute of Statistics as the main provider of statistical data, through of a survey carried out belonging to the Innovation of Companies, indicated that the relationship in the decrease of jobs with greater demand in tasks that involved aspects of technological innovation, it was contrasted with those activities in which the people who carried them out had a superior profile in labor and academic skills.

It is important to bear in mind what was suggested by Reséndiz-Prado, Torres-Mansur & Placeres-Salinas (2020), given the new technological requirements, the presence of people with cognitive and problem-solving skills; as well as various IT capabilities, will facilitate their permanence in new tasks regardless of acceleration to renew and improve processes within the organization. Rodríguez, Castro & Tijerina (2020), carrying out an analogous study in the state of Oaxaca; considered the cognitive and non-routine work activities of women, assessing the effects caused on them by the use of technological tools, exposing an increase in the participation of women in jobs that involve non-routine cognitive actions, underlining that participation is the result of the insertion of the technology used in the work; as well as the educational level and salary they have.

Minian & Monroy (2018), predecessors of the works to estimate the risk in activities and jobs to be computerized in Mexico, used the first study published by Frey & Osborne (2013), assessing 63% as feasible for the jobs to be automated because of the implementation of some technology in the manufacturing sector, projecting that 64.5% of the activities would exhibit a high risk of susceptibility to being computerized. The risks associated with some technological implementations are in a holistic context, that is, even in the educational environment they can occur, for example, Dandalt (2021) outlined a scenario in which education would be using robots something not studied by other researchers, consequently, due to current technological advances in a long term get to be reality.

Undoubtedly, work activities have gradually experienced some type of automation, even in professional services (Sampson, 2021), which were usually carried out by people specialized in certain areas of knowledge. An antecedent, a different effect is observed in customer service where through technological resources the tasks that people performed now are through automated telephone means or IVR (Interactive Voice Response, for its acronym in English), the use of bots conversational by integrating AI and specifying common questions that customers ask, organized in tools to establish conversation flows, make people feel served in a timely and efficient manner.

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Sampson (2021), used the data of 996 jobs contained in O*Net, identifying those that correspond to professional services, to later group them by areas, years of experience, and the academic level necessary to carry out the activities. Their conclusions were achieved by the implementation of structural equation modeling or SEM (Structural Equation Modeling, for its name in English), stating that most people dedicated to simple tasks with a high academic level, began the search for more complex tasks. complex and creative -difficult to be computerized (Coupe, 2019)- according to their abilities.

Cheng, Pien, Kubo & Cheng (2020) considered the classification methodology established by Frey & Osborne (2013), which allowed them to generate 38 groups according to the occupations identified in the Standard Occupational Classification of the Taiwan Ministry of Labor. The results showed that the labor sectors most susceptible to being computerized involve low-level tasks, that is, vehicle operators and people hired in the construction field, who showed a decrease in the quality of their health compared to the activities that require a higher educational level and without risk to be automated.

Ghimire, Skinner & Carnathan (2020) distinguished the professional profiles of people and their educational levels in Atlanta, showing that an elementary school education added to the income they can receive for their work activity and, even more, if the remuneration The economic situation is low, it enhances the probability that they will be relieved of their tasks due to technological automation. Furthermore, Ghimire *et al.* (2020) pointed out the correlation between the above variables and the geographic area of origin of the people, for example, the Latino population presented a high risk of losing their jobs due to technological insertion, additionally, the probability was greater if they had an academic preparation within the same geographical area in which some people carry out the same activities, only with a higher professional profile.

Sarfati (2020) stated that “social, economic differences; as well as the age, sex and remuneration of the working population increase the risks associated with a change in technology or the existence of the digital divide” (p.169). It highlights a concern about these circumstances and how they affect workers emotionally, expressing on the one hand the need for an improvement in the bidirectional relationship between workers and employers, in addition to the development of new skills that allow them to perform more complex activities, it is that is, those where technological implementations are below human capacity (Doménech, García Montañez & Neut ,2018).

Rani & Grimshaw (2019) agree with Sarfati (2020), referring to the fact that social inequalities and technological changes increase the negative effects derived from the automation of work activities, for which workers, on the one hand, lack professional experience. -mainly they are young- and with a mid-level academic training, affirming that in the face of technological advances it is important to have regulatory frameworks and adequate support in the transition towards them, to guarantee that there is progress in the organization, optimizing productivity due to the new job opportunities for people.

Franks (2016) defined new technologies and specifically those related to AI as catalysts, due to the use of tools that will optimize the tasks of people making their hiring unnecessary, for example, "when a robot can read a set of accounts, analyze a million emails or phone records, write annual reports, why hire a lawyer, investigator or accountant?” (p.19). The foregoing conclusively expressed the future vision that the professions or work activities would experience at the same time as the people involved in an organizational automation process.

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Organizations, companies, and various industries will notice great challenges due to the automation of activities and/or jobs, as Kim & Scheller-Wolf (2019) expressed in their work establishing a concept called an axiological challenge. Part of his approach puts on the table the question that organizational leaders, businessmen, investors, and other actors at the top of the labor pyramid should ask themselves before implementing a technological solution, trying to mitigate the negative effects on people as a result of a bad decision in the business model imputing ethical issues that are harmful to society and their future work, which is why, for some workers, their situation is the same before computerization of their activities (Chomanski, 2019); however, there will be a need in a worse context to receive the savings generated for your unemployment.

The generation of new jobs is a real and current need, according to Abeliansky, Algur, Bloom & Prettner (2020) approximately 50.1 million employees will be at risk of losing their jobs due to the use of robots within the industry in a decade and, 340 million worldwide because of any type of computerization in the same period.

Method ML-UPAEP

Estimating the probability of automation of labor occupations in Mexico by the inclusion of technological solutions entails locating the ideal sources of information in the labor, economic, educational, and technological fields, as well as asserting the feasibility of systematization by using tools and techniques of Data Science and Mining to collect, model and analyze the data at the national level in a holistic manner through the ML-UPAEP methodology.

The universe of the population used to forecast the susceptibility to automation of labor occupations in Mexico is delimited according to the Economically Active Population, in this sense, the proposed methodology (see Figure 2) considers a geographical, economic, and educational context, as well as the characteristics of the workers, making use of techniques and tools in science and data mining to classify and forecast in an objective and reliable way the level of automation of labor occupations in Mexico.

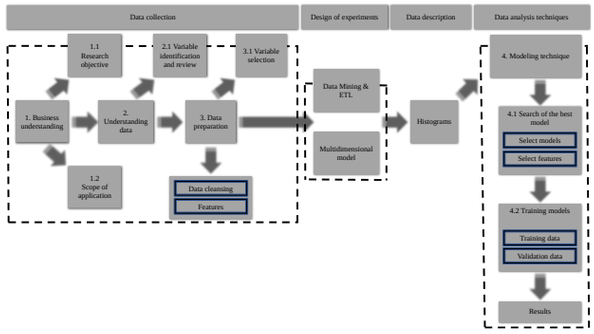

Figure 2 Data mining and modeling processes implicit in the ML-UPAEP methodology
Source: Own elaboration and adaptation according to the reviewed literature, 2022

ML-UPAEP has nationwide application, through the collection and preparation of data, the selection, training, evaluation, and adjustment of parameters through a Machine Learning model to make predictions that show the scenario of labor automation in Mexico.

The **data collection** integrates an *understanding of the business* that identifies the objective of the research and its scope of application, i.e., what moment of automation in labor occupations does Mexico have when using open access data that governmental agencies have.

In addition, it is essential to *understand the data* because it involves the identification and review of important variables related to the objective of the research.

Subsequently, there must be a *preparation of the data* that makes it easier to choose the variables that provide important elements to satisfy the research, thus strengthening the Machine Learning algorithms.

The **design of experiments** considers ETL (Extraction, Transformation, and Loading) techniques. Subsequently, a **description of the data** is made, i.e., the sources identified, the number of records in each database, the implicit variables, the type of file, and the source of origin, to mention some requirements that allow visualizing the content of the variables selected for the development of the research, preferably in histogram-type graphs.

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According to the methodology scheme presented, it is important, after the stages described so far, to include a **modeling technique** that facilitates the identification of the Machine Learning models required to meet the needs established in the research and subsequently evaluate the results obtained.

Methodology

A literature review involves a series of procedures embodied in their proposed methodology, that is, applying filters and generating lists of documents, downloading the articles, generating a database with relevant data of each document, graphically present the information of the articles, group substantive elements and the development of maps with the structures of each document.

The method used is highly relevant for empirical studies and the construction of the theory, databases such as IEEE, SPRINGER, EBSCO, SCIENCE DIRECT, SCOPUS, DIALNET and JSTORE were used.

A total of 113 articles were analyzed, of which 46 fulfilled the historical part of the field of study referring to the automation of work occupations due to the inclusion of some emerging technology within organizations and/or countries. In addition, different boolean combinations AND, OR, and truncation * were applied for the filtering of relevant information? helping to collect specific information.

The search was carried out in a period from 2018 to 2021 mainly, however, knowledge trigger articles were used from years ago considering the following combinations of keywords: technological automation, technological unemployment, computerization of work occupations, and automation of work occupations.

Results

The evidence in the works has shown that the use of the methodology of Frey & Osborne (2013), simultaneously with the classification of O*NET occupations, facilitates the homologation of the data that is held locally in each government and allows to have a comparable global picture (47% of jobs in the United States by Frey & Osborne, 2013; 9% of jobs in the United States by Arntz, Gregory & Zierahn, 2016; 65% of jobs in Mexico by Cebreros *et al.*, 2020; 50% of jobs in Mexico by Ramos & Carrasco, 2019; 36% of jobs in Spain by Doménech *et al.*, 2018; 64.5% of jobs in Mexico by Minian & Monroy, 2018; 25% of jobs in Singapore by Fuei, 2017; 35.7% of jobs in Finland by Pajarinen & Rouvinen, 2014; 57% of jobs in the United States by Sungki & Shell, 2018; 69% of jobs in Ecuador by Méndez-Mantuano *et al*., 2019; 44.8% of jobs in Russia by Zemtsov, 2020) of the susceptibility in the activities data to be computerized.

Particularly in the labor context in Mexico, according to the data collected, processed and analyzed through the ML-UPAEP methodology, professionals and technicians have a greater presence of labor occupations in Mexico with 28.3%, civil servants, directors and managers (16.3%), industrial machinery operators, assemblers, chauffeurs and transport drivers (11. 8%), craft workers and workers in elementary and support activities both with 11%, workers in personal services and security (7.9%), workers in agricultural, livestock, forestry, hunting and fishing activities (5.5%), auxiliary workers in administrative activities (5.1%) and traders, sales clerks and sales agents (3%).

The Economically Active Population represented by the state shown the center of the country and the west concentrate most of the labor force (Mexico with 13.70%, Mexico City with 8.02%, and Jalisco with 6.95%).

Conclusions

Current times inevitably lead to interacting with some technological implementation, even for several decades there have been disruptive technological changes that have benefited countries, societies, and people themselves by applying new knowledge.

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The activities that will be developed mainly by some type of technology within companies in the year 2025 are: information and data processing, technical and complex activities; as well as the labor ones that involve a physical and manual effort, leaving greater participation in coordinating, developing, managing, advising, reasoning, making decisions, communicating, and interacting with people.

The Industrial sector will carry out implementations of technology in cloud computing, internet of things and connected devices, electronic and digital commerce, big data analytics, robots (industrial automation, drones, etc.), artificial intelligence (machine learning and neural networks), 3D and 4D printing and modeling, as well as processes in cryptography and cybersecurity.

Industry 5.0 (I5.0) has people as the main executor of the processes, in addition to the use of cutting-edge technologies (Artificial Intelligence, Machine Learning, Business Intelligence, Deep Learning, Data Science or Big Data) that facilitate the collaboration of robots in tasks, something contrary to what happens with I4.0 where people are displaced from routine activities. Consequently, with I5.0, people are the backbone in the processes, working collaboratively with robots, to achieve better use of resources within companies, generating a common good.

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