Government AI Readiness Meta-Analysis for Latin America and the Caribbean

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***Abstract*—Artificial intelligence (AI)-based technology has the potential of transforming how governments function, making them better able to serve their constituents. As governments of developing countries continue to shift to more advanced digital platforms, they have adopted practices and policies that have a direct impact in the future of AI-based technology. In this paper we discussed the key factors that play an important role in the AI readiness of Latin America and the Caribbean (LAC) countries that will need to embrace the AI revolution very soon.**

***Index Terms*—artificial intelligence, government, latin america, caribbean, automation, technology and society.**

I. Introduction

EACH country is only as prepared to take advantage of AI technology as its government and citizens will allow. The US and China, have been leading the competition for the Global AI market, referred to recently as the "new space race..., where world superpowers battle to define generations of technology to come" [1]. In 2017, China announced a three step plan to become a $150 billion AI global leader by the year 2030 through investments in research, military, and smart cities. Despite $10 billion in venture capital currently being funneled towards AI in Silicon Valley, the US has been losing ground, after cutbacks on funding for scientific research and tightening immigration restrictions by the US administration, researchers and startups have been opting for grants issued by China to fund the future of AI development [2]. If this is happening in the U.S., then we are inevitably confronted with the question: where does that leave Latin American countries in such Global AI race?

A recent analysis of Government AI readiness, led by Oxford Insights and the International Development Research Centre (IDRC) [3], listed no Latin American countries in their top 20 rankings citing three key challenges in harnessing the use of AI for the common good: policies, capacity, and adequate resources. They scored each country and territories governments according to their preparedness to use AI in the delivery of public services. They have stated these findings as "...a timely reminder of the ongoing inequality around access to AI" [3].

As can be seen in Fig. 1 and Table I, despite not making the top 20, the governments of Mexico, Uruguay, Chile, Brazil, and Colombia ranked within the top 50 countries out of 194 globally. Mexico and Uruguay being the only two South American countries developing AI policies and strategies. Mexico's strategy released in March 2018 [4], "Towards an Artificial Intelligence (AI) Strategy in Mexico: Taking Advantage of

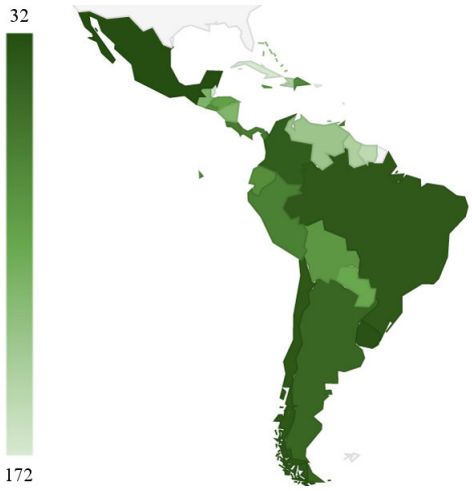

Fig. 1. Latin American regional comparison geochart produced by LatinX in AI™. Data source in [3]. See Table I for exact numbers.

TABLE I
Latin American regional comparison by country (first and third column) and AI readiness ranking (second and fourth column) from data in [3].

Country	Rank	Country	Rank
Mexico	32	Uruguay	35
Chile	39	Brazil	40
Colombia	44	Argentina	51
Costa Rica	66	Panama	69
Peru	71	Trinidad & Tobago	73
Dominican Republic	77	Ecuador	82
El Salvador	85	Jamaica	87
Bolivia	89	Honduras	96
Paraguay	102	Guatemala	115
Nicaragua	117	Bahamas	133
Venezuela	134	Barbados	135
Saint Kitts and Nevis	142	Dominica	143
Antigua and Barbuda	144	Guyana	145
Saint Vincent-the Grenadines	149	Haiti	150
Saint Lucia	153	Suriname	155
Grenada	164	Belize	171
Cuba	172		

the IA Revolution" was carried out by Oxford Insights, C-Minds, and commissioned by the British Embassy in Mexico. Uruguay opened a public consultation of Artificial Intelligence for the Digital Government on April 22nd, 2019 [5], and has since updated its Digital 2020 Agenda [6]. However, the rest of Latin American countries still need to make progress to accommodate for the AI revolution.

In this work we present an overview of the key elements contributing to the current status of Latin American AI readiness by comparing the index developed by the IDRC with economic metrics valuable in assessing the impact of automation and AI implementation in Latin American countries. First, section X does this...

II. Overview of The Current Ranking System

The ranking system created by Oxford and the IDRC [3], sums an average normalization of indexed metrics on a scale of 0 to 10, from sources including the United Nations (UN), World Economic Forum (WEF), Global Open Data Index, World Bank, Gartner, Nesta, and Crunchbase, clustered under four high-level topics including:

- *Governance:* indicators include whether they had privacy laws in place and a forthcoming AI strategy.
- *Infrastructure and data:* indicators include the availability of open sourced data, data capability within the government, and their government's procurement of advanced technology products.
- *Skills and education:* indicators include digital skills among the population, innovation capability by the private sector, and the number of registered AI startups.
- *Government and public services:* indicators include government effectiveness, availability of digital public services, and the importance of information and communications technologies (ICTs) to government vision of the future.

To view their full index, their data, and ranking assessment please consult [7].

It is interesting to report that, according to this AI readiness index, Latin American countries shown in Table II are in a unique position given that a little less than half of the countries are above the global average index, as indicated with a line. The average ranking for Latin American countries according to the analysis is 3.682, not far behind the global average of 4.032.

The authors concluded their analysis stating that "the way forward is still uncertain" [3]. They suggest the development of 'AI Centers' by connecting their academic resources to public and private capital to improve networking and innovation, and also urge that, until clear and ethical policies for AI have been developed, Latin American governments should heed the warnings of the Latin American Initiative for Open Data [8], which recently led to the publication of a research report titled "Automating with Caution" [9].

This requires closer examination of other economic factors that may affect AI readiness of LAC countries, which we discuss next.

TABLE II
Latin American regional comparison by country and AI readiness index (0-10 scale). From data available in [3].

Country	Index	Country	Index
Mexico	6.664	Uruguay	6.522
Chile	6.190	Brazil	6.157
Colombia	5.945	Argentina	5.684
Costa Rica	5.202	Panama	5.136
Peru	5.076	Trinidad & Tobago	5.038
Dominican Republic	4.804	Ecuador	4.646
El Salvador	4.566	Jamaica	4.476
Bolivia	4.399	Honduras	4.135
Paraguay	3.873	Guatemala	3.385
Nicaragua	3.280	Bahamas	2.527
Venezuela	2.476	Barbados	2.430
Saint Kitts and Nevis	2.230	Dominica	2.191
Antigua and Barbuda	2.099	Guyana	2.094
Saint Vincent-the Grenadines	2.052	Haiti	2.034
Saint Lucia	1.901	Suriname	1.769
Grenada	1.086	Belize	0.745
Cuba	0.709	**LAC Average**	**3.682**

III. Examining LAC AI Readiness Ranking against each Countries Economic Metrics

At first glance, these rankings appear intuitive, but it was surprising to find they did not account for each countries population size, unemployment rate, income equality, household income, education index, or gross domestic product (GDP). These metrics are far more telling of a government and its citizen's ability to invest in or make use of new technology and its potential effects on the population. We will now compare these indices to better assess the real risks and potential for integrating artificial intelligence in Latin America and the Caribbean.

A. Unemployment Rate

The unemployment rate, published by the International Monetary Fund (IMF), is the number of unemployed persons as a percentage of the total labor force sourced from the World Economic Outlook in 2019 [10]. Fig. 2 shows the AI readiness index in comparison with the unemployment rate. From the figure, it may appear that the AI readiness index and unemployment rate are correlated, considering all countries

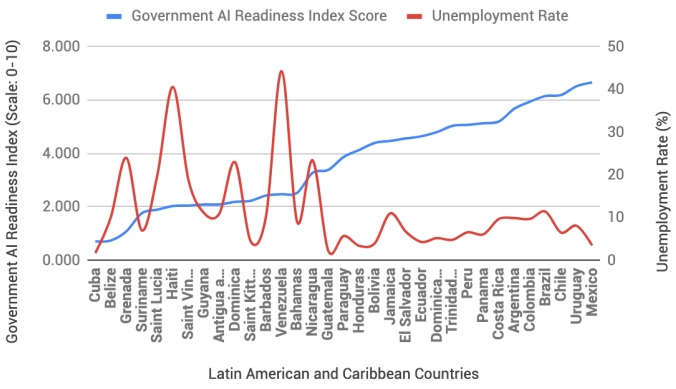

Fig. 2. Government AI readiness vs unemployment rate. Comparison produced by LatinX in AI™. Data sources are [3] and [10].

who rank above a 4.0 on the index also have a unemployment rate below 10%, but some countries who rank below average on the index also have low unemployment.

Unemployment in developing countries is often telling of a countries economy but can also be an indicator of factors outside of a government's control. Areas with conflict may see an increase in migration as refugees flee, causing unemployment rates to spike temporarily including in neighboring cities or countries.

This can be seen most clearly in Venezuela, where the unemployment rate has jumped from 6% in 2015 to 44% in 2019. "Venezuela's fall is the single largest economic collapse outside of war in at least 45 years" according to economists and others who acknowledge it is the largest refugee crisis of all time in Latin America [11]. In countries like Venezuela, which used to have a thriving economy largely based on petroleum export and manufacturing, the opportunities for incorporating Artificial Intelligence were endless. Unfortunately now, due to government mismanagement, extensive surveillance and bio-metric data collection [12], coupled with hyperinflation, some say the countries economy may never recover.

This disrupt has even led to some technologically savvy Venezuelan citizens to desperately turn to impersonate US citizen's through virtual private servers (VPSs) on sites like Mechanical Turk where they end up undermining social science research in order to earn money to feed their families [13]. Venezuelan citizen's fleeing to neighboring countries like Colombia, Argentina, Chile, and Peru, have found opportunities in the local gig economies, working for companies like Rappi, an app based delivery service startup, which is thriving in part due to this influx of migrant workers [14].

Generally, unemployment rates in a country are a lagging indicator [15], often following economic distress or improvements, and requires constant adjustments for seasonal variability [16]. Countries whose economic well-being relies upon a few industries without much room for future development may also show high unemployment rates accompanied by a low GDP per capita [17]. Unemployment and Government AI Readiness are not directly correlated, but unemployment must be considered before implementing AI technology or automation.

Cuba, which has a historically low unemployment rate, also has the lowest Government AI Readiness score out of all other Latin American and Caribbean countries, according to the Oxford and IDRC ratings, as shown in Fig. 1, Fig. 2, Table I, and Table II. Cuba's economy is owned and run by what has been qualified as a dictatorship government [18], where the state employs most of its labor force, sets price standards and controls the access to education, healthcare, and distribution of goods to its citizens [19]. The Cuban government also controls investments in the region, stifling the potential for progress and innovation, although recent economic reforms led by Raul Castro's administration, have allowed over 400,000 citizens to sign up to be entrepreneurs [20].

Cuba has also seen an increase in the availability of computers and mobile phones after legalization in 2008, as well as modernization of its telecommunications network, improving access to the internet. Research by the Lexington Institute [21] points out that $473 million of foreign investment between 1995 and 2000 had given "Cuba the potential to become a Latin American leader in information technology" as "Cuba is incubating a group of enterprises that design and export advanced business and medical software products." Anyone familiar with AI technology can easily identify this a great opportunity for incorporating Machine Learning and Deep Learning techniques as solutions for training and deploying models "on the edge" through Android and iOS platforms. AI developers can now take advantage of frameworks like TensorFlow Lite by Google, Core ML by Apple, or Caffe 2 by Facebook [22].

However, government acceptance and funding of these technologies for its research institutions and enterprises needs to be sanctioned and appropriately regulated prior to implementation. And such efforts require government and economic stability to warrant investment in the region, unfortunately, large numbers of Cuban citizens have been fleeing the country due to food shortages, impacted by its close ties and oil trade agreements with Venezuela and amplified by travel sanctions imposed by the Donald Trump administration [23].

B. Gross Domestic Product per Capita Purchasing Power Parity

Examining each country's ranking alongside the Gross Domestic Product per Capita Purchasing Power Parity (GDP-PPP) will help us to better understand an individual's ability to buy the same quantity of an item in different countries. Government agencies use this metric to compare the output of countries that use different exchange rates and it can be used to forecast future real exchange rates. The GDP-PPP is calculated using differences in taxes, tariffs, transportation costs, import costs, and labor costs.

The GDP-PPP data, published by the Central Intelligence Agency World Fact Book [24], compares each countries GDP on a purchasing power parity basis divided by population as of July 1st for the same year. Fig. 3 shows a comparison chart by LatinX in AI™ that indicates the size of the population in the diameter of the circle for each country along with their corresponding AI readiness index and GDP-PPP with data from [3], [24].

As can be seen in Fig. 3, countries with high GDP-PPP may not score highly on this Government AI Readiness index due to having a small population or specialized economy, lacking investment or opportunity for the high impact of technological innovation. This is the case for countries who rely heavily on tourism including Caribbean countries, the Bahamas, Barbados, Antigua and Barbuda, and Saint Kitts and Nevis.

Interestingly, some countries with low GDP-PPP rank higher on the Government AI Readiness Index possibly due to a growing or diversified economy combined with technological skills and data protection policies. However, countries such

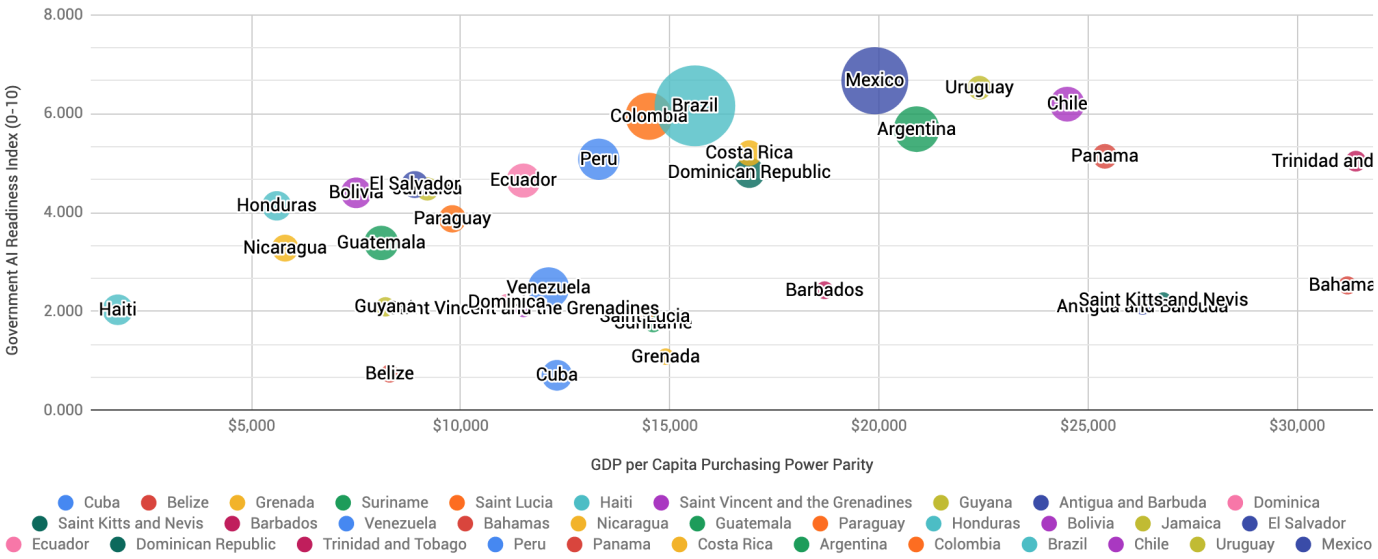

Fig. 3. Government AI readiness vs GDP-PPP. The diamaeter of the circle is proportional to the size of the population. Data sources are [3] and [24].

as Ecuador, Peru, Colombia, Brazil, Costa Rica, and the Dominican Republic score above the global average of 4.032 on the Government AI Readiness Index and yet they have historically low GDP-PPP.

Ecuador is the 8th largest economy in Latin America with its main industries being petroleum, food processing, and chemicals [25]. At a UN Summit in 2014 [26], Ecuador was one of only five countries who called for a preemptive ban on fully autonomous weapons and in late 2017, in an effort to encourage investment in the region, the National Directorate for the Registration of Public Data in Ecuador (DINARDAP), began drafting the first Ecuadorian law which would implement regulations in order to protect public personal data. But contrary to these proclamations for privacy and protection, Ecuador has also implemented a nationwide surveillance and response system called ECU 911, funded by China, and making use of controversial facial recognition technology while promoting its benefits for enforcing traffic laws and reducing crime incidents [27].

Colombia is the 4th largest economy in Latin America, and the fastest growing globally, following China, thanks to its most thriving sectors including construction, services, and agriculture [28]. Colombia also has the fastest growing information technology industry in the world and the longest fiber optic network in Latin America, installed by Azteca Co. in 2013 [29].

While Colombia is lacking an official AI strategy, it has some of the most thorough data privacy laws in South America inspired by European data protection regulations. These laws and decrees, enacted between 2008 and 2014 [30], protect its citizens by regulating the use of financial and commercial personal data in credit scoring, they also govern data processing, establish the rights of data subjects and duties of data controllers and processors, set forth requirements for international data transfers, created the National Registry of

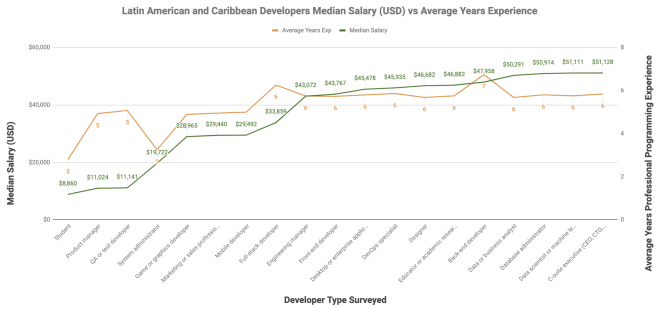

Fig. 4. Experience vs Salary from data in [32]. The results indicate that experience is highly predictive of salary. For roles involving data and machine learning, the average salary is higher for similar years of experience.

Databases and designates the Superintendence of Industry and Commerce (SIC) as the data protection authority. In 2018, the first Centre for Excellence in Artificial Intelligence was opened in Medellin, the country's second largest city, as part of the Digital Americas Pipeline Initiative (DAPI), a collaboration between Ruta N, the center of business and innovation of Medelln and the *Institute for Robotic Process Automation and Artificial Intelligence* (IRPA AI).

An analogy most often used to explain GDP-PPP is the Big Mac Index [31], which compares the price of a Big Mac in different countries in order to illustrate currencies which may be under or overvalued in purchasing power as compared to the local exchange rate. In the next paragraphs, we will use the cost to hire AI researchers as a similar indicator.

C. Comparing the Cost to Hire an AI Researcher

The cost to hire an AI Researcher is the most telling comparable metric that governments funding research and development would need to consider in the integration of AI into their policies, products, and services. In the U.S., salaries

of software engineers, data scientists, and researchers skilled in artificial intelligence techniques range between $100,000 and $150,000 according to PayScale.[1] These averages increase in densely populated or competitive markets like New York and San Francisco. While highly credentialed and "well-known names in the A.I. field have received compensation in salary and shares in a company's stock that total single -or double-digit millions over a four -or five- year period" [33].

Alternatively, in Latin America, the cost to hire engineers and researchers is significantly lower ranging between $15,000 and $30,000 dependent on years of experience and specialization. According to a 2018 Latin American Developer Survey conducted by Stack Overflow [32], engineers with some experience in Machine Learning or Data Science still tend to receive higher compensation, as shown in Fig. 4. Since the job title of Artificial Intelligence engineer and researcher is only beginning to gain popularity, this is the best available historical data to show the average compensation equivalencies by comparison.

D. Education

According to the Stack Overflow study in [32], Latin American countries also seem to produce more academic researchers than general software engineers as compared to the rest of the world. While the Government AI Readiness Index by Oxford and the IDRC [3], account for technological skills, they do not look at the overall Education level of a country. Thus, an adequate assessment tool can be the education index published by the United Nations Development Programme [34]. Fig. 5 depicts a comparison of both AI readiness index and education index.

The education index in [34], is an average of mean years of schooling (of adults) and expected years of schooling (of children), both expressed as an index obtained by scaling with the corresponding maxima. The comparison chart by LatinX in AI™, shown in Fig. 5 shows no apparent relationship between the two variables. This could suggest that education level of citizens, whether high or low, does not rigorously imply that governments are ready for AI; education by itself cannot be the only factor.

[1]https://www.payscale.com

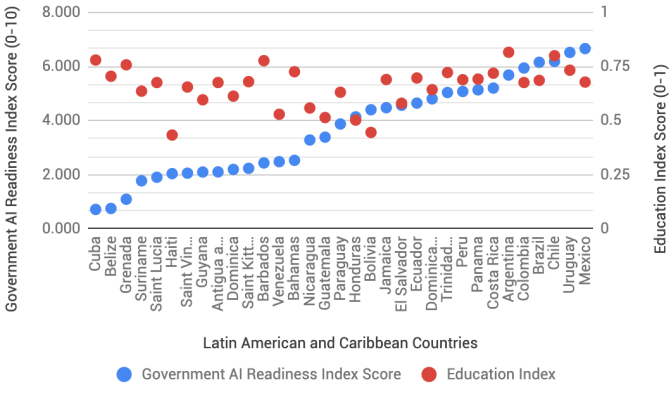

Fig. 5. Government AI readiness vs Education. Data sources are [3] and [34].

While most Latin American countries rate highly on the education index, many Latin American and Caribbean governments do not invest enough in university research and development. This coupled with unattractive pay, prestige, and working conditions leads to "Brain Drain" where the highly skilled or educated leave their country of origin. This phenomenon makes it harder for universities in those countries to reach their research potential and limits the access to quality scientific research mentors available to share knowledge to incoming students.

A report from Americas Quarterly, in 2014 [35], cited data from Mexico's National Council of Science and Technology (CONACYT) indicating that 1,271 of the 4,559 Mexicans (28%) working on master's degrees or Ph.D.s abroad in 2012 were doing so in the US. That is one of every 19 Mexicans with a bachelors degree or higher living in the US.

In Argentina, scientists often strike to protest budget cuts to research and development [36]. The directors of the National Scientific and Technical Research Council (CONICET), headquartered in Buenos Aires, which employs more than 20,000 researchers in hundreds of centers throughout the country are also fighting the cuts. They created a manifesto demanding "the immediate implementation of a plan to rescue CONICET."

Regardless of the Government AI Readiness index score or the Education index score, if a country's researchers are underfunded and left to seek grants from outside sources or relocate to other countries, their research and the future of technological innovation in that country is susceptible to influence from outside forces.

IV. Latin American Automation Potential & Risks

All of these metrics scrutinized and presented here can still only tell part of the story when it comes to a country and its citizen's preparedness for Artificial Intelligence. You cannot predict an nation's readiness for AI without including metrics for automation. Several reports have been published in the last five years by experts including the McKinsey Global Institute, the Economist Intelligence Unit, and the International Federation on Robotics (IFR), to name a few.

The IFR has been tracking and forecasting the rise of robot density globally for use in manufacturing and affiliated industries. In their 2018 Executive Summary on World Robotics [37], they noted that Mexico has become an important emerging market for industrial robots outpacing the rest of South America, including Brazil.

The use of AI and automation applied to industries such as manufacturing and agriculture could help to leapfrog a developing countries economy. Countries with a growing young workforce could use these technologies to their advantage in furthering economic development with the right education.

These days, manufacturing with robotics is no longer the largest concern when describing the automation potential and its effects on an economy. Shifts in business processes and

software intelligence through automation of data collection and processing will have a larger impact, especially in Latin America. In 2017, the McKinsey Global Institute published its executive summary on "Harnessing automation for a future that works" [38]. In this report, they have listed the countries where the potential for automation is highest by adapting current technologies. Of the Latin American countries they included in their study (*i.e.* countries with the largest population or high wages), Peru and Colombia have the highest automation potential at $\geq 53\%$, Brazil, Mexico, and Costa Rica the next highest $\geq 50\%$ followed closely by Chile, Barbados, and Argentina $\geq 48\%$. Meanwhile, the Economist Intelligence Unit (EIU) developed their own Automation Readiness Index [39], which we discuss next.

A. On The Automation Readiness Index

In 2018, the EIU developed their own Automation Readiness Index accompanied by a white paper and executive summary titled "Who is ready for the coming wave of automation" [39]. Their index, similarly to that of the IDRC and Oxford Insights, categorized metrics under 3 high-level topics:

- *Innovation Environment:* including indicators for research and innovation, infrastructure, and ethics and safety.
- *Education Policies:* including indicators for basic education, post-compulsory education, continuous education, and learning environments.
- *Labour Market Policies:* including indicators for knowledge on automation and workforce transition programs.

The authors conclude their report by comparing the global use of automation and AI technology to trial and error. Reinforcing the sentiment that "supporting basic research, clearing the way for start-ups and ensuring competitive markets are likely to be as helpful to AI and robotics innovation as they have been for past technology advances" ... while, "policy directions for education systems and labor markets are less clear for the moment, as the effect of intelligent automation have yet to be widely felt" [39].

Consequently, incorporation of AI into industries through automation which currently relies on a large blue-collar workforce will lead to concerns of increased unemployment, decreased GPD-PPP, increased migration, and population redistribution or density in city centers, gaps in education for highly technical skills, and increased income inequality between upper and lower class citizens. Most economists say these effects are temporary as the markets shift and new jobs are developed to support the growth of AI economies [38], [40], [41], but governments will have to do their part in ensuring their citizens have access to education and opportunities for investment.

V. Discussion: How Can AI Help Latin American Governments And Citizens?

Rather than just stressing how AI can be misused by government entities for surveillance to perpetuate bias and corrupt political systems or how it may diminish the middle class and render a country's lower class workers as unemployed, it is important to understand the benefits this technology can add to an ecosystem and economy when used responsibly.

In the public service sector, a myriad of new AI technologies is being implemented including advancing the availability of education, detecting fraud, triaging health care needs, making payments to welfare recipients, speeding immigration decisions, planning and implementation of large urban and industrial infrastructure projects and most importantly: it can reduce costs.

A great write up on the economics of artificial intelligence outlines five imperatives for harnessing the power of low-cost prediction [42]; here we have rephrased them and applied them to governments rather than leaving them in their original connotation that was intended for corporations.

Here are the *five imperatives for harnessing the power of low-cost prediction* and a brief description of each:

1) *Develop a thesis on time to AI impact:* How fast do I think the implementation, demand, and accuracy of prediction will increase for a particularly valuable AI application in my sector?
2) *Recognize that AI progress will likely be exponential:* Once appropriate data collection, processing, and prediction tools are in place for Government services, understand that progress and impact will be exponential rather than linear.
3) *Trust the machines:* Where AIs have demonstrated superior performance in prediction, governments must carefully consider the conditions under which to empower humans to exercise their discretion to override the AI.
4) *Know what you want to predict:* AI effectiveness is directly tied to goal-specification clarity, so knowing your desired outcomes, whether that be reducing crime rates, increasing the availability of healthcare and education, increasing employment, or reducing government overspending.
5) *Manage the learning loop:* Governments need to ensure that information flows into decisions, they follow decisions to an outcome, and then they learn from the outcome and feed that learning back into the system.

VI. Conclusion

The use of AI technology can actually transform the role of governments, making them better able to serve the population. As governments of developing countries continue to shift to more advanced digital platforms, they have added control over the data being collected on their citizens and how that data may be used to benefit society. Since data is the "new gold", governments also have a responsibility to their citizens to ensure this information is being mined in the least invasive manner while still creating value for the economy.

In this paper we discussed the key factors that play an important role in the AI readiness of LAC countries that will need to embrace the AI revolution very soon. If we fail to do so, we will be a the risk of affecting a global economies that rely heavily in an AI revolution that changes faster than what LAC countries can are able and willing to follow. By exposing

all these issues and existing efforts for exposing such struggles and difficulties, we hope that the reader can urge conversations with policy makers, ethical standards committees, and the broader scientific community with ties to AI, to pursue a unified effort to move forward and to reduce the knowledge gap among LAC scientific interdisciplinary efforts.

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