RPPI
Revista Brasileira de Políticas Públicas e Internacionais

Universities, Innovation and Automation: A Chinese Case Study

Universidades, Inovação e Automação: um estudo de caso chinês

Marcos Costa Lima[1]
Nathália Viviani Bittencourt[2]
Ana Carolina Costa[3]

10.22478/ufpb.2525-5584.2020v5n3.55299

Date of Recieval:17/09/2020
Date of Approval: 18/11/2020

Abstract: How is China acting, in terms of public policies for higher education, in order to guarantee its technological and economic progress in the face of the social impacts of automation? We make a case study of China's public policies in the pursuit of becoming a global power in the development of Industry 4.0. Indeed, some researchers argue that there is a new kind of technological war, in which both China and the United States are fighting for the supremacy of human capital and industrial production. Methodologically, descriptive statistics and bibliographic review were used to understand the historical dimension of Chinese idiosyncrasies in the search for technological progress, as well as document analysis of two strategic state documents in the area of innovation. As a result, we understand that China is showing itself with significant force in scientific production in some industrial sectors, but it still remains behind in the sense of human capital compared to the USA.

Keywords: China; Technological Progress; Universities; Geopolitics; Automation.

Resumo: Como a China tem atuado, em termos de políticas públicas para a educação superior, a fim de garantir o seu progresso tecnológico e econômico face aos impactos sociais da automação? Fazemos um estudo de caso das políticas públicas da China na persecução de tornar-se uma potência global no desenvolvimento da Indústria 4.0. Com efeito, alguns pesquisadores argumentam que existe uma nova espécie de guerra tecnológica, na qual tanto a China quanto os EUA batalham pela supremacia de capital humano e produção industrial. Metodologicamente, foi utilizada estatística descritiva e

[1] Universidade Federal de Pernambuco. E-mail: marcosfcostalima@gmail.com
[2] Universidade Federal de Pernambuco. E-mail: nvbittencourt@gmail.com
[3] Universidade Federal de Pernambuco. E-mail: scostacarolina@gmail.com

revisão bibliográfica para entender a dimensão histórica das idiossincrasias chinesas na busca pelo progresso tecnológico, bem como a análise documental de dois documentos estatais estratégicos na área de inovação. Como resultados, entendemos que a China se revela com força expressiva na produção científica em alguns setores industriais, mas ainda permanece atrás no sentido de capital humano em comparação com os EUA

Palavras-chave: China; Progresso Tecnológico; Universidades; Geopolítica; Automação.

1. Introduction

How has China acted, in terms of public policies for higher education, in order to guarantee its technological and economic progress in the face of the social impacts of automation? The Age of Industry 4.0 and the massive development in emerging technologies bring about significant social and economic changes for the whole world. From the point of view of the latter, a country's technological progress is capable of increasing its factors of production on a large scale, which produces growth in its market power and in the population's standard of living.

In contrast, with regard to the social factor, automation generates several impacts, especially in the field of work due to the replacement of intensive labor by driving machines. China, as a country that has had unique growth and modernization rates since 1978, and due to its extensive investment in the educational sector, has become an object of fundamental study to understand the new dynamics focused on its strategies in relation to investments in human capital. Acemoglu and Restrepo (2016), for example, argue that in the long run this phenomenon of automation can generate new tasks, but these require specialized human capital for new skills. This model also illustrates that, at first, inequality widens due to the heterogeneity between unskilled jobs, which are directly affected by the rigging of machines, and the need to provide new tasks that require specific skills. Thus, it is observed that this reality imposes modern challenges on States with regard to technoscientific development and the safeguarding of social rights, such as employment and quality of life.

In this light, Atkinson (2015) asserts that States have a central role in the healthy investment of innovation and the need to maintain the “human dimension in the provision of services”. To this end, the author indicates that the promotion of scientific research and public regulatory policies are fundamental steps in achieving the reduction of inequality. In this sense, the formation of qualified human capital through investment in education

(basic and tertiary) is a key element in this process. In this perspective, China has stood out on the international stage for its national techno-scientific development strategies. In his quest to occupy a new space in the World Multiplayer System, Xi Jinping (XI, 2014) made it clear that his nation's prosperity must align with technological progress. To this end, many measures were taken to align state investments in high technology with the maximization of the supply of resources and specialized human capital.

Thus, this article begins its theoretical discussion by examining the new configuration of geopolitics in relation to the new power struggles for the development of the information industry. After all, part of the recent International Relations literature argues that, in addition to the Sino-American trade war, there is a new race for the mastery of highly computerized complex systems, of which artificial intelligence is the most prominent. Thus, we will seek to understand the mechanisms used by the Middle Kingdom to increase its international economic competitiveness, based on a special focus on public policies aimed at the development of new technologies in Universities. Certainly, the country's higher education has undergone multiple reforms in the last decade, and research in innovation has a fundamental role in achieving socioeconomic progress and adapting qualified and specialized labor to the new model of robotic industry.

In order to answer the initial research question and to systematize the triad of public policies, universities and automation in China, this article was organized as follows: first, a brief explanation of the methodological aspects used in this research will be made. , then we started a contextualization of the theme, in order to present the challenges of the current situation in relation to the advances of the cutting edge technology by the expressive search of the Chinese government for Réncái [人才 (talented individuals)]. Soon after, we present the theoretical discussion, in which we show some statistics and systematize the main theories and studies that address automation, international competition for complex information systems and Chinese national strategies; then, we bring the results of the documentary analysis and, finally, our conclusion.

2. Methodological Aspects

The research design of this work is based on the use of descriptive statistics and document analysis of official Chinese government documents listed below:

a) Next Generation Artificial Intelligence Development Plan – State Council (2017);
b) Artificial Intelligence Innovation Action Plan for Institutions of Higher Education - Ministry of Education (2018).

In addition, regarding descriptive statistics, indicators from several institutions were accessed on digital platforms with the assistance of the SPSS Program = *Statistical Package for Social Scientists* (IBM SPSS *Statistical Package* - 26, 2019), which can be checked below. We believe that this quantitative analysis will be essential to highlight our conclusions in relation to our research question.

a) *China AI Development Report,* 2018. In this report, we use data referring to the body of talent in artificial intelligence in the world, as well as the categorization of Chinese Universities that have specific laboratories for innovation;
b) Indicators of investment in research and development in the OECD world (*Organization for Economic Cooperation and Development)*
c) IFR *(International Federation of Robotics)* robots operational stock indicators*;*
d) *Mind the (AI) Gap Report, 2018.* We use data for the sectors in which companies from China and the USA invest the most in AI*, 2018*;
e) *National Science Board (NSB)* - Indicators of computer engineering graduates and doctors in the USA, China and aggregated data from the six members of the European Union that produce the largest number of these degrees in computer engineering, 2016: France, Germany, Italy, Poland, Spain and the United Kingdom.

From this exposition of the methodological aspects of our work, we will continue with a brief contextualization of the theme.

3. Contextualization

The United Nations Conference on Trade and Development[4] discussed the transformation of the global structure and the increase in inequality due to the innovations

[4] Note from the UNCTAD Secretariat - United Nations Conference on Trade and Development. Structural transformation, Industry 4.0 and inequality: Science, technology and innovation policy challenges, 2019. Available at: <https://unctad.org/meetings/en/SessionalDocuments/ciid43_en.pdf. > Last accessed March 25, 2020.

brought about by Industry 4.0[5], mainly by Artificial Intelligence and Robotics. This modern form of production is capable of completely changing the rules of the game for nations that are embarking on the path of automation. One of the highlights of the economic and social disruption is justified by the dismantling of current labor relations, mass unemployment and the high market concentration by a few dominant companies in the digital industry.

In addition to illustrating this situation, ways are pointed out so that States can enjoy the benefits of border technologies without its harmful effects. The role of regulatory policies in science and technology, as well as public investments in inclusive digital education are recognized as the main ways of promoting social stability and diversifying their promotion. Therefore, one of the great motivations of this article is, without a doubt, to understand the way in which state actors are facing this dilemma of automation.

In addition, we selected China as a case study for its relevance in the international system, its massive development in cutting-edge technologies in the last decade and its unique political system configuration. Through this descriptive mechanism, we can make a historical-analytical immersion of the main factors that justify the technology to have become one of the main engines of this society.

Furthermore, Kai-fu Lee (2019), a scientist and investor in technology in the USA and China, points out that the latter is going through a Sputnik moment in innovation, especially with the implementation of the national strategy of "Made in China 2025" (2015) and the "Next Generation Artificial Intelligence Development Plan" (2017). The author states that there is a new world order accentuated by the growing competition of both countries for market dominance and development of technologies, especially with regard to the possibilities of systematization of large amounts of data (big data) emanating from artificial intelligence (hereinafter AI). The author states that there is a dazzle in China in AI, mainly due to the performance of specific tasks more accurately than humans, which makes this market quite attractive at the moment. However, Kai-Fu Lee

[5] The definition of Industry 4.0 is presented as "(...) (it) refers to the increased use of automation and data exchange in manufacturing - a current trend - resulting in smart and connected production systems. It is one of the major drivers of the fourth industrial revolution. Industry 4.0 is associated with increased digitization in manufacturing through connectivity, the industrial Internet of things, big data collection and analytics, new forms of interaction between humans and machines, improvements in using digital instructions due to robotics and three-dimensional (3D) printing. " Ibid., Page 4.

understands that the United States has a significant advantage in human capital and innovation production than in China.

Faced with this scenario, the Chinese government has shown concern about the power to disrupt social stability due to the rapid expansion of border technologies. In a recent White Paper on Security and Artificial Intelligence (2018)[6] published by a think thank from the Ministry of Industry and Information Technology, the negative risk of AI was the reduction or complete elimination of some tasks, which can lead the country to structural unemployment . Thus, one of the proposed alternatives to avoid this disruption in automation is the strengthening of a talent pool in AI technology and industry through the financing of laboratories in qualified Universities and the investment of specific courses to these needs.

Table 01: Estimated Displacement and Job Creation With AI and Related Technologies in China by Industrial Sector (2017 - 2037)

Sector	Displacement of Workstations		Creation of Workstations		Work Networks	
Services	-72m	-21%	169m	50%	97m	29%
Construstion	-15m	-25%	29m	48%	14m	23%
Industry	-59m	-36%	63m	39%	4m	3%
Agriculture	-57m	-27%	35m	16%	-22m	-10%
Total	-204m	-26%	297m	38%	93m	12%

Source: PricewaterHouse (PcW)

In this sense, a complete implementation of the "AI Action and Innovation Plan for Higher Education Institutions" is proposed, prepared by the Ministry of Education (2018), so that it is possible to provide professional education that promotes skills and abilities. AI man-machine collaborative operation capabilities. Thus, it is noted that China, carefully observing the advances and harms of automation for the national economy and society, seeks to minimize these impacts through, above all, the restructuring of the scientific academy. Below there is a table with estimates of job displacement and creation of new tasks in some strategic sectors in China, in order to observe the difference in impacts brought about by automation. The survey projects a majority of net job gains for service sectors, where an increase of 29% (about 97 million)

[6] The full document exists only in Chinese, and can be accessed at <http://www.caict.ac.cn/kxyj/qwfb/bps/201809/t20180918_185339.htm>. The English translation can be found at <https://seer.ufs.br/index.php/tempopresente/article/view/12590>

is estimated, while predicting a negative impact on the agriculture sector, with a loss of 10% (about 22 million) net jobs.

In view of the above, China believes that Universities play a fundamental role in balancing the tripod of innovation, economic progress and the labor market. In relation to the latter, we argue that the country has many challenges in relation to the balance of the specialized human capital network and the replacement and intensive labor by automation, but it is acting strongly in the quality and massification of Higher Education specialized in emerging technologies such as bet to reduce the impacts of technology to social inequality.

4. Theoretical Discussion

This section aligns the bibliographic review, theories and statistics that cover our research topic. For better understanding, we have systematized our structure into topics, which can be viewed below.

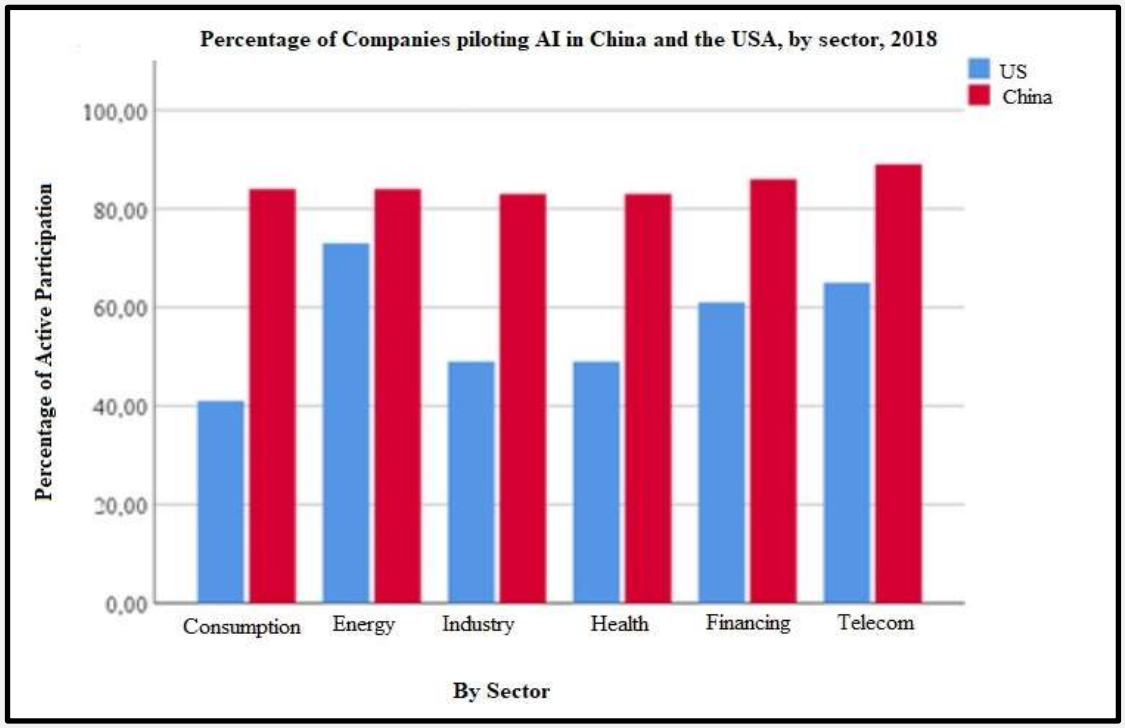
4.1.Geopolitics, Technological War and the Chinese Dream

In an analysis of the historical transformations of Chinese Foreign Policy, Flint and Zhang (2019) theorize that the international geopolitical context must be understood to support the decisions of States. In this perspective, the authors argue that the historical retrospective of World Systems Theory is able to clarify enough the current political tensions between the USA and China that involve disputes for the trade and dominance of emerging technologies, especially AI. Thus, it is noted that investments in scientific research and development represent a fundamental historical process in the countries' search for prominence in the international economic scenario (FLINT and ZHANG, 2019).

In addition, from an economic point of view, several researchers understand that long-term growth in living standards depends on an economy's capacity to sustain technological progress (BRANDT and RAWSKI, 2008; LI et al., 2019). In the particular Chinese case, a large part of their society is connected, and giant companies such as Baidu, Alibaba and Tencent that work especially with the support of the information industry and large data in their favor. As an example of this social immersion of central Chinese cities to technology, we can mention the extensive use of facial recognition in stores and payment for purchases only with the cell phone (mainly through the WeChat

Pay and AliPay platforms), which made cash money a tool almost obsolete. In order to illustrate the immersion of Chinese companies from different sectors that use modern technologies, the following chart shows the percentage of AI use compared to the USA. In all the fields below, it is possible to note that Chinese companies use more AI than those in the USA, with a special advantage in relation to consumption, industry and health.

Figure 01: Percentage of Enterprises that are Using Artificial Intelligence per sector, China and the US (2018)



Source: Boston Consulting Group (BCG) (2018)

Furthermore, the Chinese innovation system reflected a strong determination by the Party to become a world leader in S&T. Policies and strategies for economic development expressed the feeling that foreign technology was the basis of the Chinese process and that a strong shift towards an "indigenous innovation" capacity was needed. As innovation is generally understood to be happening in a complex system, that is, a network involving universities, firms and governmental organizations, a national innovation system should be structured.

In this sense, the 1990s fulfilled the intention. Around 2002, more than 400 incubators and 53 high development zones were established, with government support (Kjersem and Gammeltof, 2009), (Kjersem, 2006), (Gammeltof, 2006) (Huang et al, 2004). The Zhongguancun Science Park in Beijing, which articulated 40 universities and

130 research institutes, has become one of the most well-established scientific zones and, given the attractiveness of the Chinese market, the government has also pursued a "technology to market" policy, where they encouraged foreign investors to transfer technology to China (Gassman and Han, 2004).

In addition to the business initiative in China, many national policies have been developed since the beginning of 2010 for the development of industry 4.0, notably the Internet of Things (IoT), robotics, cloud computing and AI. Made in China 2025, launched in 2015, was one of the most talked about innovation plans in the world due to the intensive strategy of accelerating the computerization of industries and the focus on product quality. This policy was launched as a way for the country to maintain its high levels of productivity and improve the value chain in technology, in order to guarantee its economic growth with efficiency in the creative standard.

However, artificial intelligence[7] deserves special attention due to its prominence in the country since the AlphaGo supercomputer, developed by Google Deepmind AI to play the ancient Chinese game weiqi (圍棋), defeated the world champions Lee Sedol, South Korean, and Ke Jie, Chinese, in 2016 and 2017[8], respectively. These matches aroused a lot of curiosity and popularity across the country, mainly due to the discussion of Human-Machine interaction and speculation about the superiority of computer intelligence to humans. In August 2017, the State Council launched a national strategy focused only on the development of AI: the "Next Generation Artificial Intelligence Development Plan" (2017), this is one of the factors that guided the decision to analyze the content of this document in this article.

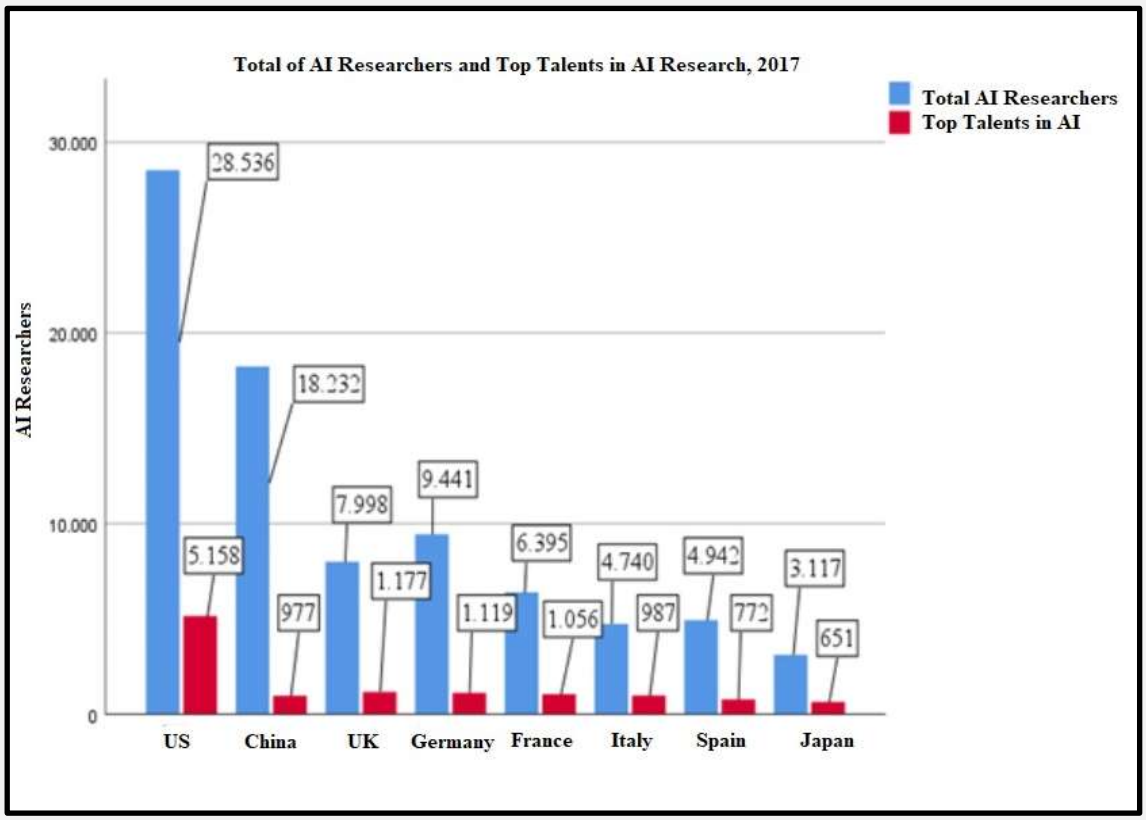
In this document, one of the key elements is, without a doubt, its geopolitical aspect. Roberts et al. (2019) illustrate that the plan encompasses three steps for China to become a major AI power by 2030: maintaining competitiveness with the largest producers of this technology and optimizing its development environment; be a leader in some AI applications and advance your theory; establish itself as a world center for

7 In general, AI is a computer system that helps us to make decisions or execute them autonomously, based on the processing of available data. The evolution of software engineering techniques considers AI as an umbrella term that encompasses machine learning (machine learning) and deep learning (deep learning) systems, whose skills, especially in relation to the latter, bring up ethical discussions on the increase in the object's autonomy and the difficulty of scientists in making their development models more "explainable". Given their ability to facilitate individuals' choices and allow accurate responses to any type of problem, AI agents have come to be widely used by companies, governments and individuals as mechanisms capable of finding quick answers from systems immersed in large amounts of given away.

8 Byford, Sam. "Google's AlphaGo AI Defeats World Go Number One Keie", 2017. Available at: <https://www.theverge.com/2017/5/23/15679110/go-alphago-ke-jie-match-google-deepmind-ai-2017>. Last Accessed in April, 2nd 2020.

innovation in AI. It is noted, therefore, that this technology has become essential to leverage its power in the structure of the international balance. Given this, Ding (2018) believes that the construction of AlphaGo by Google demonstrates that the advances in AI are linked to the national prestige and the status perceived by the great powers.

Figure 02: Total Number of AI Researchers and Leading Researchers in IA (2017)



Source: China AI Development Report (2018)

In addition, the author states that the government is very attuned to the strategies and advances of this technology in countries that it considers to be prominent in this industry: the United States (the nation with the largest body of talent), the European Union (due to the great project for the reproduction of the human brain by AI), Japan (largest consumer of robots) and the United Kingdom (leader in the standardization of ethical issues in Industry 4.0 (DING, 2018). Regarding the USA, Wang You and Chen Dingding (2018) consider that there is a growing tension between China and AI policy manipulation. However, despite massive Chinese investment to achieve it, there is still a huge American advantage in terms of its industrial scale, product quality, theory and, above all, qualified human capital. The authors conclude, therefore, that "*even with the relatively higher salary offer for AI developers, the lack of talent will continue to be a bottleneck for the development of China's AI industry*"(pg. 249)

As an illustration, the chart below shows the eight countries that have more researchers with technical expertise and creative skills in AI development (in blue), as well as the researchers who lead and stand out in this field internationally (in red). As can be seen, the USA has a great advantage in relation to the total of specialist researchers, as well as in top talents in AI. It is interesting to note that, regarding the volume of researchers, China is in second place, while it falls to the sixth position with respect to leading AI specialists, behind the United Kingdom, Germany, France and Italy.

In this context, it is clear that the international scenario encompasses a geopolitical and economic dispute over technological development and the production of talents that create innovative projects for industry 4.0. China sees the evolution of AI as an opportunity to highlight its national strength and scientific pioneering spirit, and while still far from overtaking the US in terms of its talent pool, it employs many policies to bridge the gap in the long run. The "Artificial Intelligence Innovation Action Plan for Institutions of Higher Education" (2018), which will be analyzed in the results section, is a great example of this future vision to become the main world center in research and development. Finally, it is opportune to illustrate part of President Xi Jinping's speech in 2018, when he calls for healthy AI development.

> Accelerating the development of a new generation of artificial intelligence is an important strategic starting point for us to win the initiative in the global scientific and technological competition. It is also an important strategic resource to promote the development of China's science and technology, optimization, industrial upgrading and general productivity leap. (Xinhuanet, 2018[9])

In view of the above, Rosales (2020) emphasizes that the national revitalization of China, through economic integration with the rest of the world and the positive reception of modern scientific and technological advances, was the Chinese dream of all leaders who succeeded the policy of closing of Mao Zedong. In terms of foreign policy projection, Professor Yan (2014) alludes that Xi Jinping changed the low-profile profile of international relations to a determination in striving for achievement. It is noted, therefore, that innovation has a fundamental role in the pursuit of the Chinese dream for a worldwide presence.

9 Original: "加快发展新一代人工 能是我们赢得全球科技竞争主动权的重要战略抓手, 是推动我国科技跨越发展, 产业优化升级, 生产力整体跃升的重要战略资源".

Next, we will make a historical retrospective of the importance of innovation for the country, analyze the educational reforms in the last decade for higher education and, finally, address the modern dilemma of work, unemployment and automation.

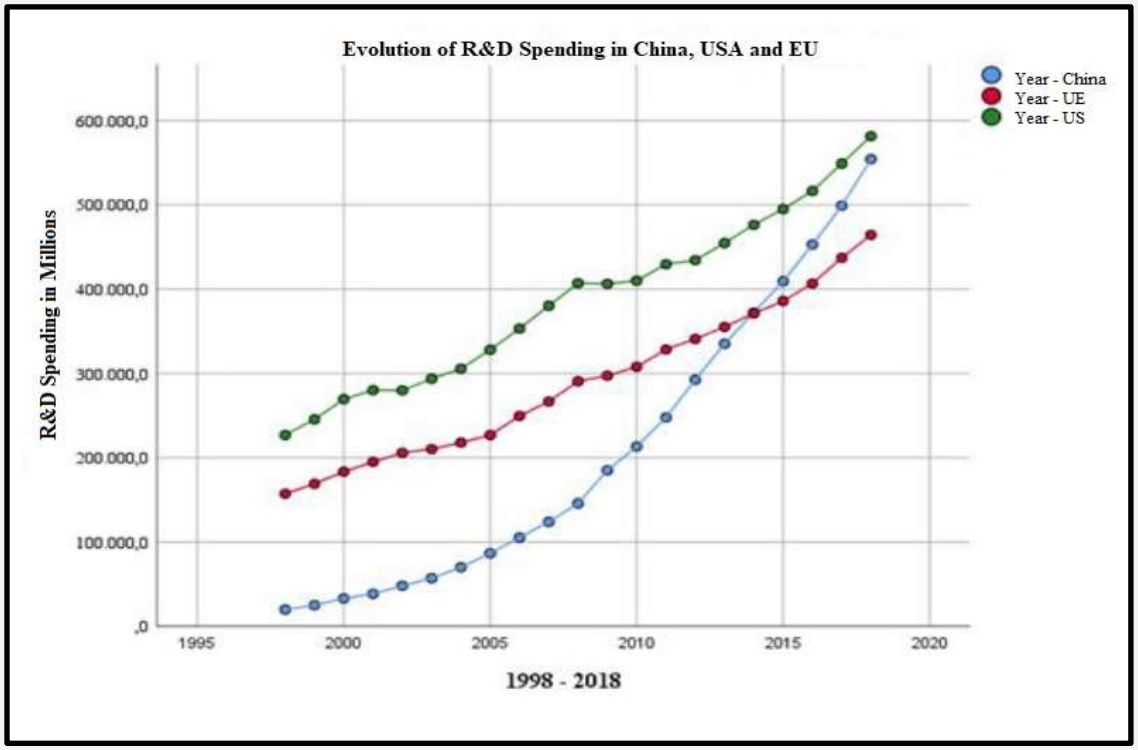
4.2. Innovation Dilemmas: Challenges and Opportunities for Chinese Politics and Economy

When analyzing the role of science as a national development project, Wu (2019) looks back on China's last 150 years and argues that research and technology have always been strongly rooted in the country's culture. In addition, as pointed out, the last decade of the 21st century was marked by an expressive search by the Chinese government for Réncái (才 - talented individuals), as well as massive investments of Government public policies exclusively for the promotion of innovation in the State.

In this context, there is a certain consensus in the literature that it is from the government of Deng Xiaoping that China begins its technological trajectory and economic opening that allowed the country to reach the level it has today (SHAMBAUGH, 1993). One of Xiaoping's main objectives was to modernize four strategic areas for the Chinese economy: agriculture, industry, science and technology and military defense (JUNG-SEUNG, 2012). Despite some setbacks throughout the country's political history, today China presents itself as one of the largest investors in cutting-edge technology and scientific research within its territory. The Chinese government has been advocating a policy of scientific use since its inception, requiring research institutes and universities that serves the national economy, to solve practical issues and problems in the industry.

The graph below illustrates the exponential growth of Chinese investment in research and development (research and development - R&D) compared to the USA and the European Union over the past twenty years. The data were extracted from the OECD and attest that the budget for this area is close to the United States, as well as exceeding that of the EU bloc by millions of dollars. Thus, the narrowing of the curve demonstrates the country's strategic vision and continuity of the development plan created since the economic opening.

Figure 03: Investments Evolution in R&D in China, US and EU (1998-2018)



Source: OCDE

Under this prism of reform and opening up markets in China, it is important to highlight the expectation of a change in political structure with its entry into the World Trade Organization (WTO) in December 2001. Indeed, as the internet made the world hopelessly more connected, it was speculated that it was impossible to maintain a closed political regime in the face of advances in globalization[10]

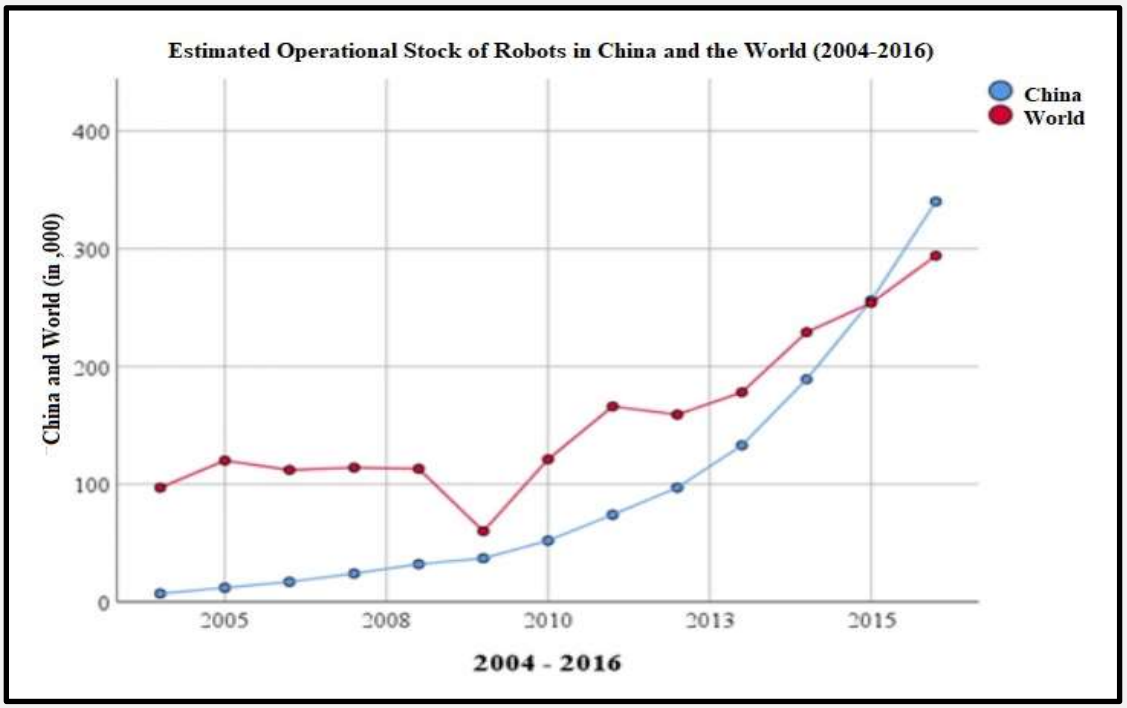
However, it should be noted that the Chinese system has shown itself to be quite firm and has managed to adapt to the new institutions and challenges that have emerged in the Digital Age. In fact, an empire of data has been built that strengthens the centralized political system, the basis of which is based on the ideology of the Communist Party. In this sense, Xi Jinping, in an important speech given on the 40th anniversary of the reform and opening up, expressed that the model of socialism with Chinese characteristics and the leadership of the party are elements that represent the great strength and socioeconomic advances of its territory. National and cultural identities are on their way to the center of the national community and many contributions have already been made

10 In 2000, former US President Bill Clinton made a speech with this line of reasoning, arguing that it was impossible for China to combat the open changes brought about by the massification of the internet. "We know how much the Internet has changed America, and we are already an open society. Imagine how much it could change China. Now there's no question China has been trying to crack down on the Internet. Good luck! That's sort of like trying to nail Jell-O to the wall. ". Available at <https://www.nytimes.com/2000/03/09/world/clinton-s-words-on-china-trade-is-the-smart-thing.html> Last accessed March 25, 2020.

to the progress of human civilization[11]. Thus, it can be said that information technology is a great ally to the functioning and control of Chinese politics.

In this context, the continuity of reforms, maintenance of economic growth and safeguarding the quality of life of the population depend on facing some modern challenges. Rosales (2020) argues that the guarantee of stable and healthy growth in the country is linked to some socioeconomic transitions that occur simultaneously: the prevalence of consumption; the shift from traditional manufacturing to smart manufacturing; the expressive increase in the service sector; intense urbanization and industrialization; and demographic changes.

Figure 04: Estimated Operational Stock of Robots in China and the World (2004-2016)



Source: IFR - International Federation of Robotics

Regarding the latter, the author understands that the one-child policy, among others, has substantially changed the scenario of the country's economically active population. Despite still being the most populous nation in the world, China must prepare for a situation in which local labor may be lacking, given the growing population aging. To overcome this issue, it is suggested that China increase its productivity levels, when

[11] XINHUANET. "**Highlights of President Xi Jinping's remarks on China's reform and opening-up".** 2018. Available at:. http://www.xinhuanet.com/english/2018-12/20/c_137687815.htm. Last Accessed on April, 2nd 2020.

innovation, automation and the implementation of the Made in China 2025 plan come into play. A study by the International Robotics Federation (IFR, 2017) found that the operating stock of industrial robots in China marked the highest level in the world in 2016, in addition to highlighting the expansion of national market share, so that there was never an increase so dynamic in such a short period of time in any market.

However, this strategy of maintaining the high production standard through innovation and automation also causes social demands that challenge the healthy development of Chinese society. In effect, the problem of mass unemployment and substitution of occupations is capable of causing several disruptions, such as increasing inequality and decreasing quality of life. Spitz-Oener (2006) carried out a fundamental study by correlating the need to increase the requirements for new skills in the workplace due to technological changes. Its results are based on the fact that occupations have increased in complexity, insofar as repetitive and manual activities are programmable by computer, while tasks that require dynamic cognitive effort encompass a new reality at work. Thus, the author's analysis suggests that the change in occupational skills requirements explains a significant part of the educational update of the last decades.

Given this situation, the work of Chen et al (2019) takes an interesting approach to the impacts of automation in cities with different industry structures fostered by the State Council. The results show that cities with more dynamism in occupations and more government investments in educational reforms for higher education have more resilience in relation to the effect of unemployment through automation. In this context, large technological hubs such as Beijing, Shanghai, Guangzhou and Shenzhen have less negative developments from automation than cities Nanyang and Zhumadian. These cities, as they are specialized in isolated activities, such as agriculture and mining, should have the highest impact of unemployment. Thus, the two studies above demonstrate a correlation between the implementation of educational reforms, the replacement of tasks with new technologies and the resilience of the negative effects of automation.

When addressing the five themes above, it is clear the structuring role that economic development plays in Chinese politics and how technological development presents itself as a “double-edged sword”. If, on the one hand, technological input appears as a new factor of economic development, on the other, the lack of state planning can cause a lack of control between the rate of economic growth and the rate of

unemployment. This may threaten what some authors have agreed to call "the implicit governability pact" (ROSALES, 2020) between the Chinese state and society.

Finally, it is important to highlight that regulatory policies have been developed by the State in order to combat some deleterious effects of Industry 4.0. As illustrated, the White Paper on Security and Artificial Intelligence (2018) suggests the complete implementation of the "AI Action and Innovation Plan for Higher Education Institutions" (2018) in order to streamline the role of the new tasks that these disruptive technologies demand. Next, we will illustrate China's most important educational reforms in order to present, in the results, some significant data on the relationship of Universities in the policy of expanding innovation in the country.

4.3. From Quantity to Quality: Key Educational Reforms

Chinese educational institutions have an ancient tradition that goes back to the Tang Dynasty (in Chinese: 唐朝, 618-906). However, the historical outline that interests us for this article is the long process of educational reforms initiated by the Cultural Revolution of 1949, which flows into the current Chinese educational context. In 1949, the Chinese higher education model started to be deeply influenced by the current model of the former USSR, therefore, it was characterized by a structure strongly focused on the central government, through the allocation of resources, selection of University leaders and at the limit enrollment per institution. The first national education conference on the new regime was held in December 1949, and discussed the main normative guidelines for education defined in the Common Program of the Chinese People's Consultative Conference (CCPPC)[12] which established educational policies and had the task of raising the cultural level of people and training them for national construction works.

At that time, the main values established were patriotism, love of work and love of science. Current literature agrees on the understanding that there was a political commitment to the development of natural sciences at the service of industry, agriculture and national defense, and the application of a scientific and historical point of view to the study and interpretation of history, economics, politics, culture and international affairs. (CAI & YAN, 2017; HAYHOE, 2004). HAYOE (2004) reports that, between 1957 and 1960, the number of Chinese institutions rose from 229 to 1,289. Likewise, the percentage

12 In chinese: 中国人民政治协商会议. China's advisory body that meets annually.

of students enrolled in engineering increased from 26% in 1949 to 37% in 1957, while teacher training increased from 10.3% to 26%.

However, the 1970s and Deng Xiaoping's reopening policy brought about new educational reforms due to the transition from a planned economy to a market reopening. CAI and YAN (2017) point out that the effective transition from the Soviet model to American influence in universities occurred only during the period between 1993 and 2010, when political strategies were introduced that emphasized the decentralization, liberalization and privatization of University education. It is important to highlight that the result of these reforms impacted the number of Universities controlled by the Ministry of Education, which dropped from 358 to 35 until the 2000s.

In addition, these changes have resulted in developments in the percentage of this control by the central government, which fell from 51% in 1995 to 9% in 2002, with a view to transferring the tutelage of these institutions to local governments (HONG, 2008). This last cycle of reforms aimed to favor the environment of collaboration and knowledge-transfer between local universities and industry, which generated a greater strengthening of the autonomy of Chinese technological hubs, such as Beijing, Shanghai, Guangzhou and Shenzhen. (HONG, 2008). However, FUTAO (2017) argues that these reforms focused on decentralization were fundamental to provide less political interference and more autonomy for the academic development of the provinces, but the basic characteristics of governance and internal politics, in general, are still quite influenced by the Central Government.

With regard to educational reforms, it is important to highlight the two most recent ones, which reflect the rapid Chinese economic growth and the relevance of innovation to ensure the healthy development of the country's new consumption and production demands. Thus, on the one hand, in 1993, the “Outline for China's Educational Reform and Development (1993 - 2010)” was published, in which strategies were introduced that promoted the massification of courses and the broad entry of students to higher education.

On the other hand, in 2010 the State Council enacted the National Plan for Educational Reform for Medium to Long-Term Development (2010 - 2020), based on the ideology that education is the pillar for the nation's rejuvenation and social progress. CAI and YAN (2017) assert that the difference between the reform from 1993 to 2010 is the alteration of a model focused on quantity for the quality of universities. Chinese. Thus, it can be said, in general, that the higher education system has undergone deep reforms,

which have the following priorities: transformation of governance in higher education, restructuring of institutions, construction of world-class universities, social involvement and internationalization of the university, whose objective is to attract more talented students.

Furthermore, it is important to highlight two national projects that were fundamental to demonstrate the deep involvement of the communist party in transforming universities into quality institutions at the international level. The "National Project 211", whose name is formed by "21", the new century, and "1", which refers to an average of 100 universities, started in 1995 with the government's intention to invest heavily in development higher education and improve national production standards for scientific research. In total, 117 were awarded in order to cultivate talents for the country's economic and social development strategies.

In addition, in May 1998, the Chinese government launched the “National Project 985”, whose name is related to the date of its edition, May (month “5”) of the year “98”, with the clear objective of promoting internationalization of students and establishing several world-class universities. Only 39 (thirty-nine) institutions were contemplated, and all of them are listed in the “National Project 211”. The project involves national and local governments that allocate funding to certain universities in order to build new research centers, improve facilities, hold international conferences, attract world-renowned professors and visiting academics, in addition to helping Chinese professors to attend conferences in the outside.

Therefore, it is noted that China has a clear policy of expanding the quality of universities, in order to reach international levels of productivity and scientific research. At first, as analyzed, the search was to massify the entry of students in higher education institutions, in order to expand this access to the plan of the entire nation. In this perspective, this coordinated effort by the Central Government and the locals has promoted advances in the classification of Universities in global measurement indices. The Times Higher Education[13] has a global reputation for measuring the quality of higher education worldwide, and in the last ranking of 2021, some Chinese institutions stood out in the ranking among the 100 best rated, including Tsinghua University (20th), Peking

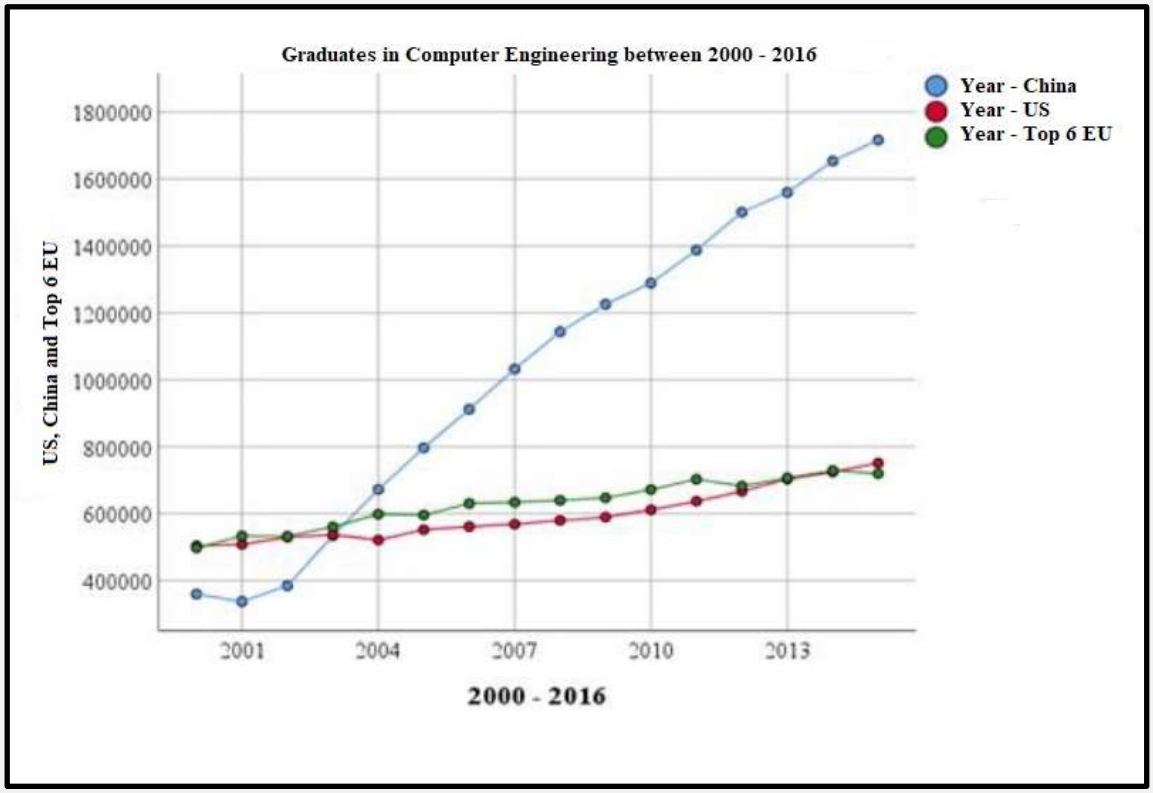
13Times Higher Education. **World Universities Ranking 2020.** Available at: <https://www.timeshighereducation.com/world-university-rankings/2020/world-ranking#!/page/0/length/25/sort_by/rank/sort_order/asc/cols/stats>. Last Accessed April, 20th 2020.

University (23rd), Fudan University (70th), China University of Science and Technology (87th), Zhejiang University (94th) and Shanghai Jiao tong University (100th).

It is important to notice the last edition of the *Shanghai Ranking*[14] (2020) where China obtained similar results, with emphasis also on Tsinghua University (29th), Peking University (49th), Zhejiang University (58th), Shanghai Jiao Tong University (63rd), China University of Science and Technology (73rd) and Fudan University (100º). All of these universities, with the exception of the University of Science and Technology of China, are part of National Projects 211 and 985.

With regard to policy coordination in higher education to encourage innovation and Industry 4.0, there is an exponential growth in student interest in courses related to computing. In this sense, the two graphs below show the number of graduates and doctors (respectively) in the Computer Engineering course between 2000 - 2016 compared to the USA and the 6 largest European countries that produce these diplomas (France, Germany, Italy, Poland, Spain and the United Kingdom):

Figure 05: Computer Engineering Graduates per Year: US, China, Top 6 EU Countries (2000-2016)

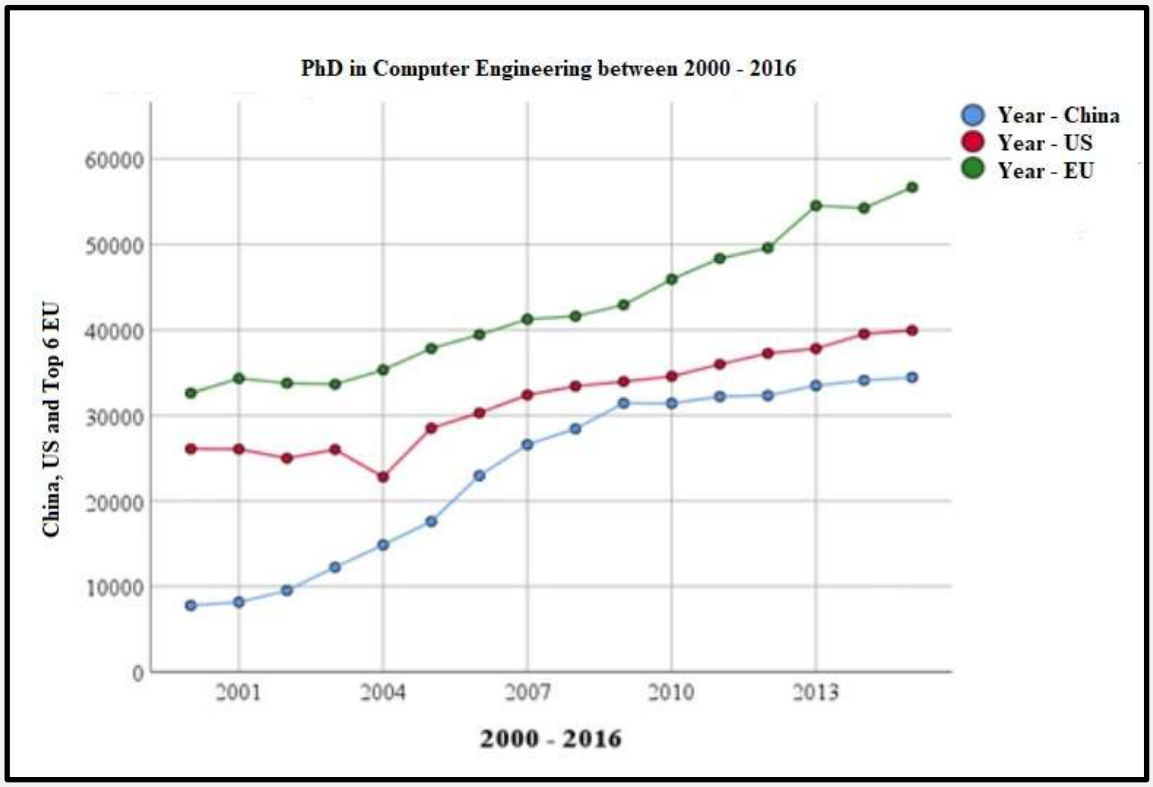


Source: IFR - International Federation of Robotics

14 Shanghai Ranking. **Academic Ranking of World Universities.** Available at: <http://www.shanghairanking.com/ARWU2020.html>. Last Accessed April, 20th 2020.

It is noted that China leads the training of professionals in computer engineering, producing more than one million graduates in this area in 2016, while the USA and the top 6 in the EU do not exceed 800,000 graduates in the same year. However, the graph changes considerably in relation to the training of doctors in the same area, with the EU as the leader.

Figure 06: Computer Engineering PhDs per year (2000-2016)



Source: IFR - International Federation of Robotics

Source: IFR - International Federation of Robotics

Furthermore, it is important to illustrate that several Chinese universities, paying attention to the recommendations of the AI Action and Innovation Plan for Educational Institutions (to be analyzed in the next item), have integrated laboratories of modern technologies combined with AI to promote innovation. Below there is a table with the Chinese institutions and their respective institutes:

Furthermore, it is important to illustrate that several Chinese universities, paying attention to the recommendations of the AI Action and Innovation Plan for Educational Institutions (to be analyzed in the next item), have integrated laboratories of modern technologies combined with AI to promote innovation. Below is a table with the Chinese

institutions and their respective institutes[15]. As for citations in the world of AI articles, the University of Systems of California (USA) leads in this classification, followed by the Chinese Academy of Sciences and Technology (2nd).

Table 02: List of the main Chinese Universities and their respective Integrated Artificial Intelligence Laboratories.

Top Chinese Universities	Integrated AI Laboratories
Tsinghua University (Project Participant 211 and 985)	State Laboratory of Technology and Intelligent Systems
Peking University (Project Participant 211 and 985)	State Laboratory for the Processing of Visual and Auditory Information; Machine Perception Laboratory
Chinese Academy of Sciences and Technology	State Standards Recognition Laboratory; Intelligent Information Processing Laboratory
Zhejiang University (Project Participant 211 and 985)	Institute of Artificial Intelligence; I-MD Research Center for Artificial Intelligence
Shanghai Jiao Tong University (Project Participant 211 and 985)	Intelligent Computing and Intelligent Systems Laboratory (co-developed with Microsoft Research Asia)
Nanjing University (Project Participant 211 and 985)	State Laboratory for New Software Technology
Fudan University (Project Participant 211 and 985)	Institute of Science and Technology for Brain-Inspired Intelligence
Harbin Institute of Technology (Project Participant 211 and 985)	Laboratory of Natural Language and Speech Processing
China University of Science and Technology (Project Participant 211 and 985)	National Engineering Laboratory for Brain Inspired Intelligence, Technology and Application
Beijing Post and Telecommunications University (Project 211 Participant)	Mobile Robot and Intelligent Technology Laboratory

Source: China AI Development Report (2018)

In this perspective, it can be said that China is making great strides in its goals of winning quality higher education institutions. With regard to innovation and scientific

15 China AI Development Report, 2018. Page 16.

production, it is clear that the Government includes universities as a fundamental ally in the search for a body of talent worldwide, capable of moving the nation towards progress, international competitiveness and economic development. It is understood, therefore, that the cultivation of a highly qualified workforce is fundamental for China to be able to make the transition to an economy based, above all, on innovation.

In the next section, we illustrate the results of our content analysis of two essential documents so that we can understand the Chinese strategic vision for AI and its scientific production.

5. Document Analysis

5.1. Document Analysis of the Next Generation Artificial Intelligence Development Plan

The Next Generation Artificial Intelligence Development Plan is a document issued by the Chinese Council of State addressed to the provincial governments, autonomous regions and municipalities directly subordinate to the Chinese central government, as well as to all ministries of the State Council and institutions directly controlled by him. The plan not only outlines China's political objective in relation to S & T & I, but also presents evidence of the Chinese state view. Below, we present the inferences of this document analysis.

The Development Plan of the Chinese State Council is a thorough and detailed document that outlines the Chinese political strategy on the use of A.I. The document is divided in a way that presents the strategic vision of the Chinese State and the general requirements that are subdivided into four categories. Then, it delimits the essential tasks that must be performed by the State and all subordinate bodies. There are 16 tasks subdivided into 6 strategic categories. Finally, the council presents how the allocation of resources will take place, the security measures of the strategic plan, and, finally, it deals with the organization and implementation of the A.I for the new generation.

With regard to the strategic vision presented by the State, it is interesting to highlight the government's understanding that: "*artificial intelligence has become the new focus of international competition, and it is believed that it is the strategic technology that will lead the future; the main developed countries in the world consider its development as the main strategy to increase national competitiveness and national*

security." In other words, there is a confidence in innovation and cutting-edge technology to guarantee a new Chinese space in the international system.

In addition, caution is noted with regard to China's current space in this system. You can see this motivation in the document in the following lines:

> "Currently, China's national security and the international competition situation are more complex, so we must look at the world, plan the development of artificial intelligence at the national strategic level, firmly understand the strategic initiative of international competition during the new stage of development artificial intelligence, create new competitive advantages, open new spaces for development and effectively protect national security."(p.2)

The general requirements for this development plan are divided into four categories: the guiding thinking, based on the ideology of the Chinese government, and the basic principles that should outline the AI for the new generation. Here it is relevant to mention them one by one: technological leadership, systematic structures, all oriented towards the market and open source. With regard to what systematic structures mean, it is possible to observe the government's will that AI will assist in the integration of various sectors of society, such as research, innovation and industry, as well as the latent understanding that the socialist system it is fundamental to this task, *"since (he) focuses on getting things done, promoting projects and creating a collaborative force between strengthening innovation capacity, institutional reform and the political environment.*" The political goals of this plan converge with those of the second document analyzed, therefore, they will be treated as more specific in the next session.

Regarding the general implementation of this plan, it is worth highlighting the clearly defined political agenda of the Chinese state, which aims to fully support science and technology, economic, social development and national security, as it understands that through this technology, a comprehensive discovery of the capacity for innovation in China could be made. The state aims to strengthen the artificial intelligence industry, cultivate the smart economy to create a new cycle of growth for the next ten years or decades of economic prosperity in China. In this section, we explain the following lines

> "we will build an artificial intelligence society to improve people's livelihood and well-being in society and to implement the people-centered development ideology; we will increase the national defense force of artificial intelligence to protect and safeguard national security.(p.7)"

With regard to the essential tasks of the plan, it is possible to map six categories of action: a) Build an open and cooperative technological system of artificial intelligence; b) cultivating a cutting-edge and efficient smart economy; c) Build a safe and convenient smart society; d) Strengthen AI in the field of military-civil integration; e) Build a safe and efficient intelligent infrastructure system; f) Establish a new generation of major AI science and technology projects. This last category can be seen as the guiding thread of this great Chinese enterprise, since that is where the leading role of innovative technological research is inserted. As we will see in the next section, the success of this initiative outlined in this document depends on the successful implementation of the Action Plan for Chinese Education Institutions.

However, before focusing on the analysis of the second document, it is worth mentioning the caution of the Chinese state that defined security measures to guarantee the success of this initiative. Security measures are based on six strategic points, which are: to develop laws and regulations and ethical standards that promote the development of AI, to improve the main public policies that support the development of AI, to set standards in the intellectual property system aimed at for AI technology, ensure supervisory and security assessment systems for AI, strengthen the training of the workforce that deals with AI on a day-to-day basis, and perform a wide range of scientific activities related to Artificial Intelligence.

5.2. Document Analysis of the Artificial Intelligence Innovation Action Plan for Institutions of Higher Education – Ministry of Education

The document is the action plan of the Chinese Ministry of Education that serves as a guide for the action of Chinese universities in relation to the use of Artificial Intelligence, issued in 2018 and aims to encourage higher education institutions to focus on the vanguard of global science and technology, continually improving the ability to promote scientific and technological innovation, international cooperation and exchange, in addition to providing training in the field of AI and providing strategic support to the Artificial Intelligence Development Plan, which was the document analyzed in the section above. Below, we present the main inferences of this documentary analysis.

Right in the basic precepts of this action plan, what draws attention in the state discourse is the concern with the citizen-IA relationship in the passage that demonstrates the state's view of what this relationship should be like: "*The Chinese people's desire for*

a good life and the requirements for high-quality economic development have created a bright future for the development and application of AI in China." It is possible to infer a concern for social well-being and the notion that the development of S&T&I is a resource that can assist in relation to this state concern.

Still on the basic precepts, the Chinese state declares the understanding that:

> *"AI technology is permeating and reconstructing the connections between the economic activities of production, distribution, exchange and consumption."* and therefore it is necessary to *"use AI to innovate in new ways of providing training, revolutionize teaching methods, improve academic administration and create an intelligent, networked, personalized and lifelong education system is an important measure for promote the development of balanced education".(p.2)*

The excerpt reiterates the Chinese commitment to educational modernization, a topic discussed in our theoretical discussion session. The difference that can be expected for this new phase (post-2018) is the new role of A.I in the Chinese educational model. It is also one of the general political lines of the Ministry of Education to understand that universities should: a). intensify its basic applied research and increase the advances in the main technologies of general use, b) to continuously promote the wide integration of artificial intelligence with the real economy, in order to promote new drivers of economic development.

With regard to the guiding ideology of the ministry's policy, the action plan reiterates the commitment to Xi Jinping's political line on Chinese Socialism with characteristics for a new era, which is spelled out in the President's two published works. In addition, the ministry reaffirms its ideological commitment to: 1. development philosophy focused on innovation, coordination, environmental sustainability, openness and solidarity, 2. strategic policies that include the rejuvenation of China, 3. support for science education, 4. strengthening of China with Réncái [Talented Individuals], 5. innovation-oriented development and 6. civil-military fusion.

When analyzing the basic principles of the document, it is possible to outline four types of principles: those related to scientific development, civic development, structural development and civil-military development. The first concerns the notion of the centrality of the role of Innovation for the development of AI in universities and, consequently, in the economy. Civic development is about understanding the need to merge science and education and fully implementing a plan that promotes civic character and virtue. Structural development concerns the intensification of structural and

institutional reforms that strengthen cooperation between colleges and universities and local governments, companies and research institutes. It also concerns the objective of accelerating the transfer and application of scientific and technological achievements in the field of AI to the main industries and economic sectors. Finally, the basic principles in relation to civil-military development relate to the Chinese will to actively merge China's military and civil integration systems and to continuously promote the bi-directional transfer of military and civilian technologies.

Consequently, the Chinese Ministry of Education has ambitious political objectives to be achieved. Delimits that by 2025 China should significantly improve the capacity for scientific and technological innovation and the quality of training in the field of artificial intelligence, and demonstrate internationally theoretical relevance in the scientific field of S&T&I and AI, which demonstrates political ambition in the development of hegemony in the cultural and scientific field. In addition, they intend by 2025 to modernize national industries, transform the economy and build an intelligent society (with the active use of AI). The goals set for 2030 have the goal that by this year, universities will become the main force behind building the world's leading AI innovation centers and will lead the development of a new generation of AI talent to provide to China scientific and technological support and guaranteed talent to put the country at the forefront of innovation-oriented countries.

The remainder of the document presents 18 essential tasks that universities and their deans must fulfill to ensure that political objectives are achieved. The focus on the international academic cooperation that Chinese universities must have draws attention, some of the guidelines concern the exchange of scientists, as well as the importation of brains that can help in initiatives aimed at expanding scientific development and training new scientists. In addition, the deep concern with the insertion of Chinese research in the international academic-scientific debate. In addition to these tasks of expanding the development of S&T&I, there is a latent concern at the end of the document to transform this scientific capital into S&T&I into commercial products and to demonstrate to the international market the ability to apply AI in fields such as finance, agriculture, architecture, production, judiciary and related fields.

6. Conclusion

In view of the above, we can see that China's continuous search for Réncái (talented individuals) has a broader and more ambitious objective than just guaranteeing a body of talent in specialized scientific research. Behind these goals is a political agenda that aims to strengthen your nation, but more than that, an implicit (sometimes even explicit) feeling of actively participating in the construction of a new technology-friendly society, guided by a notion of well-being for people. Undoubtedly, massive public investments and educational reforms in the country encompass a long-term strategic plan that includes safeguarding the shift from a manufacturing economy to an innovative and service-oriented one; a geopolitical plan for international competitiveness with regard to the dream of scientific and technological leadership; and the alliance of Industry 4.0 innovation with a new, highly qualified workforce that is able to combat the unwanted effects of automation.

However, as stated, there are still many pitfalls for China in its talent hunt and production of innovation for technological leadership, since the United States has a large advantage in this regard. According to researcher Zhang Jiang, *"there is still a very big gap before China can lead the competition, because it lacks fundamental innovations. China is still a good student, but not a good innovator. "* (p. 261)[16].

With regard to our research question: "how has China acted, in terms of public policies for higher education, in order to guarantee its technological and economic progress in the face of the social impacts of automation?", Was it possible to observe so much the history of the role given to universities in Chinese politics, the evolution of educational reforms, the evolution of autonomy of research centers in relation to the central government, and the role of universities in the process-making of the Chinese government.

We emphasize that the research design used here, as well as all research models, has limitations, which is why we encourage the growth of the research agenda on this topic, but it is possible to affirm the importance of the role of Chinese universities and the alliances between market and universities when we observe the advancement of the use and research in technological innovation in the country. However, the Chinese government's view appears to be that the greater the economic development, the greater

16 CYRANOSKY, D. "**China Enters the Battle for AI Talent".** Nature, 553, no 7688 260–61. <https://doi.org/10.1038/d41586-018-00604-6>. 2018.

the inputs for research, which consequently will generate greater economic development. However, this understanding may overestimate the consumption capacity of the world market, but these and other issues cannot be analyzed here, so we suggest and encourage them to be investigated by our fellow researchers.

References

Acemoglu, D., & Restrepo, P. (2018). The race between man and machine: Implications of technology for growth, factor shares, and employment. American Economic Review, 108(6), 1488-1542.

Bittencourt, N. V., & da Costa Lima, K. G. (2019). Assessing China's Policy thinking on ai development. Boletim do Tempo Presente, 8(02).

Barry, N. (2008). A political economy of China's economic transition.

Cai, Yuzhuo & Yan, Fengqiao. (2017). Chinese Higher Education and University. In book: "Handbook of Chinese Education", capítulo 8.

Chen, H. C., Li, X., Frank, M., Qin, X., Xu, W., Cebrian, M., & Rahwan, I. (2019). Automation Impacts on China's Polarized Job Market. arXiv preprint arXiv:1908.05518. Acesso em 07 de abril de 2020.

"China AI Development Report" (2018). Universidade de Tsinghua. Disponível em:<http://www.sppm.tsinghua.edu.cn/eWebEditor/UploadFile/China_AI_development_report_2018.pdf>.

China State Council. (2017). A New Generation of Artificial Intelligence Development Plan. Recuperado em 09 dezembro, 2020, de <http://fi.china-embassy.org/eng/kxjs/P020171025789108009001.pdf>

Cyranoski, D. (2018). China enters the battle for AI talent. Nature, 553(7688).

Ding, J. (2018). Deciphering China's AI dream. Future of Humanity Institute Technical Report.

Flint, C., & Xiaotong, Z. (2019). Historical–Geopolitical Contexts and the Transformation of Chinese Foreign Policy. The Chinese Journal of International Politics, 12(3), 295-331.

Ford, M. (2015). Rise of the Robots: Technology and the Threat of a Jobless Future. Basic Books.

Fu, Ying (傅莹) (2019). "A Preliminary Analysis of the Influence of Artificial Intelligence on International Relations" (人工智能对国际关系的影响初析). Tsinghua

University. Quarterly Journal of International Politics (国际政治科学), 04, nº 01, pgs. 1–18, http://qjip.tsinghuajournals.com/CN/abstract/abstract153607.shtml.

Gammeltoft, P. (2006). Internationalisation of R&D: trends, drivers and managerial challenges. International journal of technology and globalisation, 2(1-2), 177-199.

Gassmann, O., & Han, Z. (2004). Motivations and barriers of foreign R&D activities in China. R&D Management, 34(4), 423-437.

Highlights of President Xi Jinping's remarks on China's reform and opening-up— Xinhuanet | English.news.cn. ([s.d.]). Acesso em 02 de abril e 2020, de http://www.xinhuanet.com/english/2018-12/20/c_137687815.htm

Hong, W. (2008). Decline of the center: The decentralizing process of knowledge transfer of Chinese universities from 1985 to 2004. Research policy, 37(4), 580-595

How Does Education in China Compare with Other Countries? (2016, novembro 15). *ChinaPower Project*. http://chinapower.csis.org/education-in-china/

Huang, F. (2017). Who leads China's leading universities?. Studies in higher education, 42(1), 79-96.

Huang, C., Amorim, C., Spinoglio, M., Gouveia, B., & Medina, A. (2004). Organization, programme and structure: an analysis of the Chinese innovation policy framework. r&d Management, 34(4), 367-387.

IFR. ([s.d.]). *Robots: China breaks historic records in automation*. IFR International Federation of Robotics. Disponível em: https://ifr.org/news/robots-china-breaks-historic-records-in-automation

Is China Ready for Intelligent Automation? (2018, outubro 19). *ChinaPower Project*. http://chinapower.csis.org/china-intelligent-automation/

Jung-seung, S. (2012). Another take on prospects for the foreign policy of the Chinese fifth-generation leadership. In China's Foreign Policy (pp. 65-83). Palgrave Macmillan, New York.

Kjersem, J. M., & Gammeltoft, P. (2008). Knowledge Exchange with Offshore R & D Units: Novo Nordisk, GN Resound, and BenQ Siemens Mobile in China. China: business opportunities in a globalizing economy, 1st edn. Copenhagen Business School Press, Frederiksberg, 63-89

Kjersem, J.M. (2006), The Internationalisation of R&D – Offshoring Knowledge to China Viewed Through Case Studies of Novo Nordisk, GN Resound and BenQ Mobile; Master's Thesis,Copenhagen Business School.

Li, X., Frank, M., Qin, X., Xu, W., Cebrian, M., & Rahwan, I. (2019). Automation Impacts on China's Polarized Job Market (No. 1908.05518).

PRC Ministry of Education. (2018). Notice of the Ministry of Education on Issuing the Artificial Intelligence Innovation Action Plan for Institutions of Higher Education 教育部关于印发《高等学校人工智能创新行动计划》的通知. Recuperado em 09 dezembro,2020, de <http://www.moe.gov.cn/srcsite/A16/s7062/201804/t20180410_332722.html>

Roberts, H., Cowls, J., Morley, J., Taddeo, M., Wang, V., & Floridi, L. (2019). The Chinese approach to artificial intelligence: An analysis of policy and regulation. Available at SSRN 3469783.

Rosales, O. (2020). El sueño chino: cómo se ve China a sí misma y cómo nos equivocamos los occidentales al interpretarla. Siglo XXI Editores.

Shambaugh, D. (1993). Editorial Introduction: Assessing Deng Xiaoping's Legacy. The China Quarterly, 135, 409-411.

Spitz-Oener, A. (2006). Technical change, job tasks, and rising educational demands: Looking outside the wage structure. Journal of labor economics, 24(2), 235-270.

Wang, Y., & Chen, D. (2018). Rising sino-US Competition in artificial intelligence. China Quarterly Of International Strategic Studies, 4(02), 241-258.

Wu, S. (2019). China: How science made a superpower. Nature 574, 25-28, Available at: <https://www.nature.com/articles/d41586-019-02937-2>.

Yan, X. (2014). From keeping a low profile to striving for achievement. The Chinese Journal of International Politics, 7(2), 153-184.

Xi, J. (2014). The governance of China. Foreign Languages Press

习近平：推动我国新一代人工智能健康发展-新华网. “习近平：推动我国新一代人工智能健康发展, (2018)” (Xi Jinping: Promovendo o desenvolvimento saudável de uma nova geração de inteligência artificial na China)|Xinhuanet. ([s.d.]). http://www.xinhuanet.com/politics/2018-10/31/c_1123643321.htm
2018. Acesso em 03 de Abril de 2020.