

**Review of literature in USMCA value chains on industry 4.0 environment****Revisión de literatura en cadenas de valor del T-MEC en el entorno de la industria 4.0**

LEZAMA-DE LA ROSA, Miguel\* &amp; BARRON-VILLAVERDE, Diana\*

*Universidad Popular Autónoma del Estado de Puebla - UPAEP*ID 1<sup>st</sup> Author: *Miguel, Lezama-de la Rosa* / ORC ID: 0000-0003-2019-4271 CVU CONACYT ID: 440669ID 1<sup>st</sup> Co-author: *Diana, Barron-Villaverde* / ORC ID: 0000-0003-2329-362X CVU CONACYT ID: 412746

DOI: 10.35429/JTI.2021.23.8.14.25

Received July 20, 2021; Accepted December 30, 2021

**Abstract**

The digital environment driven by Industry 4.0, which brings the implementation of technologies such as artificial intelligence, the internet of things and additive technologies, has permeated value chains worldwide and the North American region has been no exception, where the renegotiation of the trade agreement was recently carried out, modifying relevant aspects in some sectors such as modifications to the rules of origin in the automotive sector, labor aspects, intellectual property issues, environmental protection, some considerations for digital trade, as well as sunset and China clauses. These changes have generated pressure on the region's value chains in a global environment that is becoming increasingly competitive. Nevertheless, there are opportunities both in the domestic market and in emerging economies if a better integration of exportable products and services is consolidated, in this sense it is essential that under the opportunities offered by the USMCA to foreign direct investment that México promotes technology transfer. This article was prepared through a systematic literature review with the intention of linking some contributions on the topics of industry 4.0, value chains and the new trade agreement (USMCA).

**Value chains, Industry 4.0, USMCA, Competitiveness****Resumen**

El entorno digital impulsado por la Industria 4.0 que trae consigo la implementación de tecnológicas como la inteligencia artificial, el internet de las cosas, las tecnologías aditivas ha permeado en las cadenas de valor a nivel mundial, la región de Norteamérica no ha sido la excepción, donde además recientemente se llevó a cabo la renegociación del acuerdo comercial modificando aspectos relevantes en algunos sectores como las modificaciones de las reglas de origen en el sector automotriz, aspectos laborales, temas relativos a la propiedad intelectual, protección al medio ambiente, algunas consideraciones para el comercio digital, así como cláusulas expiración y cancelación. Dichos cambios han generado presión en las en las cadenas de valor de la región en un entorno global que es cada vez más competitivo, a pesar de ello existen oportunidades tanto en el mercado interno como en las economías emergentes si se consolida una mejor integración de productos y servicios exportables, en este sentido es fundamental que bajo las oportunidades que ofrece el T-MEC a la inversión extranjera, México fomente la transferencia tecnológica. El presente artículo se elaboró mediante una revisión sistemática de literatura con la intención de vincular algunas contribuciones sobre los temas de industria 4.0, cadenas de valor, el nuevo tratado comercial (T-MEC).

**Cadenas de valor, Industria 4.0, T-MEC, Competitividad**

**Citation:** LEZAMA-DE LA ROSA, Miguel & BARRON-VILLAVERDE, Diana. Review of literature in USMCA value chains on industry 4.0 environment. Journal of Technology and Innovation. 2021. 8-23:14-25.

\* Correspondence of the Author (Email: miguelangel.lezama@upaep.edu.mx)

† Researcher contributing as first author.

**Introduction**

Digitalization enhance the coordination of global value chains (GVC), allowing more products and services to be traded internationally as well as the dissemination of ideas resulting in a diversification of countries exports, creating the need to generate more holistic approaches to temporary goods, services as well as digital connectivity involving society, government and business communities that seek to further boost digital trade, which could generate regional benefits as well as generate a disruption in traditional international trade previously governed by factors such as competitive advantages (OECD, 2019).

Digital connectivity has enabled new forms of cooperation between organizations at various stages of the value chains (VCs) mainly in open innovation, manufacturing distribution, as well as in new models of collaboration, such trends have emerged as viable tools to foster creativity, participation, change, through platforms that help foster the co-creation of value in modern times helping to meet the demand for needs (WEF, 2017).

By 2018 digital services exports for countries such as Mexico represented 16% of its total services exports, tripling this figure in the period from 2005 to 2018. In the last decade digital platforms have emerged making use of information causing the emergence of new business models that are revolutionizing various industries, this has been reflected in the fact that 7 of the 8 companies with the highest market capitalization are digital platforms (UNCTAD, 2019).

The objective of this article is to analyze information from scientific research with a technological focus on both the changes that are arising from a digital transformation driven by Industry 4.0 as well as to review the changes that the free trade agreement has undergone generating pressure in the VCs of the North American region.

This article is structured as follows, the introduction presents the context of digitalization leading to the Industry 4.0 environment, which triggers further optimization, which should generate value.

The second part delves into Industry 4.0 issues as well as VCs in the North American region driven by the Free Trade Agreement relations between Mexico, the United States and Canada (NAFTA). In the third part, an analysis was conducted to find the influence that these topics have on each other. The fourth part shows the methodology used for this article. Finally, the last section presents conclusions and recommendations for future research.

**Review of literature**

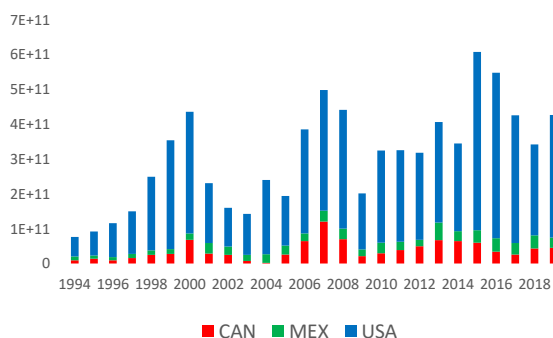
Hernández-Trillo (2018) commented that the entry into force of NAFTA in 1994 was positive for all parties, trade exchange soared, however Mexico increased its dependence, which it has not been able to assimilate through economic or technological strategies that are reflected in sustained growth, he mentioned that supply chains became more profitable and competitive in sectors such as automotive, electronics or aerospace, In this sense, the modernization of the United States, Mexico and Canada Agreement (USMCA) points to necessary modifications in the rules of origin, labor productivity, intellectual property and e-commerce aspects. He pointed out that the benefits of long-term trade policies lead to a better technological environment and concluded that in order to take advantage of the agreement, public policies must focus on promoting economic growth, reducing poverty and combating inequality.

Mexico policies should support more activities that foster innovation giving resources to research and development (R&D) in order to improve the capabilities to promote a technological environment that led the country to a competitive position through technology and less dependency on sectors, like energy. One example that the country has the capabilities to receive Foreign Direct Investment (FDI) and became a major container, is the automotive industry.

Ramírez Sánchez (2018) mentioned that NAFTA for Mexico meant the culmination of free trade and boosted spontaneous investment schemes in manufacturing or assembly sector mainly to re-export inputs with low level of national integration, they conducted a study making use of shared market analysis in the period from the years 1994 to 2014, they studied the possibility of being able to develop national supply, in addition to a statistical analysis of the economic impact related to Mexican exports in the region to see if they raise competitiveness, they concluded that due to factors such as Chinese products, the low level of integration of exportable products, dependence and economic vulnerability with the United States, perhaps in the short term there are advantages such as skilled labor, but in the long term the benefit of the treaty is questionable.

Casey (2016) mentioned both positive and negative effects of NAFTA for Mexico in terms of FDI, as it has significantly benefited its Gross Domestic Product (GDP), however it has made it both dependent and vulnerable to US economic fluctuations, they commented that investment by multinational corporations brings economic benefits, however, Mexico has not developed the optimal conditions to provide certainty for FDI in areas such as lack of infrastructure, protection of property rights, insecurity due to drug trafficking, human resources, productivity and few incentives for investment.

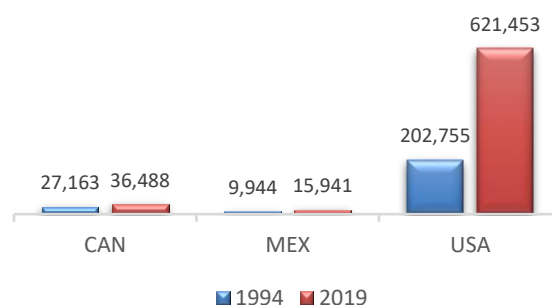
The next chart (Graphic 1) shows the behavior of the FDI since the trade agreement began, the investment grew in the three countries but the major investment went to the US.



**Graphic 1** FDI net inflow (BoP, usd billions) in North America, 1994 – 2019

Source: World Bank Data Indicators, 2021

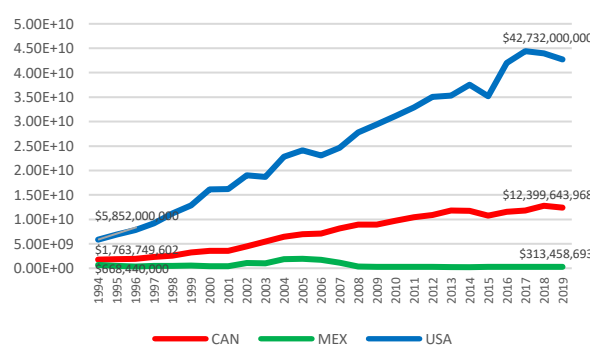
Also, the patents from residents and nonresidents of the North America region registered an increase of applications since the trade came into effect comparing the years 1994 vs. 2019 (Graphic 2), as well the US registered a greater result comparing with its partners.



**Graphic 2** Patents applications of residents & nonresidents (thousands) comparative years 1994 vs 2019, in North America

Source: World Bank Data Indicators, 2021.

As a result, the revenues of payment for the use of intellectual property and the exports of high technology significantly change since the year 1994 to present days (Graphic 3), nevertheless the gains for Mexican economy in this area have not improved in contrast to those numbers reported from the US or Canada.

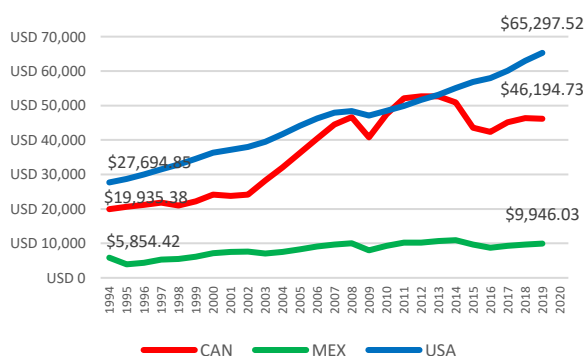


**Graphic 3** Payment for the use of intellectual property (Bop, usd billions) in North America, years period 1994 – 2019

Source: World Bank Data Indicators, 2021

Armas and Rodríguez (2017) mentioned that Mexico's participation in the NAFTA has resulted in greater FDI, apparently reflected in technological transfer as well as a more competitive economy although large differences remain such as per capita income, job creation, or increase in productivity, they conducted a study on the unintended technological benefits derived from FDI, they commented that in order to achieve a sustainable competitive advantage it is necessary to develop effective learning capabilities. They presented a model to see Mexico's technological capabilities by FDI or by the increase in exports, they found that FDI has not been able to close the technological gap with its trading partners in the region, they concluded that it is necessary to develop capabilities to assimilate foreign knowledge and technology.

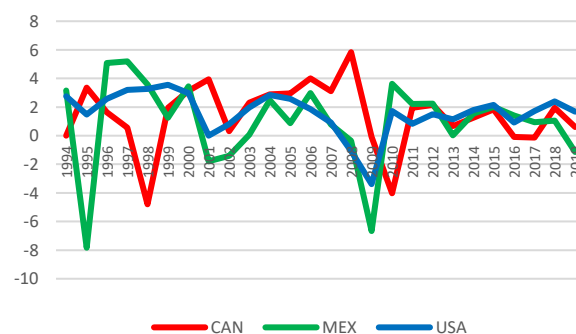
As can be observed the GDP per capita (fig. 4) improved since the NAFTA came into action, conversely the Mexican per capita income has not performed as good as its counterparts, like pointed the authors (Armas and Rodríguez, 2017) the lack of some capabilities like knowledge comprehension and technology transfer reflects one of the barriers to develop a better environment to push the Mexican income.



**Graphic 4** GDP per capita North America, 1994 – 2019  
Source: World Bank Data Indicators, 2021

Puyana (2020) commented that although Mexico's GDP has grown thanks to NAFTA, this has not been reflected in a better per capita income, but in a worrisome economic dependence of around 50% of Mexican GDP and 85% of its exports depend on trade with the US, while the US imports 13% of its total GDP from Mexico and Canada respectively, he pointed out that the modifications in the USMCA strengthen the US economy, consolidating its global hegemony, concluded that the negotiations of the treaty took place under a political climate introduced by the Trump administration of international realism focused on applying pressure to achieve its objectives through threats or sanctions, for Mexico the renegotiation facilitated the securing of a labor reform promoted by President López Obrador that was reflected in the increase of salaries as well as apparently providing certainty for investment.

According to the GDP growth chart (Graphic 5) the performance of the three economies is similar and shows the linkage between them, however Mexico GDP variation is more vulnerable when face crisis.



**Graphic 5** GDP growth (percentage variation) North America, 1994 - 2019, Source: World Bank Data Indicators, 2021.

## INDUSTRY 4.0

Buer et al. (2018) commented that the term Industry 4.0 (I4.0) is a term that was introduced at the Hannover Fair, Germany in 2011 by the German government that presented a project to raise the competitiveness of its manufacturing industry, where academia, government and industry participated. In their study they looked for the link between I4.0 and *lean manufacturing*, which share general objectives such as increasing productivity, flexibility and introducing new possibilities that point towards *smart manufacturing*.

LEZAMA-DE LA ROSA, Miguel & BARRON-VILLAVARDE, Diana. Review of literature in USMCA value chains on industry 4.0 environment. Journal of Technology and Innovation. 2021

They found that companies that already had lean systems in place have been pioneers in implementing I4.0 in their processes.

In the economic world, digital technology has increased enormously in all its facets unleashing changes by information and production disruption (IPD) such as technology accessible to all, the internet of things (IoT), Big Data, scalability in information technologies, open source, artificial intelligence (AI), additive manufacturing (3D Printing); altering patterns in global innovation, defined as the commercialization of knowledge fundamental for growth. IPDs are driving the evolution of the *Cluster* model, expanding its boundaries to a greater number of locations, experts and industries through *Digital Clusters* (Cowhey and Aronson, 2017).

Götz and Jankowska (2017) pointed out that global relationships are currently characterized by value chains, massive information flow, business investments with intellectual property nexus, as well as the combination of manufacturing with services. They conducted a study in Germany on the relationship between clusters and Industry 4.0, leading country on this topic, finding that will facilitate the *digital transformation* those who have ecosystems that promote industrial stimulation because intrinsic conditions are required to *Clusters* thanks to spatial concentration as mutual reliability, compatibility, close cooperation, shared standards which has prompted the reflection of traditional business models to develop new structures for the year 2025, six industrial sectors chemical, machinery, electricity, automotive manufacturing, agriculture, IT, will reach 78 billion euros with a government policy called *Go Clusters*.

Gerrikagoitia et al. (2019) commented that as a result of advances in digitalization, manufacturing systems must now deal with integrated processes, where all components are coordinated. They pointed out that digital manufacturing as well as digital factory are predecessor concepts to I4.0, which are mainly focused on *Product Lifecycle Management* (PLM).

They mentioned that the concept *cloud manufacturing*, refers to a model of advanced manufacturing in the cloud, which covers the entire life cycle of a product from design to maintenance preparing the way to digital manufacturing platforms. Such platforms have been promoted by the Public - Private partnership in Europe, with programs such as *Factories of the Future* (FoF). They conclude that the implementation and development of digital platforms requires planning with incremental mapping to ecosystems that enable digital transformation.

Čámská and Klečka (2020) reported that one of the positive effects of Industry 4.0 in the VCs is reflected in flexibility, reduction of documentation, availability of information, cost savings, traceability, as well as reduction of incorrect deliveries, opening a way to *logistics 4.0*, because the activities of manufacturing, trade and logistics are interconnected in the process of distributing goods or services to the final customer. In their study they reviewed the investments in technology made by large and also small companies, dedicated to transportation and warehousing, from a financial point of view, considering their sales behavior, labor costs, depreciation of assets, finding that investing in technological assets will give better results in profits than keeping workers.

Partham and Tamminga (2018) conducted a study focused on the logistics sector to see the impact of I4.0, integrated by components including artificial intelligence through Big-Data, Cyber-Physical Systems (CPS), IoT, Internet of Services (IoS) as well as *Smart Manufacturing* all with applications in a wide variety of businesses marking a technological trend towards *business process management* (BPM) with circular economies, competitive advantage through innovation or strategic management through efficiency, These changes will have an impact on the labor market, they pointed out that there will be an important influence on personnel management, where it will be necessary to prepare employees in the new technological context, they also found that the combination of machines with humans is a better answer for logistics systems both in flexibility and costs.

### Value chains

Rhemann (2017) indicated that the future cannot be predicted, however, in the age of information many events can be predicted, thanks to the union between information and artificial intelligence. He pointed out that both are forcing the value proposition, reducing reasoning time, eroding technology life cycles, giving way to shorter cycles, shortening the acquisition of knowledge for decision making process. Porter's VC, which has traditionally been used in organizations to understand how activities contribute to generate value, has been under attack by global forces, such as consumers moving towards electronic marketplaces, breaking the traditional VC model, as an example is the case of the Amazon era, achieving *Fulfillment* of customer needs through new business model.

Beach (2019) mentioned that since GVCs took off worldwide in the early 1990s, more than one billion people had an increase in their income exceeding \$1.90 dollars a day to overcome the extreme poverty line. In China 66% of the population was below this income in the 1990s, 20 years later by 2010 only 11.2% of the population remains below, with similar results in India, Indonesia, Southeast Asia, Eastern Europe. This improvement was thanks to the GVCs relocating production plants from G7 countries, driven by factors such as labor costs, cost of components, as well as the interest in entering emerging markets. He indicated that we are facing a global transformation of labor and production where artificial intelligence combine with machine learning will improve productivity.

Choi (2020) mentioned that VCs vary from product and industry, in recent decades communication technologies has facilitated their expansion, he presented a study on East Asia in which rename the value chain, by calling her at *Chimerica* (combination China and America), he said that China has been benefited by globalization, information of technologies as well as the World Trade Organization (WTO) system allowing them greater access to the largest economies in the world under the most favored nation precept.

However, a new environment is emerging, which he called the *New Normal*, referring to the fact that many unconventional things can happen under the pressure of significant changes driven by a trade war with the United States, which is halting its expansion not only in the purchase of goods but also in the acquisition of technology companies. Dávalos (2020) said that world trade drives the exchange of goods through VCs, in this sense the integration of Mexico in NAFTA originated its insertion in regional VCs mainly to the automotive sector, generating a growth above the national average in the manufacturing sector, it went from thirteenth place in the year 1995 to sixth in the year 2018 as a world producer of automobiles. He pointed out that the modifications in the rules of origin section are the opposite of free trade, which was eliminated from the name of the agreement and points towards the protectionism promoted during the Trump administration, however as a consequence of the trade war with China, there will be opportunities for both Mexico and Canada to counteract the dependence of Chinese products in the region, he concluded that one of the challenges will be the fourth industrial revolution that through technology will transform productive processes towards intelligent processes that should implies substantial changes in the regional value chains.

Yuan (2019) presented a study on construction mechanisms for the development of an algorithm in cross-border e-commerce based on intelligent logistics through artificial intelligence from the point of view of VCs, due to high transportation costs as well as low efficiency, indicated that the construction of intelligent logistics systems are key to improve it, proposed the application of neural networks with back propagation for the selection of logistics distribution centers, he proposed the application of neural networks with back propagation for the selection of logistics distribution centers, using the swarm optimization particle in conjunction with the ant colony algorithm forming a hybrid model to optimize processes, also for the decision making model in the selection of transport he used the Electre-II algorithm with the perspective of VC, he concluded that there is a great complexity of factors that make it difficult to perform accurate analysis due to constant changes, affecting decision making process and increasing logistics costs.

**USMCA value chains on industry 4.0 environment**

Hitpass and Astudillo (2019) mentioned that there is a transition process towards digital transformation, which affects the ecosystem, resulting in the integration of information technologies with the VCs. They presented a study on the impact of I4.0 in relation to BPM and *e-commerce*, finding that it will generate changes such as the autonomy of the VCs, intelligence in the decision process, the integration of external agents with the VC, as well as business transactions. They also commented that another challenge will be to integrate VC with monitoring processes such as real-time performance indicators, reflecting strategic objectives because the control processes and the analytics are handled independently.

Labonté et al. (2020) commented that there was some opposition at the signing of the USMCA on issues such as drug prices, labor and environment due to the lack of compliance, they conducted a study focused on the protocols that were eliminated or made more flexible such as intellectual property rights within the agreement (TRIPS), compliance with labor provisions where Mexico put up some resistance due to its sovereignty and also created a rapid response mechanism in case of violation or abuse for workers. Finally, the language on multilateral environmental agreements was improved, pointing out that non-compliance is a way to affect investments between the parties involved. They conclude that although the changes were an advance, it is still necessary to refine how the new agreement will create substantial and compliance measures that will affect public policies in the future

Beaulie and Klemen (2020) mentioned that NAFTA generates economic benefits in addition to providing certainty for investments, they presented the term CUSMA instead of the original name trying to give an approach seen by Canada which depends largely on the energy sector, they commented that former President Trump originated a climate of uncertainty by taking actions against all its trading partners including Mexico and Canada, they pointed out that this new agreement was more from a perspective of revision to the rules of origin mainly for the automotive sector as well as revisions to labor, environmental.

Intellectual property protection issues, some provisions to e-commerce, elimination of tariffs for steel and aluminum, they concluded that the new agreement has not transformative nature, however it was crucial its signature to resolve the uncertainty generated by the negotiations.

The automotive and autoparts industry have positioned as one of the most dynamic and competitive industries worldwide being one of the driven forces behind the FDI, in Mexico has been consolidated thanks to free trade agreements, skilled labor, low production cost and strategic location becoming an export platform, extended in several clusters through the country thanks to original equipment manufacturers (OEMs) and their suppliers (Tier 1,2,3) improving the social and business environment, encouraging more investment where the success has been tested. (Carbajal y Torres, 2021)

In this regard, expansion of the automotive industry in Mexico responds to a direct strategy of the VCs generating vertical integration, taking advantage of the proximity with the US market, nowadays the requirements of the USMCA pushed to a reduction in imports on the region, looking for the production of parts and components that comply with the rules of origin, moreover the labor value content requirement could reduce competitiveness forcing Mexico to pay better wages (Mendoza, 2021).

Esparza Rodríguez et al. (2021) commented that the chapter 25 of the USMCA recognizes the role of Small and Medium Enterprises (SMEs) in maintaining trade dynamism and competitiveness, although for Mexico the problem remain in different topics like productivity, funding, lack of public safety, informal business, low demand on products of services, lack of skilled human resources, they made a study related to regionals contingency on the organizations due to Covid-19, they found that manufacturing sector implemented action to counteract driven by external influence, they conclude that the SMEs required a multivariate regional strategy.

Nava-Aguirre (2021) commented that within the framework of the T-MEC negotiations, the automotive industry was a sensitive issue due to the degree of integration of supply chains; for Mexico it is one of the manufacturing sectors that contributes the most to GDP with 20.8 percent and 89 percent of its production is destined for exports; conducted qualitative research with the application of surveys to participants from the public, private and academic sectors, and some of the participants from the *Next Room*, Mexican mechanism to listen the private sector, founded that in support of this mechanism, were created a communication and intelligence rooms to provide accurate and strategic information and also give continuity to NAFTA operation. concluded that the participation of the private sector was of great importance, reaching consensus to benefit supply chains, favoring supply and investment opportunities.

García and Echeverría (2019) pointed out that the modifications resulting from the USMCA included the review every six years of the agreement, in case of cancellation by one of the parties, it will be effective ten years later; dispute settlement was negotiated bilaterally for specific sectors such as the automotive sector where the Regional Value Content (RVC) will be gradually increased from 62.5 percent to reach 75 percent in a period of 5 years; the chapter on subsidies and antidumping was kept intact as well as the State - State disputes, while there were increased *de Minimis* shipments value levels (the maximum value of a good that can enter a country without paying taxes) going from 50 to 117 dollars, such measure with the objective of boosting electronic commerce, also included wages issues, labor rights, currency manipulation, agreements with China, cargo transportation. In addition, they commented that companies, mainly automotive companies, will have to review their strategies regarding possible increases in production costs that could be reflected in final prices.

Rosas (2020) indicated that copyright as a trademark, both for products and services, helps consumers to identify goods with a certain essence and quality, conducted a comparative study between NAFTA and USMCA, found that under the new agreement not only modernized but also strengthened intellectual property, which is an engine to drive innovation, generate economic growth and employment.

Changes included national treatment for copyrights or related rights, better practices in patent offices to strengthen the protection of innovative inventions, copyrights for up to 70 years, increased standards in the protection of digital content as well as procedural safeguards for the recognition of new geographical indications (appellation of origin). The scope of trademark protection for intangible terms such as sounds was also improved; however, the definition of trademark is not described as it was in the case of NAFTA.

Kordoš (2019) conducted a study on the US trade policy agenda and its relationship with the implementation of I4.0, which could strengthen its competitiveness, as well as modify its strategy in relation to international trade, due to its importance for the global economy. He pointed out that there is evidence that both trade and digitalization have brought benefits to consumers by facilitating access to goods and services, he found that there are great opportunities in the next 15 years for US exports mainly to emerging economies where there will be a growing middle class and the way to stay competitive is through technological innovation through *Smart Manufacturing* that allows costs reduction and increase of productivity.

Rutherford and Frangi (2020) conducted a study in Canada on the role of unions in the adoption of High Performance Work Systems (HPWS) developed since the late 1980s, which involve *hard technologies* such as computer support in design or manufacturing, as well as *soft technologies* such as quality analysis to improve productivity, they observed that automation is increasing, however both countries and manufacturers disagree on the adoption of I4.0. Some believed that by focusing on technology, the environment will be less inclusive, although at present economies are more interconnected through global production networks, so the specific strategies of each company in GVCs will depend on the public policies and also what labor unions negotiate with companies and governments.



**Materials and methods**

Information was collected using databases such as Ebsco, Scopus, Web of Science, Applied Science and Technology Source. The analysis of the topics that were directly related to the proposed study on USMCA Value Chains on Industry 4.0 Environment was carried out, searching for works related to this topic focused on the North American region. Likewise, for the filtering of relevant information, different Boolean combinations AND, OR and truncation \*, ? were applied in order to obtain more specific information.

The search for such articles was conducted in the period years from 2016 to 2021, collecting 46 articles of which 27 were used to make this article, with the following keyword combinations such as: Industry 4.0, GVCs, Strategy, USMCA, Competitiveness.

Author/ Authors	Topic	Concept	Contribution
Hitpass y Astudillo (2019)	New ecosystems (I4.0 + VCs)	Transition towards digital transformation (BPM and e-commerce)	Value Chain Automation
Labonté et al. (2020)	Non-Compliance	Flexibility of Trade-Related Intellectual Property Rights	Impact on future public policies
Beaulie and Klemen (2020)	Economic benefit and investment certainty	CUSMA	The agreement not has a transformative nature
Nava-Aguirre (2021)	Importance of stakeholders	Next Room Mechanism ( <i>Cuarto de Junto</i> )	Reaching agreements with the private sector
García y Echeverría (2019)	Relevant USMCA Modifications	Minimal boost to e-commerce	Review strategies for possible cost increases
Rosas (2020)	Trademarks and Copyrights	Strengthening protection on Innovative Inventions	Best Practices in Patent Office
Kordoš (2019)	Trade and digitization for the benefit of customers	Industry 4.0-focused trade policy could boost competitiveness	Export opportunities from the U.S. to emerging economies over the next 15 years
Rutherford and Frangi (2020)	Unions vs Industry 4.0	high performance work systems	Specific strategies vs. Global Value Chains
Yuan (2019)	Artificial Intelligence for Decision Making Process	Intelligent Logistics	Complexity of constantly changing decision-making factors
Esparza Rodríguez et al. (2021)	Contingency response	Counter measures actions	Multivariate regional strategy

**Table 1** Chart of references on contributions of USMCA value chains on Industry 4.0 environment  
 Source: elaborated with proper information from the cited authors.

**Conclusions and recommendations**

The present research found that both the renewal of the USMCA agreement and the technological changes driven by Industry 4.0 contribute to a more competitive environment for the different actors putting pressure on value chains in the North American region.

The digital transformation driven by Industry 4.0 is inevitable; countries must join through effective public policies that allow for a gradual implementation in different production and logistics processes. One of the sectors that will benefit the most from investment due to conditions such as labor, as well as the proximity to the US is the manufacturing sector, especially the automotive and auto parts industry, which in recent years have been among the largest recipients of foreign direct investment, but are also the sectors where the implementation of digitization through intelligent systems is booming, however the knowledge of process in the supply chain activities is vital to achieve this.

Nevertheless, the automotive industry in Mexico has not an impact on other productive sectors in terms of technology transfer. Unlike the US or Canada, which have more consolidated sectors, being developed economies with technological development capabilities, they are even pioneers in several topics that make up Industry 4.0, better known as *smart manufacturing* in the region, while Mexico does not stand out in the generation of technology, but as a receiver of machinery and line production from other countries bringing the equipment from multinational companies, an aspect in which the USMCA has benefited the country in terms of investment but not improving research and development.

Efforts should be focused on promoting plans and policies that facilitate the implementation of technology along global or regional value chains, as has been done by leading countries in the area of Industry 4.0, following up on long-term projects, working together with companies and society to create an environment conducive to a technological development that fosters a competitive environment.

For this reason, government policies must be aligned not only with the attraction of investments but also with policies that on the one hand promote collaboration with its commercial partners to achieve technology transfer and on the other hand develop capabilities for the technological and knowledge assimilation from different sources, generation the collaboration between companies and universities. In addition to fostering better conditions it is necessary through government investment the creation and improvement of infrastructure and services in order to attract more investment that will trigger technology transfer and strength the intellectual property protection.

The aim of this research is to show that the USMCA framework should help the regional economy and the different public and private actors should take advantage in order to achieve regional development, as well as to increase competitiveness in the value chains.

The constraints were not very material with a technological sense of value chains directed toward USMCA as the central theme.

It is recommended for future research to investigate deeper into specific sectors, in addition to understand the digital transformation and the impact driven by Industry 4.0 on Value Chains in the North American region.

### **Conflict of interest**

The authors declare that does not exist conflict of interest.

### **References**

OECD (2019), Trade in the Digital Era, OECD Going Digital Policy Note, OECD, Paris, [www.oecd.org/going-digital/trade-in-the-digital-era.pdf](http://www.oecd.org/going-digital/trade-in-the-digital-era.pdf).

WEF (2017) Impact of the Fourth Industrial Revolution on Supply Chains, World Economic Forum, October 2017.

UNCTAD, Digital Economy Report 2019 (2019)., Digital Economy Report 2019, Value Creation and Capture: Implications for Developing Countries, United Nations Publications. NY, USA

Hernandez-Trillo, F., (2018) Mexico, NAFTA and beyond, The international trade journal, Vol. 32, No. 1, 5-20, <https://doi.org/10.1080/08853908.2017.1387622>

Ramírez Sánchez, J.C., Calderón, C., & Sánchez León, S. (2018) Is NAFTA really advantageous for Mexico? The International Trade Journal, Vol. 32, No. 1, 21-42, <https://doi.org/10.1080/08853908.2017.1387623>

Casey, W.L., (2016) The Effect of NAFTA on Foreign Direct Investment flows and economic development in México, International Journal of Business and Economics Perspectives, Volume 11, Number 1, Spring 2016.

Armas, E. & Rodríguez, J.C., (2017) Foreign direct investment and technology spillovers in Mexico: 20 years of NAFTA, Journal of Technology management & Innovation, Universidad Alberto Hurtado 2017, Vol. 12, Issue 3, Facultad de Economía y Negocios, ISSN: 0718-2723

Puyana, A. (2020) From the NAFTA to the USMCA. A new chapter of the Mexico-United States integration? El Trimestre Económico, vol. 87 (3), núm. 347, julio-septiembre 2020, pp. 635-668, <https://doi:10.20430/ete.v87i347.1086>  
World Bank (2021) Data Indicators, World Bank <https://data.worldbank.org/indicator>

Buer, S.V., Strandhagen, J.O. & Chan, F.T.S., (2018) The link between Industry 4.0 and lean manufacturing: mapping current research and establishing a research agenda, International Journal of Production Research, Taylor & Francis Group, Vol. 56, No. 8, 2924-2940, <https://doi.org/10.1080/00207543.2018.1442945>

Cowhey P. F & Aronson J. D. (2017). Digital Trade and Regulation in an Age of Disruption, UCLA Journal of International Law & Foreign Affairs, [https://gps.ucsd.edu/\\_files/faculty/cowhey/cowhey\\_publication\\_112018.pdf](https://gps.ucsd.edu/_files/faculty/cowhey/cowhey_publication_112018.pdf).

Götz, M. & Jankowska, B. (2017) Clusters and Industry 4.0 – do they fit together? European Planning Studies, Vol. 25, No. 9, 1633-1653, <https://doi.org/10.1080/09654313.2017.1327037>

LEZAMA-DE LA ROSA, Miguel & BARRON-VILLAVARDE, Diana. Review of literature in USMCA value chains on industry 4.0 environment. Journal of Technology and Innovation. 2021

- Gerrikagoitia, J.K. Unamuno, G., Urika, E. & Serna, A., (2019) Digital Manufacturing Platforms in the Industry 4.0 from private and public perspective, MPDI, <https://doi:10.3390/app9142934>
- Čámská D. & Klečka J. (2020) Cost Development in Logistics due to Industry 4.0, *LogForum*, 16(2), 219-227, e-ISSN 1734-459x, <http://doi.org/10.17270/J.LOG.2020.415>
- Parham, S., & Tamminga, H.J. (2018) The adaptation of the logistic industry to the fourth industrial revolution: The role of Human Resource Management, *Journal of Business Management & Social Research*, Vol. 6, No. 9, September 2018, ISSN No. 2319-5614
- Rhemann, M.K. (2017) A Futurist Revisit to the "Value Chain", *Journal of Futures Studies*, March 2017, 21(3): 25-34. [http://dx.doi.org/10.6531/JFS.2017.21\(3\).A25](http://dx.doi.org/10.6531/JFS.2017.21(3).A25)
- Beach, W.W. (2019) Productivity in the Global Value Chain World, *Atlantic Economic Journal*, 2019, vol. 47, issue 4, No. 1, 388 pages., <https://doi.org/10.1007/s11293-019-09641-6>
- Choi, B. (2020) Global Value Chain in East Asia under "New Normal" Ideology-Technology-Institution Nexus East sian Economic Review vol. 24, No. 1 (March 2020) 3-30, <http://dx.doi.org/10.11644/KIEP.EAER.2020.24.1.370>
- Dávalos, E. (2020) Protectionism, USMCA and its Possible Effects on Mexico's Automotive Industry, *European Review of International Studies*, Vol. 7, pp.81-104, doi:10.1163/21967415-bja10016
- Yuan, Q. (2019) The construction mechanism and algorithm of cross border E-commerce export logistics mode from the perspective of value chain, *Journal of Intelligent & Fuzzy Systems* 37 (2019) 3393-3400, Department of Finance and Economics, Shandong University of Science and Technology, Jinan, China, doi:10.3233/JIFS-179142
- Hitpass, B. & Astudillo, H. (2019) Industry 4.0 Challenges for business Process Management and Electronic-Commerce, *Industry 4. Journal of Theoretical and Applied Electronic Commerce Research*, Universidad de Talca, Chile, Vol. 14, Issue 1, January 2019, <https://doi.org/10.4067/s0718-18762019000100101>
- Labonté, R., Gleeson, D., and McNamara, C.L., (2020) USMCA 2.0: a few improvements but far from a healthy trade treaty, *Globalization and Health*, <https://doi.org/10.1186/s12992-020-00565-4>
- Beaulie, E. & Klemen, D., (2020) You say USMCA or T-MEC and i say CUSMA: The new NAFTA let's calle the whole thing on, *The School of Public Policy Publications*, University of Calgary, Vol. 13:7, April 2020, <http://dx.doi.org/10.11575/sppp.v13i0.70040>
- Carbajal, S. Y., & Torres, P.V.H., (2021) Economías de especialización y diversificación regional en la localización de la inversión extranjera en México en el sector automotriz [Economies of specialization and regional diversification in the location of foreign investment in Mexico in the automotive sector], *Actividad Económica en México, Un análisis sectorial* (primera edición, Cap. IV, pp. 81-105) Universidad Autónoma del Estado de México, Ediciones y Gráficos Eón, ISBN 978-607-633-255-9.
- Mendoza, C. J. E., (2021) La industria automotriz mexicana en el marco del tratado Estados Unidos, México y Canadá [The Mexican automotive industry within the framework of the USMCA treaty], *Actividad Económica en México, Un análisis sectorial* (primera edición, Cap. V, pp. 107-122) Universidad Autónoma del Estado de México, Ediciones y Gráficos Eón, ISBN 978-607-633-255-9.
- Esparza Rodríguez, S. A., Martínez-Arroyo, J. A., Guerrero Dávalos, C., & Esquivel Fernández, E. (2021). Contingencias empresariales y regionales en la gestión de Mipymes manufactureras mexicanas de alimentos y bebidas. *Acta Universitaria* 31, e3179. doi: <http://doi.org/10.15174.au.2021.3179>

Nava-Aguirre, K., M., (2021) La colaboración del sector privado en la renegociación del Tratado de Libre Comercio de América del Norte. Análisis de la industria automotriz Mexicana [The collaboration of the private sector in the renegotiation of the North American Free Trade Agreement. Analysis of the Mexican automotive industry], Universidad de Monterrey, Escuela de Negocios, Departamento de Economía, doi.org/10.29059/cienciauat.v15i2.1427

García G. E. & Echeverría, L.J.L., (2019) USMCA: una nueva aproximación al nuevo NAFTA [USMCA: A New Approach to the New NAFTA], Boletín Económico del ICE, abril 2019, <https://doi.org/10.32796/bice.2019.3110.6782>

Rosas, R. (2020) A comparative study of trademark: USMCA (U.S.-Mexico and Canada) and NAFTA (North America Free Trade Agreement), Boston University International Law Journal, Vol. 38:1, spring 2020.

Kordoš, M., (2019) The synergies of USA foreign trade policy agenda challenges within industry 4.0, Journal of Interdisciplinary Research

Rutherford, T.D., & Frangi, L. (2020) Is industry 4.0 a Good fit for High Performance Work System, Trade Unions and Workplace change in the Southern Ontario Automotive Assembly Sector, Industrial Relations