Mapping the Potential Supply Chain Impressions of the COVID-19 (SARS-CoV-2) Pandemic on Artificial Intelligence and Big Data Analytics: A Sustainability Framework and Programmatic Research Review With Deep Learning Approaches

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This body of knowledge focuses on the impacts that Covid-19 has had on Artificial Intelligence and Big Data Analytics of global organizations and their supply chains or logistics mechanisms through deep learning approaches (Queiroz et al., 2020). The authors of the current study detail it out to define Artificial Intelligence and Big Data Analytics to help further understand and quantify the impact that the Covid-19 pandemic has had on broken supply chains and small businesses (Naude, 2020; Vaishya et al., 2020). Going into further discussion on how the after-effects changed technologies and data analytics for companies, we also point out that organizations require the support of innovation technologies like Artificial Intelligence (AI), Internet of Things (IoT), Big Data and Machine Learning (Moosavi, Fathollahi-Fard, & Dulebenets, 2022) to fight and anticipate against new infections (Queiroz, et al., 2020). The study concludes that COVID-19 has not only devastated the critical thinking, innovation, and sustainability capabilities of scientific organizations but has also deteriorated the in-root causes of future successes of brilliant and extraordinary minds (Jamshidi et al., 2020).

Keywords: artificial intelligence, big data analytics, Covid-19, SARS-CoV-2 virus, supply chains, deep learning, internet of things, machine learning, entrepreneurship, learning, reinforcements, business success, innovation, sustainability

OVERVIEW AND INTRODUCTION

Artificial intelligence, big data analytics, and televised or social media have a very powerful and important role in of our daily lives, not only personally but also in business predictions and decisions (Lalmuanawma, Hussain, & Chhakchhuak, 2020). So much of our world revolves around business ethics and technology, such as entertainment, social media, work ethics from business meetings to ethical transactions, to connecting with family and friends (Jhamb, Stephenson, & Bibelhauser, 2021). As technologies such as Artificial intelligence and Big Data have advanced over the years, they also have been implemented more and more into the business world (Naude, 2020; Pham, Nguyen, Huynh-The, Hwang, & Pathirana, 2020). There is and was a certain standard of use and how these technologies had functioned,

but with the COVID-19 pandemic impacting the world, there was changes with AI and Big Data with function and usage. This study will dissect what Artificial intelligence and Big Data is, as well as what uses there are for these technologies in the business world and how COVID-19 has impacted the technologies and uses (Moosavi, Fathollahi-Fard, & Dulebenets, 2022).

What are AI, big data analytics, and digital technologies? Starting with AI, short for Artificial Intelligence, a phrase that was coined 1956 at the conference in Dartmouth. This term was not describing an item or technology because it was still the 50's. Technology was not nearly as advanced enough to have the AI now (Naude, 2020; Queiroz, Ivanov, Dolgui, & Fosso Wamba, 2020; Vaishya et al., 2020). But the term was describing an idea that was robots would eventually be able to help humans with tedious tasks like cooking, laundry, yardwork. That was the hopes at least. Fast forward to present day, AI is completing tedious tasks for humans', but they are not done around the house simply. The tasks are performed by scanning and using previous patterns from massive amounts of data to predict future trends or solutions. It is a software that is always learning and teaching itself as it digests more data.

AI is responsible for the speed in which our society has advanced so quickly, by eliminating the need for humans to complete complicated and tedious tasks. It gives time which would have been spent on that put towards other tasks that need human interaction. It is a prime example of the classic phrase "work smarter not harder" (Jhamb, Stephenson, & Bibelhauser, 2021; Moosavi, Fathollahi-Fard, & Dulebenets, 2022).

Ever since the industrial revolution, there happened a vast development in the field of technology. Many hard manual works had been replaced by technology, which helps humankind a lot. Artificial Intelligence (AI) is one of the technological innovations that happened, to replace the manual work that is done by human in various fields. Artificial Intelligence is a branch of science and technology that creates intelligent machines and computer programs to perform various tasks which requires human intelligence (Jamshidi et al., 2020; Vaishya et al., 2020). It is a system that mimic various functions which a human can do. AI uses external data like the big data in order to achieve excellent performance for the given tasks. Today, AI is so advanced that it is now teaching itself, it is always adapting to learn more information in order to have better and more accurate predictions and or solutions to problems. One of the million dollar questions to ask scientists is how does a software teach itself and learn from itself? (Moosavi, Fathollahi-Fard, & Dulebenets, 2022).

REVIEW OF LITERATURE

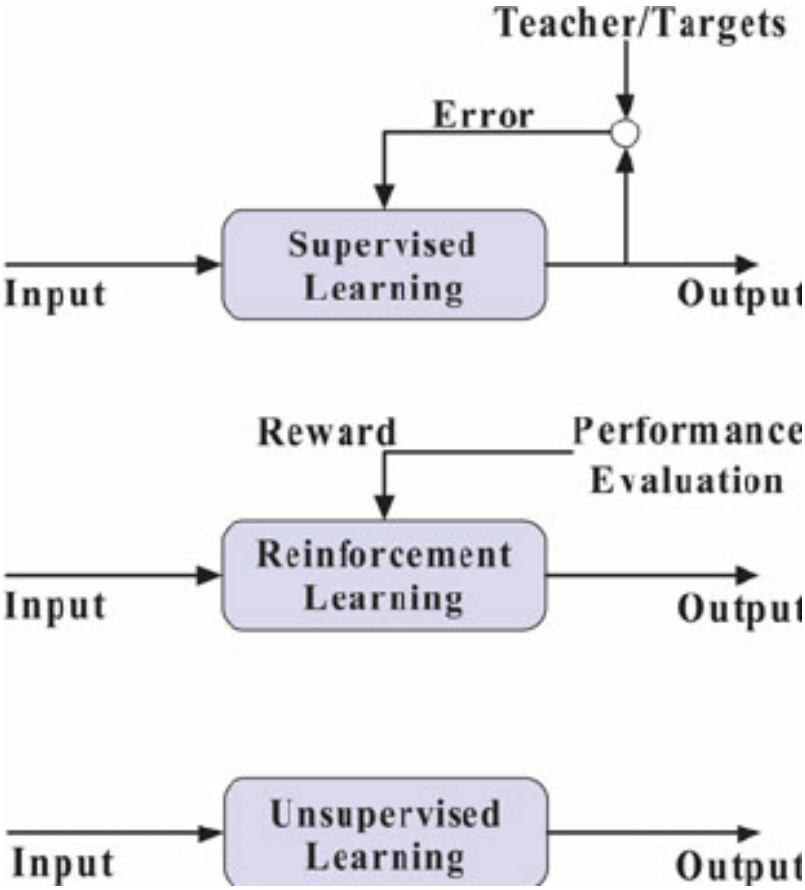
Deep Learning and Machine Learning: Who Does What?

There are three different types of Machine learning: supervised learning, unsupervised learning, and reinforcement learning. Unsupervised learning is where a software will use an algorithm to find a desired outcome. There is no human interaction, and the more the software runs typically the more accurate of an output there will be (Lalmuanawma, Hussain, & Chhakchhuak, 2020). For example, how would we be able to see this in the world around us? This could be used on a shoe store website to help find the best shoe for a customer depending on what they are looking for. There could be a series of questions ranging from what is your price range? How important is comfort? Do you want good ankle support? And what activity will you be doing in these shoes. The software would be able to use all that data and compare it to the online survey ratings (Onguslee, 2017; Pham, Nguyen, Huynh-The, Hwang, & Pathirana, 2020) that there are for all shoes on the market and suggest the top 3 recommended shoes for that customer.

Supervised learning is very similar to unsupervised learning. The only exception is that there is no human interaction. Supervised learning is the same basic algorithm except there is the ability for humans to edit or determine rather or not the outcome is expectable (Dimiduk, Holm, & Niezgoda, 2018; Pham, Nguyen, Huynh-The, Hwang, & Pathirana, 2020). An example of this would be just one step further on the previously noted shoe store example. When the customer was recommended a few shoes, there could be a kiosk inside of the store that offered the same questions and recommendations. But there would be a person on deck who was able to take those recommendations and get even more specific or creative, by manipulating adding or subtracting questions, to alter the final recommendations.

Reinforcement learning is taking data to help predict future trends, which is done by using trial and error with human feedback to know rather or not the outputs its creating is helpful or not (Jamshidi et al., 2020; Pham, Nguyen, Huynh-The, Hwang, & Pathirana, 2020). Whether the output that was generated by the AI was valuable or useful or not, it gets rewarded and is now going to look to formulate similar algorithms that were just successful. Because you can't give a computer a cookie as a reward, so when the AI gets "rewarded" it's just giving a higher value to the output that was just created. The main area we see this with is in the medical field (Naude, 2020; Vaishya et al., 2020), reinforcement learning AI is used to help predict a future illness and or help get a more accurate visual of what a medical diagnosis will look like down the road. Here is a visual representation to these three types of learning functions.

FIGURE 1
BASIC STRUCTURES OF THE THREE LEARNING PARADIGMS: SUPERVISED LEARNING, REINFORCEMENT LEARNING, AND UNSUPERVISED LEARNING



Adapted from Chavoalitwongse, W. (2012). Retrieved February 23, 2022, from https://www.researchgate.net/figure/Basic-structures-of-the-three-learning-paradigms-supervised-learning-reinforcement_fig1_260652455

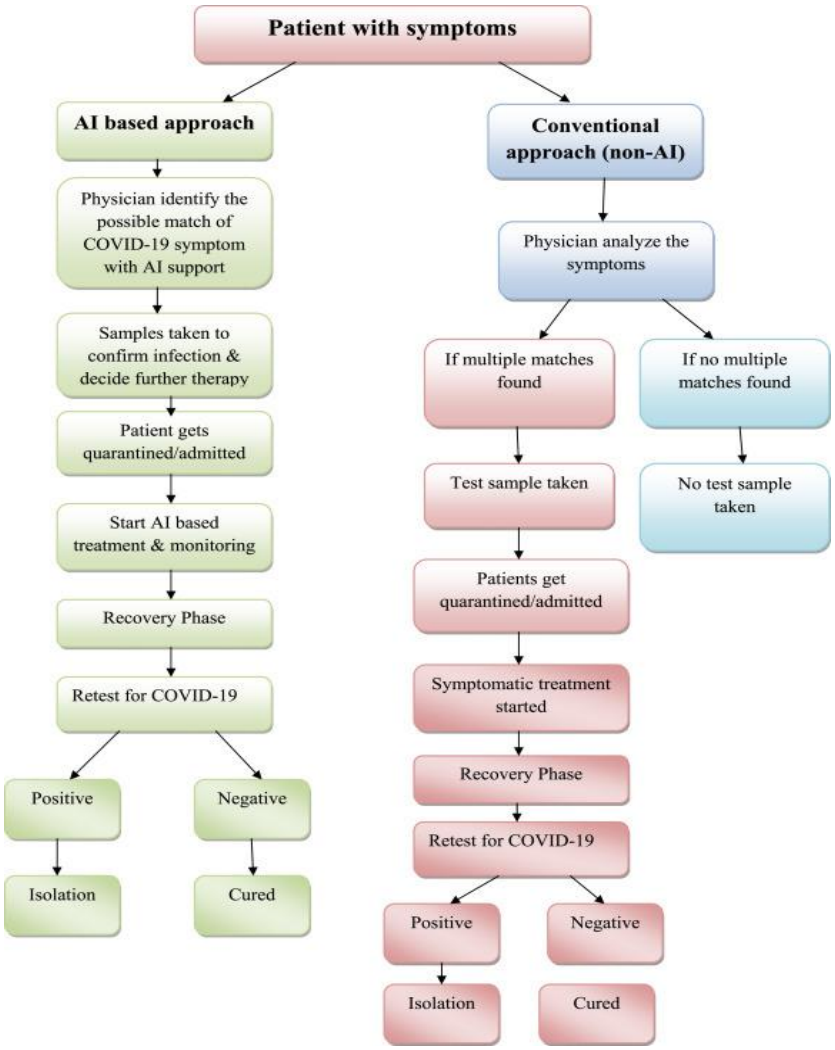
Big Data Analytics and Business Process Improvement/Management

Big data analytics is the process of obtaining, storing, organizing, and using large amounts of data, rather than those that are numbers, measurements, etc. But Big Data Analytics is best described by the Office of Research Integrity as "Data Analysis is the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data (Pham, Nguyen, Huynh-The, Hwang, & Pathirana, 2020; Vaishya et al., 2020). According to Shamoo and Resnik (2009), various analytic procedures "provide a way of drawing inductive inferences from data and distinguishing the signal (the phenomenon of interest) from the noise (statistical fluctuations) present in the data (ORI, 2021)." Big

Data and AI go hand in hand with the ability to use numbers and values at a large volume and be able to organize and sort through it (Pham, Nguyen, Huynh-The, Hwang, & Pathirana, 2020; Surya, 2015). AI needs a large amount of data to be able to use in order to produce an output or solution. As does Big Data need something to be able to harness and use all of the pointless amounts of numbers and values that are sitting idle.

How do organizations use AI and Big Data? Most all organizations use these two technologies, we are aware but sometimes we don't notice (Shamoo & Resnik, 2009). An example would be Fred Meyers (a big box store retailer in Alaska and other northwest pacific states) and the deals you get a checkout for putting your phone number in. There are millions of members at Fred Meyer and entering your number it can find your account and give discounts, email you recommended products that are tailored to what trends of products you buy. In the medical field, this combination of AI and Big Data is used all the time, and especially for COVID-19, AI and Big Data (Surya, 2015) was used throughout the entirety of trying to figure out the pandemic from the start to its current point, even when diagnosing patients. Here is a graph representing that process.

FIGURE 2
ARTIFICIAL INTELLIGENCE (AI) APPLICATIONS FOR COVID-19 PANDEMIC

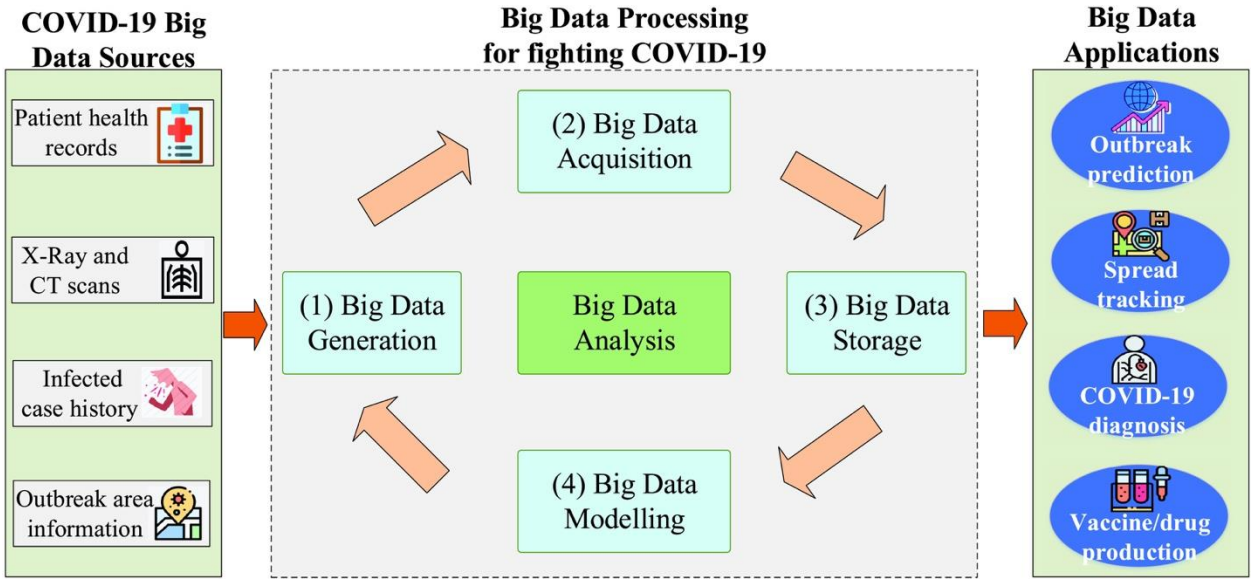


Adapted from Vaishya, R., Javaid, M., Khan, I. H., & Haleem, A. (2020). *Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 14*(4), 337-339.

The development and usage of Big Data and AI in business came from when business itself in general had reached a point of advancement where physically they had been performing at one of the highest levels. So, businesses asked themselves how else they could improve. That's when the usage of Big Data was discovered, there was all this information about how much of a certain product was bought and how many of certain products were expired on the shelves. Data on busy times of work vs slower times at work, and data on demographics of the customers were brought into the grand picture and the grand scheme of things (Pham et al., 2020; Shamoo & Resnik, 2009). Questions were then raised on how businesses could use this data to benefit from?

COVID-19 has impacted the world in almost every facet of life, and that's not excluding AI and Big Data. Three central ways that COVID-19 has impacted Big Data and AI is through tracking, economy, and overall trends (Jamshidi et al., 2020; Ongsulee, 2017). There are endless ways in which COVID had impacts on these two technologies from a bunch of examples (Queiroz, Ivanov, Dolgui, & Fosso Wamba, 2020). At the start of the Pandemic, there was major confusion on what this disease was, how contagious it was, and even how deadly it was. People scared to leave the house, the country going into mandatory lockdown, people terrified to the nature of the unknown of the disease! As more and more research was done, they realized that one of the best ways to help slow the spread was to contact those who may have been close contacts to the COVID positive patient. The medical industry used Big Data and AI to contact possible exposed individuals. Here is an image that shows the use of Big Data and the case tracking that helped slow the spread of COVID (Hwang, 2020).

FIGURE 3
ARTIFICIAL INTELLIGENCE (AI) AND BIG DATA FOR CORONAVIRUS (COVID-19) PANDEMIC: A SURVEY ON THE STATE-OF-THE-ARTS



Adapted from Pham, Q. V., Nguyen, D. C., Huynh-The, T., Hwang, W. J., & Pathirana, P. N. (2020). *IEEE Access*, *8*, 130820.

Impact on Global Supply Chains – Pitfalls, Challenges, Constraints, and Limitations

The overall economy, not just the United States, but globally took a hit. Trades and transactions were slowed to a halt until a process for being able to transport goods was deemed safe for COVID. Where the trend of most all business has slowly moved from Brick-and-Mortar structure to both Brick-and Mortar with online access has been the newest trend over the best few decades (Meier & Pinto, 2020; Ongsulee, 2017; Queiroz, Ivanov, Dolgui, & Fosso Wamba, 2020). More and more online purchases without the need to go into the store was the normal, but business was not prepared for there to be zero in store purchases

during the pandemic. All work being either forced to work from home, and if unable to work from home, the work was paused until further notice.

Trends, as mentioned previously AI is constantly learning and consuming data. When COVID hit there was numbers and data that were way off the predicted trends and patterns that AI was used to. How can you tell a computer and have it understand what COVID 19 is and the implications it had on the world was the question computer scientists were wondering. All of these patterns from a huge spike in online sales, and zero in store sales. All the data and previous patterns that had been established and used for future business plans and decisions were all out of order (Meier & Pinto, 2020; Ongsulee, 2017; Queiroz, Ivanov, Dolgui, & Fosso Wamba, 2020).

The Covid 19 had one of the strongest impacts on the global supply chain, "similar to the Great Recession (Meier, 2021)." A survey was conducted on supply chains and how the Covid -19 pandemic impacted them. 78% it had impacted them in a negative way while only 11% argued that it helped them. The 11% was most likely involved in some sort of health necessity such as paper towels, hand soap, disinfectant spray, etc.

So how exactly did this pandemic effect supply chains? (Moosavi, Fathollahi-Fard, & Dulebenets, 2022). While before COVID-19 there was fairly free and widely used trades from Cargo ships to Cargo planes, without the rare exception of embargo acts such as the United States had with Cuba over a decade ago. But when COVID hit, all supply routes were temporarily closed down and the ability for free-flowing trade was brought to an abrupt stop (Moosavi, Fathollahi-Fard, & Dulebenets, 2022). Even shipping within countries were getting difficult to do, the number of shortages of supplies in grocery stores was something out of an apocalyptic movie. Shelves of Canned food and water were empty, there was no store in miles that had a supply of toilet paper, and medicine to break fevers and flu like symptoms were scarce.

This broke a lot of trust and favorability for them and the customers. Customers have brand loyalty due to consistency and delivery, what that means is customers will always return to a supply chain (or company) because they consistently give them the service/product they want. During this time when so many highly demanded needs were not being meet, many supply chains lost a lot of their customer loyalty because the customer needed a product anywhere, they could find it (Meier & Pinto, 2020; Moosavi, Fathollahi-Fard, & Dulebenets, 2022). After shopping everywhere to find a product that they needed, they soon became a COVID regular throughout the craziness of the pandemic and out of habit did not return to the previous supply chain once the dust of the chaos had settled.

Another impact that supply chains had was to scratch some of their most signature characteristics such as free food samples. Another feature that was taken away from supply chains were the amount of food that was being cooked at the bakery or by the butchers. With less and less in person shopping happening, the need to have so much food on display was just wasteful (Naude, 2020).

A major question is being asked about the data that was collected during that time of the crazy pandemic madness, what will we use that data for? (Lalmuanawma, Hussain, & Chhakchhuak, 2020). The only logical reason that we could see that data being useful is to show or represent how well we are doing in the future compared to those tough times. Besides the fact at looking at the data for comparison purposes it will be tough data to use because of the changing and uncertain times.

The data that was being displayed and used during the pandemic was very volatile because of restrictions and mandates that were being constantly installed and lifted within countries and states. There were several states across the country that would lift a mandate of having maximum capacity inside all businesses set to 50%. Then 1 month later it would go to 75%. The following month after that it would fall back down to 50%.

What this means is that by using data in predicting future trends and using the data to make financial or operational business decisions, the impacts could be made less severe and threatening (Dimiduk, Holm, & Niezgoda, 2018). Making business decisions at this point is more so on logic rather than data, the data that it might be showing to increase purchase of inventory won't make sense because logically you know your state is going into lockdown again in a few weeks. Or on the opposite side of the spectrum your data shows that you should purchase less of a product for the following few weeks, perhaps keeping the ethical perspective in picture (Jhamb, Stephenson, & Bibelhauser, 2021). The state you are in is lifting all COVID-

19 restrictions and there is going to be a big spike in sales that week from all the emails and comments that have been seen on social media about that product.

Overall, the impact that Covid-19 has had on Artificial Intelligence and Data Analytics differed changes in how businesses and supply chains suffered in the process (Dimiduk, Holm, & Niezgoda, 2018; Moosavi, Fathollahi-Fard, & Dulebenets, 2022). Artificial Intelligence and Data analytics both had to make changes to keep up with the new demand and begin new processes for the way businesses were being run. During the pandemic, a lot of the supply and demand was moved to online interactions which caused a shift in the way Artificial Intelligence and Data analytics were being used. Artificial Intelligence and Data Analytics were not trained necessarily for the concept of a pandemic, as numbers in business began to decrease in demand, they also began to increase in cost. As the economy and businesses are still continuing to see the effects of Covid-19, consumer-packaged-goods companies are under a lot more pressure than they were prior to the pandemic. As mentioned previously, one is able to note how prices for packaging commodities are continuing to increase. Artificial Intelligence that was being used in businesses during the pandemic not only had to alter some of the original logistics but had to work extra hard for companies when online interactions increased with the pandemic.

CONCLUDING NOTES

In conclusion, one can note the major effects in businesses and supply chains when the pandemic arose and how they altered the uses of Artificial Intelligence and Big Data Analytics. Both of these technologies have had contributed heavy for not only the total advancement but the speed in which our modern world has developed. Both artificial Intelligence and Big Data work hand in hand with one another. Big Data is not very useful without Artificial intelligence, and Artificial intelligence cannot run without Big Data.

It is important to be aware of Artificial Intelligence and Big Data analysis and how they are implemented in the business world all around us. These technologies can often be taken for granted but it is important to know what they are and how much time and energy they save humans from wasting time on mundane task, especially after the SARS-CoV-2 Virus destroyed so many beautiful creations of mankind! (Moosavi, Fathollahi-Fard, & Dulebenets, 2022).

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