1. **Introduction**

Industry 4.0 is the fourth industrial revolution urging industries to adopt new technologies like AI, Machine Learning, and big data analytics to minimize expenditure while increasing production efficiency and speed, making manufacturing systems into intelligent factories. These technologies have a vast area of applications in different fields. This phase of the industrial revolution is a mixture of IT and industrial operations to help with the entire product life cycle, starting from design to consumer services. The duration gap between Industry 4.0 and Industry 3.0 is much less than all consecutive industrial revolutions, which says that the growth in automation is exceptionally high and exponential.

Introduction of Industry 4.0 made improvements in many industries and brought many challenges to all the fields to bridge that gap between old technologies and the newer ones. In this manuscript, we examine the difficulties encountered by the various industries, how they dealt with those challenges and the level of advancement that happened in those fields because of enforcing new technologies in the place of earlier methods. There are many obstacles to implementing these technologies in various areas. In agriculture, only building software for analysing the crop pattern and predicting the crop problems would not help solve the difficulty completely. We need proper infrastructure, training, and funding to solve the problem of supply chain and marketing.

Industry 4.0’s prime focus is on digitalization and bringing all the industries onto the digital platform, like introducing chatbots in the banking sector for improvised customer service and implementing AI for analysing the pattern from uncertain data and give the best potential solutions, which helps decision-makers of the organization to be equipped with proper and ample amount of information to make the next move. The COVID-19 pandemic is also a dominant reason for proceeding industries towards digitalization to decrease human contact as much as possible. It also generated many new employment opportunities with high and creative skill types, but at the cost of eliminating the previous occupations with the old technology.

The new industrial revolution defines a whole new era of technology where technologies like IOT link every aspect of business, including design, supply chain, inventory, and after-sale consumer experience. Big International companies fastly adapted to modern technologies to meet the up-to-date requirements of customers and set up the market tone. To be in the competition, all the industries must develop and execute these modern methods as soon as possible to sustain themselves in the market. It is also vital for presently working employees and upcoming students to train accordingly. It is challenging to train the employees and students to prepare them for these continuously developing technologies, as it raises concerns about the availability of resources and acceptability in organizational culture.

Major Sectors that adapted technologies of Industry 4.0 into their current Systems are:

1. Health Care
2. Manufacturing
3. Tech-Companies
4. Banking
5. **Health Care**

**Pushing frontiers of medical expertise:**

Artificial Intelligence (AI) can revolutionize the health care department by predicting possible health issues and giving suggestions and warnings accordingly. It can provide an alert on your phone for catching the flu every time you enter a particular type of region according to the climatic conditions there. Based on your medical records cross-referenced with general medical trends, it can also predict the root cause of your health problem or suspect a situation you may have to deal with. Blockchain Technology is becoming more prominent and secure for storing data in the medical domain. It has data stored in various distributed servers worldwide, which offers a high degree of availability. This property gives protection against network breaches and hardware failure. Also, the format of storing data is so that it becomes almost impossible to alter data. Combining AI and Blockchain can push the frontiers of the medical field. Using Blockchain Technology in Electronic Health Record System can provide us a detailed medical record of every medical transaction between a doctor and a patient with high security and availability. By updating the commerce of the patient, we can construct a graph database. A graph database is a way of storing unstructured data and relationships amongst the data. This graph database can show the hidden information within the data and draw insights. By which we can predict the possible health problems and give the best possible solutions [2].

**AI doing jobs like Data Entry:**

Storing and preserving the data carries a lot of importance in the health department, as the present case could be easily understood and or at least could make a relevance or give insight with the help of past medical records. Also, medical data is essential for research and new inventions in the medical field. AI can do jobs like data entry and give extra time for humans to do more value-adding works. Like a human, AI Engine can do Classification, Extraction, and Validation.

1. Classification: The software can recognize different types of documents after being given a set of example documents just like a human for cross verification. It doesn't need to see every single version of a contract or check request to recognize it. The machine-learning engine cuts down on the rules it needs to apply, resulting in a high level of confidence in document classification with minimal manual effort.
2. Extraction**:** AI has done wonders for data extraction in semi-structured and unstructured documents—including handwritten forms. For instance, invoice number identification usually involves building complex templates and providing keyword tags and pairings around fields and labels. An employee can look at a document and immediately locate invoice numbers, no matter what the form looks like. Now, the software can do that, too, without the need for programming. The machine-learning engine trains itself to understand context, such as what an invoice number is *not* and what should (or shouldn't) be around the number, so there's a high degree of accuracy in the extraction.

Additionally, extracting data from complex stacked tables with lines that don't match up (i.e., transcripts) is now a breeze. Mature AI software learns how to understand patterns and formatting, looks for different types of information, and identifies vital data elements without the need for someone to rope and band the information. Only the exceptions would require human intervention.

1. Validation: AI can do tasks that go beyond the "scrape-the-page" approach, such as an advanced search capability that validates extracted data from a document with existing information in another system. It can even match a line item in an invoice with purchase information stored in another system. AI-driven search also allows for multi-way tracking, which means it can use multiple pieces of information (i.e., quantity, price, description, and amount) to match an exact item in the back-end system. And even if things aren't precise matches—say, an abbreviation is used in the description of the invoice, but not the back-end system—the software can deduce they are the same item [1].

**Democratizing specialist activities:**

Virtual reality offers a solution to train inexperienced surgeons in a virtual

environment before they operate on patients. There won't be any severe consequences even if surgeons make mistakes during training. And they can practice as many times as they want. Many studies have demonstrated that VR training significantly improved surgeon's performance. Yale University concluded that surgeons trained using VR performed 29% faster and made 6x fewer errors than those prepared with conventional methods. In case of complicated surgeries such as the brain and spine, VR helps doctors plan and practice the surgery as many times as desired beforehand. They can try various possibilities for the surgery and settle down for the best one. Without VR, doctors would have only one shot to give — directly on the patient.

VR training for surgeons is just one example of the potential of Virtual Reality. Right from education and sports to training the military for combat, VR will transform many sectors. VR Training Helps Even the Experienced Surgeons [3].

**Allocation of resources during scarcity:**

Artificial Intelligence (AI) has been widely applied in COVID-19 for [early detection of disease, monitoring patients, contact tracing, and the development of drugs and vaccines](https://www.sciencedirect.com/science/article/pii/S1871402120300771). [Machine learning (ML)](https://royalsociety.org/topics-policy/projects/machine-learning/videos-and-background-information/) is a subset of Artificial Intelligence (AI) that allows systems to automatically learn and improve from experience, making predictions or decisions without being explicitly programmed to do so. Given the explosive nature of COVID-19 and the [phenomenon of asymptomatic transmission](https://www.ecdc.europa.eu/en/covid-19/latest-evidence/transmission), digital systems that use real-time data, improve over time, and provide adaptive feedback, will be vital to mitigate the impact of COVID-19. With health systems stretched, and concerns about COVID-19 [vaccine nationalism](https://theconversation.com/why-vaccine-nationalism-could-doom-plan-for-global-access-to-a-covid-19-vaccine-145056), machine learning presents a valuable opportunity to help guide decisions on allocating scarce resources like hospital beds, staff, and vaccines, in low- and middle-income countries (LMICs).

**Rationing hospital beds:**

Machine learning has been utilized in high-income countries to help better ration resources for COVID-19. In the UK, [a team at the Cambridge Centre for AI in medicine developed a system called Cambridge Adjutorium](https://www.cam.ac.uk/research/news/progress-using-covid-19-patient-data-to-train-machine-learning-models-for-healthcare), which uses a state-of-the-art ML framework to accurately predict the rate of mortality, ICU admission, and the need for ventilation in hospital patients with COVID-19. Even though trained using tiny datasets (CHESS data from Public Health England), [the system had a high accuracy rate, ranging from 77 percent to 87](https://www.cam.ac.uk/research/news/progress-using-covid-19-patient-data-to-train-machine-learning-models-for-healthcare) percent. Another [ML-based model using electronic health records in the US](https://www.statnews.com/2020/04/01/stanford-artificial-intelligence-coronavirus/) analyses patients' data and assigns them a score based on how sick they are and how likely they need escalated care. [Fu-Yuan Cheng et al.](https://www.mdpi.com/2077-0383/9/6/1668) similarly developed an ML-based risk prioritization tool for COVID-19 patients to identify patients with an increased need for ICU transfer.

Although such tools have not yet been widely used in LMICs, they have huge potential. India has approximately [one ICU bed per 13,684 people](https://cddep.org/wp-content/uploads/2020/04/State-wise-estimates-of-current-beds-and-ventilators_24Apr2020.pdf) compared to the US, with [one ICU bed per 3,398 people.](https://sccm.org/Blog/March-2020/United-States-Resource-Availability-for-COVID-19) Many LMIC health systems are dominated by large private sectors, further limiting affordable and accessible hospital resources. Since the pandemic began, personal sector engagement has increased and is [actively encouraged by the WHO](https://ghpu.sps.ed.ac.uk/all-hands-on-deck-mobilising-the-private-sector-for-the-covid-19-response/#_ftn4) to help mobilize and coordinate resources in often-fragmented systems. The South African government, for example, has agreed to pay [a daily fee of up to 16,000 rands ($950) for COVID-19 patients](https://www.reuters.com/article/us-health-coronavirus-safrica-hospitals/south-africa-government-private-hospitals-agree-deal-on-covid-19-patients-idUSKBN23E0EQ) who are getting treatment in ICU beds in private hospitals. By reducing the unnecessary use of private beds, ML-based risk stratification tools may help preserve public sector finances during a [significant global economic downturn](https://www.worldbank.org/en/news/press-release/2020/06/08/covid-19-to-plunge-global-economy-into-worst-recession-since-world-war-ii).

**Workforce Planning:**

We can also use ML to guide workforce planning. Health professionals are integral to the response to COVID-19. There are typically fewer health professionals in urban poor and rural areas, and [this problem is particularly stark in LMICs](https://europepmc.org/article/pmc/pmc6791300), raising concerns about the spread of COVID-19 in rural areas. [In Zambia, there are 20 times more physicians in urban than in rural areas](https://www.who.int/bulletin/volumes/88/5/09-072892/en/), despite having a predominantly rural population. Cities have been the focus of several large COVID-19 outbreaks until now. But with individuals unable to continue working in urban areas and moving away from cities, many experts are worried about [COVID-19 emerging in largely isolated rural areas](https://www.theguardian.com/global-development/2020/aug/17/indias-invisible-catastrophe-fears-over-spread-of-covid-19-into-poor-rural-areas) that lack the qualified health professionals they need.

[ML-based risk monitoring systems](https://targetrecruit.com/uk/artificial-intelligence-in-healthcare-staffing/) can analyse the electronic health records of patients in a hospital or cases identified through COVID-19 testing to predict future clinical and public health staffing requirements. Identifying the geographical areas in which staff shortages are most likely to develop will be valuable for policymakers, given that outbreaks are now widely distributed across many countries and are rapidly changing. Many countries have reacted by scaling up their existing medical and public health workforce. In India, with [more than a quarter of India's 736 districts having no district-level epidemiologists](https://www.indiaspend.com/india-tries-to-hire-227-epidemiologists-in-the-middle-of-covid-19-pandemic/), authorities began a rapid search for epidemiologists in April. ML can be linked with adaptive online assessments to help [predict how well-suited people are to the job they are applying for](https://www.docwirenews.com/docwire-pick/how-ai-is-transforming-healthcare-recruitment/). This may be particularly useful in an epidemic where the immediate need for expanding workforce capacity risks hiring poorly qualified candidates.

**COVID-19 vaccine:**

Another major issue that countries face is ensuring adequate uptake of a novel COVID-19 vaccine. It is possible that a [COVID-19 vaccine will require more than one dose](https://www.cbsnews.com/news/coronavirus-vaccine-bill-gates-multiple-doses/) or boosters to maintain immunity over a long period. This will be a massive challenge in LMICs. In 2018, it was estimated that the [average dropout rate for the second dosage of BCG vaccine was 34.6 percent in low-income countries](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6231754/). Traditional factors responsible for poor vaccination uptake and completion will be exacerbated because a novel COVID-19 vaccine will have a [limited safety and efficacy profile](https://www.bmj.com/content/370/bmj.m3209). We can use ML to identify and target people who are less likely to seek or complete vaccination actively. [Subhash Chander et al.](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6231754/) used predictive analysis to identify children at a higher risk of missing routine immunization appointments. They used variables like gender, place of residence, vaccine, language, timeliness of the vaccination, vaccinator, date of birth, and age to predict how likely a child would miss their follow-up vaccination. [The system had a relatively high accuracy of 79.1 percent.](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6231754/)

Approaches like this can be utilized to improve future COVID-19 vaccination programs, given the wealth of data that will likely be available for a vaccine in such high demand. When aiming for herd immunity in LMICs, it will also be essential to focus public health efforts on areas where vaccination is needed most. [A group of researchers at the Facebook Boston office](https://tech.fb.com/ai-is-supercharging-the-creation-of-maps-around-the-world/) used ML-powered maps to filter out 97 percent of uninhabited terrains in Malawi. They then used the remaining 3 percent of inhabited landscapes to focus their vaccination efforts. With [66 percent of India's population living in rural areas](https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=IN&most_recent_value_desc=false) that can be hard to locate and access, ML-based maps can be valuable in LMICs to help better allocate vaccines to vulnerable people that may otherwise be missed.

**Challenges:**

**Infrastructure:**

Applying ML in these ways will be a massive challenge for LMICs, with many costs arising from investing in expensive technology that relies on the availability of basic infrastructure. It is estimated that [less than 30 percent of the health facilities on the continent of Africa have reliable electricity](https://www.frontiersin.org/articles/10.3389/fdgth.2020.00006/full), and there is a deficient level of internet penetration across the continent (39 percent). In many low-income countries, it will be necessary to remove these barriers before digital tools can aid resource allocation in the fight against COVID-19.

**Data gaps:**

COVID-19 has highlighted many data gaps in LMICs, meaning a priority for COVID-19 control must be [generating better information using real-world data to inform modelling forecasts](https://www.cgdev.org/blog/does-one-size-fit-all-realistic-alternatives-covid-19-response-low-income-countries) for evidenced-based policy. But data on individual health is both [expensive and time-consuming to collect](https://www.frontiersin.org/articles/10.3389/fdgth.2020.00006/full). There is generally a low level of digitization of the available health data in LMICs because [medical records are often handwritten in local languages.](https://gh.bmj.com/content/3/4/e000798) Due to the unavailability of datasets, the few ML systems developed in [LMICs often have to rely on the publicly available datasets from the US and Europe](https://assets.publishing.service.gov.uk/media/5ebd6c1886650c278fc64bd2/780_barriers_to_AI_in_the_health_sector_in_India.pdf). Since ML systems are only as good as the trained data, this approach could be damaging.

India provides a great example of how data can be locally generated and used to improve systems. Following a nationwide rollout in 2011, [the Aadhaar program has registered over 1.2 billion individuals on its biometric database](https://www.cgdev.org/publication/digital-governance-krishna-glimpse-future-working-paper). This data can be linked with mobile phones, bank accounts, insurance policies, income tax, pensions, and welfare programs. Mobilizing existing digital infrastructure, such as Aadhaar, to support the development of ML systems in healthcare may be a practical next step to aid the COVID-19 response in some LMICs.

**AI and health workforce:**

A survey of local professionals in Pakistan revealed that a [lack of trained professionals was the most commonly cited barrier to using AI in healthcare.](https://assets.publishing.service.gov.uk/media/5ebd6c1886650c278fc64bd2/780_barriers_to_AI_in_the_health_sector_in_India.pdf) Using ML to aid resource allocation decisions in COVID-19 will require trained and prepared professionals to embrace digital tools fully. Effective, sustainable [support systems and training, as well as clarity on roles and accountability for decision-making and supervisory structures](https://globalizationandhealth.biomedcentral.com/articles/10.1186/s12992-018-0424-z), are essential. The cost of embedding ML and other digital tools into LMIC health systems initially may therefore be substantial. In northern Ghana, it was estimated to cost [$1,060 per health worker to implement a computer-assisted clinical decision support system](https://www.liebertpub.com/doi/full/10.1089/heq.2018.0037) for antenatal and delivery care alone.

Improving supportive infrastructure, the digitization and linkage of health records and public health intelligence, and training and engaging professionals will be difficult. But with [prominent development actors](https://www.oecd.org/coronavirus/policy-responses/strengthening-health-systems-during-a-pandemic-the-role-of-development-finance-f762bf1c/) and [LMIC governments](https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19) making substantial investments into the COVID-19 response, alongside an [increased focus on digital health at an international level](https://www.who.int/docs/default-source/documents/gs4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf), the pandemic may serve as a critical juncture, where some of the traditional challenges associated with integrating technology into LMIC health systems are finally overcome.

**Conclusion:**

Low-and middle-income countries must make the most of scarce resources to mount a successful response to sudden pandemics like COVID-19. Given the possibility of [asymptomatic transmission and rapid local spread](https://www.nytimes.com/2020/08/06/health/coronavirus-asymptomatic-transmission.html) and the continued [surge in cases in LMICs](https://www.worldometers.info/coronavirus/), ML tools present a valuable opportunity through using real-time data to inform decisions on the future allocation of scarce healthcare resources. Effectively embedding technology into health systems and decision-making processes has traditionally been challenging in LMICs. But there are many examples of progress, with many LMICs [already building the infrastructure needed to implement national digital health strategies](https://itif.org/publications/2020/05/26/building-global-framework-digital-health-services-era-covid-19) before the arrival of COVID-19. The pandemic provides a chance for policymakers in LMICs to double down, build on this progress and vitally aid the public health response to COVID-19 [5].

1. **Manufacturing**

**Digital Twin:**

The digital twin is a virtual representation that serves as a real-time counterpart of a physical process that considers every possible element at every stage and predicts the potential problems early in time. It helps us act before the problem causes more damage to the system. This concept was developed by advanced technologies like AI, Machine Learning, and big data analytics. Digital twin technology simulates every element in real-time, many of which we would not be able to recognize and work upon physically. The five critical capabilities of Digital twin technology are:

1) Analysis: This technology helps us analyse the whole process by giving attention to every small detail and automatically identifying the root cause, which accelerates the improvement by not wasting time and resources on the event that is not the root cause.

2) Monitoring: This technology helps us continuously monitor the process and gives early warnings to reduce downtime and waste.

3) Prediction: This helps us to predict the problems early on. These types of proactive actions improve the quality, stability, and reliability of the organization.

4) Simulation: what-if simulations consider every possibility to accelerate accurate decisions at a lower cost than a physical system.

5) Optimisation: optimal process setpoints improve throughput at acceptable quality by up to 10%.

To sum up, everything that has been stated so far, Digital twin is a unique technology that immensely decreases the cost and increases the accuracy in decisions and improves the quality and stability of the organization [4].

**Smart supply chains:**

The significant advantage of Industry 4.0 is it is not urging the industries to completely replace their existing models with new ones with advanced technology. Instead, they are implemented in the current supply chain to drive efficiencies, automation, enable greater visibility and integration across the supply chain. Implementation of technologies like AI and ML helps the management counter environmental and socio-economic disruptions, which is very difficult to predict in physical analysis. This gives a broader sense of understanding and a more remarkable ability to make critical decisions at the time of severe disruptive events. Technologies to create a smatter supply chain will allow the companies to scale and deliver significant value. Many companies are looking to build remarkable resilience into their supply chains, and that requires real-time visibility and actionable analytics to make data-driven decisions. These smatter supply chains provide the companies with optimizing routes, increasing transparency across the supply base through greater traceability through n-tier suppliers, ensuring compliance, and limiting overproduction, waste, and excess inventory. This paves the way for the sustainability of an organization.

**Customer Behaviour:**

AI refers to the ability of a digital computer to perform tasks that are commonly linked to humans, such as the ability to reason and generalize, discover meaning, or learn from experience. In other words, AI is a machine capable of learning and imitating or simulating the intelligent behaviour of humans. Meanwhile, machine learning is a branch of AI that applies algorithms to synthesize the underlying relationships of data and information. The machine learning system can convert automatic speech into a semantic structure expressed in the form of words. In addition, machine learning improves the efficiency of marketing functions in every step taken by the customers. To make predictions of customer behaviour, supervised learning is needed to provide a learning basis for future data processing. Supervised learning is a model built to make predictions, given unforeseen input instances ([Kotu and Deshpande](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB007), [2019](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB007)). It has an algorithm to respond to the dataset and makes the classification model generate future data processing. Therefore, with the help of machine learning and supervised learning, AI can provide valuable data to predict their behaviours in real-time processes using automation.

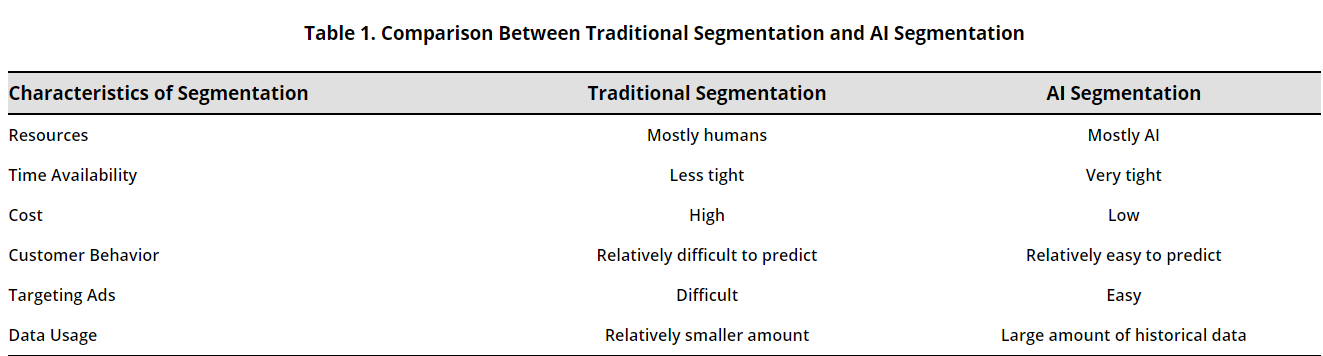
Although the terms "AI," "automation," and even "robotics" are interchangeably used, these terms are different. In particular, AI primarily uses algorithms to learn a process and involves logical reasoning, learning, and problem-solving, whereas automation and robotics use sensors and manual programming ([Oswald and Mascarenhas](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB012), [2018](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB012)). The primary purpose of AI is to develop software to imitate a human mind, just like how humans handle general problem solving, learning, and decision-making in specific ways through an expert system and computer vision. The role of AI in increasing the efficiency of companies was explored in several past studies. For instance, [López and Casillas](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB009) ([2013](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB009)) examined the potential of AI-based systems in the marketing context, whereas [Cao *et al.*](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB004) ([2015](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB004)) highlighted the potential of AI in bringing automated negotiation for e-commerce.

On the other hand, [Vanneschi *et al.*](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB015) ([2018](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB015)) developed a model to predict the probability of default when it comes to payment in e-commerce. Meanwhile, [Omoteso](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB011) ([2012](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB011)) stressed the development process of AI systems in auditing. Besides that, the adoption of AI to assess internal control systems and monitor the effectiveness of audit committees was also reported ([Lo and Campos](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB008), [2018](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB008)).

Notably, AI is important for businesses to analyse the behaviours of customers for the development of specific marketing strategies. Studies have demonstrated the positive influence of applying IoT solutions on developing long and successful relationships through engagement insights. For instance, [Radaceanu](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB013) ([2007](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB013)) examined the potential use of AI to reproduce specific actions that must be validated by the human factor in terms of productivity, quality, and competitiveness. In education, [Bajaja and Sharmab](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB001) ([2018](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB001)) proposed a framework of a tool on multiple learning models and AI techniques to determine the most suitable of learning styles for a particular environment. For medical purposes, AI is believed to minimize human error and subsequently improve the reliability of imaging interpretation ([Fazala *et al.*](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB005), [2018](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB005)). Meanwhile, [Fujii and Managi](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB006) ([2018](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB006)) observed a shift from biological- and knowledge-based models to specific mathematical models and AI technologies, particularly in the United States and Japan.

When it comes to customer targeting, personalization is essential given the significance of niche markets. Segmentation is dividing the market into specific parts with similar behaviours ([Cahill, 1997](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021BIB003)). Through segmentation, companies can gain a competitive advantage by optimizing their resources on the target customers. In the past, the availability of quality data was limited and dominated by demographic information from the field reports. Without AI, segmentation can be rather costly to collect an extensive customer database from many different areas. Nowadays, AI has made segmentation easier and cheaper, as it is designed like the human brain to recognize and solve problems. Moreover, in this digital era of AI technology, marketers can understand their customers deeper.

Therefore, marketing has begun to treat customers differently at a lower cost for its data storage with more effective technology solutions, general advancements in know-how, and the ability to reach customers through digital channels. As indicated in Table [1](https://www.worldscientific.com/doi/10.1142/S0217590820480021?__cf_chl_captcha_tk__=pmd_rW2tdQm0ZS6tZF4oEJt_9KBpEPOM1nAAeuA56xDPWxM-1629658582-0-gqNtZGzNAtCjcnBszQi9#S0217590820480021TBL001), traditional segmentation mainly involves analysing customers manually using simple tools and data. Recently, using the power of AI, such as predictive analytics, marketers can predict the behavioural patterns of customers with the combination of their demographic information to identify the appropriate target customers. Based on the prediction output, marketers would understand the customers' behaviours, motivations, and expectations to deliver relevant messages. This would help them to create an optimized and targeted campaign for the target customers.

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Moreover, AI can provide data at a more granular level and predict the behaviour of customers based on their past behaviour. Data of customers who engage with specific brands benefit marketers. For example, the transactions of a female customer who browses and purchases bags of specific brands contain information on her age, gender, marital status, and income. Using machine learning with more data can deliver better personalization on customer behaviour, which differs from the kind of data the marketers used to acquire. The machine would model each customer and then predict suitable products and brands for the target customers based on various behaviours.

Therefore, marketers can quickly identify their target customers for segmentation by referring to the outputs of machine learning. In the past, demographic information was previously used as an indicator of human behaviour instead. Today, the customers' needs, motivations, and online behaviours (particularly their digital activities) are more appropriate indicators for AI systems to conclude these customers' interests. With the help of predictive audience segmentation technology, marketers can have access to valuable information about customers [6].

**Challenges:**

Driving organization-wide innovation is challenging. At the current stage of the Industry 4.0 development, [6 out of 10 manufacturers](https://www.mckinsey.com/~/media/mckinsey/business%20functions/mckinsey%20digital/our%20insights/getting%20the%20most%20out%20of%20industry%204%200/mckinsey_industry_40_2016.ashx) admit the implementation barriers to be so strong that they managed to achieve only limited progress with their industry 4.0 initiatives during the past year.

Among the top cited challenges are:

* Lack of unified leadership makes cross-unit coordination difficult within the company.
* Data ownership concerns when choosing third-party vendors for hosting and operationalizing company data.
* Lack of courage to launch the radical digitalization plan.
* Lack of in-house talent to support the development and deployment of Industry 4.0 initiatives.
* Difficulties with integrating data from various sources to enable initial connectivity.
* Lack of knowledge about technologies, vendors, and IT outsourcing partners could help execute the core initiative.

While there's no "one-fits-it-all" approach to bringing an Industry 4.0 program to life, there are several things every company can do to diminish those adoption barriers. The first step to becoming an Industry 4.0 company is to estimate the ROI different digital solutions can generate for any business [7].

1. **Tech-Companies**

**Application Design:**

In the design process, including AI will give a competitive edge in the corporate world because AI can help create designs that learn and change over time, based on multiple variables. We need a design that attracts the current customer base and adapts dynamically based on the changing context and user's decisions. AI is mostly about optimization and speed. Designers working with AI can create designs faster and more cheaply because of the increased speed and efficiency. The power of AI will lie in the rate at which it can analyse vast amounts of data and suggest design adjustments. A designer can then cherry-pick and approve adjustments based on that data. AI design tools help designers create winning designs more quickly by automatically refining a product's design based on millions of other successful methods. It can also suggest a completely new design by cross-comparing with the different successful designs and reporting why and how this design improves customer engagement and satisfaction.

**Smatter Apps:**

Competition between the Tech-Companies has always been sky-high right from the beginning of the corporate world. Competition is the prime fuel for innovation and the introduction of the latest technologies in the Tech World. That has given rise to many intelligent apps like Google Assistant, Siri, Amazon Alexa, Youper, and many more. AI helps to work on unstructured and raw data to give accurate solutions and suggestions. These intelligent apps like google assistant take our voice as unstructured input data and analyses with loads of data available to the database and then gives the output response in a precise and easily understandable way. This technology is entirely different from rule-based automation, as it learns from past experiences; moreover, it also can adjust to the new data inputs. Because of these features, it can almost accomplish human-like activities. All the Tech-Companies are competitively paving a whole new path for innovation with technologies like AI, Machine Learning, Big data analytics, and many more.

**Predicting Customer Behaviour:**

* Predicting the Trends in Customer Buying Behaviour

A fiasco is any product or service, no matter how good it is in terms of quality, if not aligned with the customer's needs and desires. Not only geographic location but also culture, religion, nationality, and environment influence customer behaviour. AI tools mine data from social media and news to past sales and reviews to tell what the customers are expecting or which goods they are ready to spend the extra bucks. These tools also account for the economic conditions and spending power of the customers. The best thing about these tools is that they are dependable as it is proven that they predict the future demand and supply with the highest accuracy level. The companies can capitalize on these valuable insights to offer personalized goods and services to the targeted regions.

* Helping in Devising Effective Marketing Campaigns

Besides accurately predicting customer behaviour, AI tools are also beneficial in devising efficacious marketing strategies. The online data in past reviews, online searches, and the number of views is gold for marketers. It is unthinkable for any business that wants to remain competitive in the business world to not leverage the powers of AI for devising its marketing strategy. With the help of AI, marketers can determine which mode of marketing received more engagement from the customers. Based on this, marketers can choose that medium for future advertisements to generate more sales.

* Content Marketing

AI has entirely transformed **content marketing** by changing how the content appears on the top results of search engines like Google. In the past, Google relied on keywords to rank the content, however after the boom of AI, it no longer depends on them. The primary weakness of the keyword strategy was that a lot of copied and fake content ended up ranking on the top beside the genuine one. With AI coming into the picture, Google is also transforming its content ranking strategy. The machine learning algorithms used by Google automatically mine through the data and identify the best and original content on the specific topic and rank it accordingly. The creation of actionable content that targets the right audience is fundamental to the success of businesses. Companies leverage AI to produce the content automatically, communicate with customers using **chatbots**, and create personalized content for the customers. Marketers can also gain valuable insights into the top-ranking content by using AI tools. Moreover, they can get recommendations on enhancing their existing content and which channel will lead to more sales.

* Reshaping Customer Experience Through Enhanced Communication

Email marketing has proven to generate more sales for some products than other mediums. Email, Facebook Messenger, and WhatsApp have removed the communication barriers between the customers and the businesses. Customers immediately contact the companies to register their complaints or to express their satisfaction with the business offerings. Responding to every message is unrealistic because these messages may be in thousands. Here, a **chatbot** powered by AI saves companies from this nuisance by sending text messages to the customers in human language. It also responds to their common queries, thus leading to higher customer satisfaction.

* Assisting in Customer Sentiment Analysis

Social media is the most excellent tool to analyse customers' sentiments regarding goods and services. **Sentiment analysis** uses text analysis techniques to decipher customers' emotions (positive, negative, and neutral) towards specific goods and services. For example, AI tools can analyse 10,000+ online reviews about your product to help you determine if customers are happy with the quality and price of your product or not. Interpreting people's emotions is essential for the success of the business. No business can survive without learning from unhappy customers. As the founder of Microsoft Bill Gates said, "Your most unhappy customers are your greatest source of learning." Customers post reviews and discuss each aspect of the products and services, from quality to price and customer service, on social media. AI tools can analyse this content from social media to divulge customers' sentiments about your goods and services. Besides this, these tools also help to determine the customer's expectations from the business. Based on these actionable insights' companies can make crucial decisions to improve their quality, affordability, and customer service in the future.

* Customer Churn Prediction

Customer churn, also known as customer turnover, refers to a percentage of customers who have stopped doing business with a company. For any company, customer churn is quite a frightening experience. Companies want to retain their existing customer base at all costs because they know that acquiring a new one will not be easy. Therefore, predicting customer churn and identifying the root cause is critical for the companies because, in this way, they can take proactive steps to save their businesses. Companies can use Machine Learning algorithms to predict which customers will stop using their product and unlock the reasons behind this behaviour. Machine learning algorithms are used to create systems that utilize customer's historical data to reveal helpful insights about customer behaviour. Through these insights, the companies can understand the behavioural patterns of the customers that result in quitting [8].

**Challenges:**

**1. A Gap in Technical Skills:**The needs required of the workforce are all evolving. Are your employees able to keep up? When looking to fill open positions, look for applicants who possess "digital dexterity" to understand both the manufacturing processes and the digital tools that support those processes. Only with the right workforce will business models be able to successfully implement new technology and maintain operations.

**2. Data Sensitivity:**The rise in technology has also led to increasing concerns over data and IP privacy, ownership, and management. A common example? To successfully implement an AI algorithm, data is required to train it and test it. For this to happen, the data must be shared. However, many companies are reluctant to share their data with third-party solution developers. Further, our current data governance policies for internal use within organizations are inadequate to support cross-organizational data sharing. Data is a powerful asset – make sure to keep it secure!

**3. Interoperability:**Another significant issue is the lack of separation between protocols, components, products, and systems. Unfortunately, interoperability impedes companies' ability to innovate. Further, since they cannot easily "swap out" one vendor for another or one part of the system for another, interoperability also limits options to upgrade system components.

**4. Security:**Threats in terms of current and emerging vulnerabilities in the factory are another significant concern. The physical and digital systems that make up intelligent factories make real-time interoperability possible—however, it comes with the risk of an expanded attack surface. When numerous machines and devices are connected to single or multiple networks in a smart factory, vulnerabilities in any one of those pieces of equipment could make the system vulnerable to attack. To help combat this issue, companies need to anticipate enterprise system vulnerabilities and machine-level operational vulnerabilities. Companies are not fully prepared to deal with these security threats, with many relying on their technology and solution providers to scope out vulnerabilities.

**5. Handling Data Growth:**As more companies become dependent on AI usage, companies will be faced with more data generated at a faster pace and presented in multiple formats. To wade through these vast amounts of data, AI algorithms need to be easier to comprehend. Further, these algorithms need to combine data that might be of different types and timeframes [9].

**4. Banking**

**Location Intelligence:**

Location Intelligence is a methodology of deriving insights from location data to solve spatial questions. Location intelligence comes from visualizing and analysing volumes of location technology and empowers holistic planning, prediction, and problem-solving. LI is mainly acquired using AI and Big data Analytics. Location-based Intelligence is becoming a great enabler for the banking sector to optimize their banking services, assisting customers for the nearest bank, for getting insights about the optimum location for establishing a new branch or office based on the analysis made by the location technology, which otherwise is very difficult for a physical study to match that accuracy.

**Personal Finance Management:**

Customer expectations are becoming a key factor for the banking sector to upgrade itself to compete. Users are well attracted to the concept of personal finance management as it saves a lot of time and helps people to keep in check their finances. To meet the customers' expectations, a Personal Finance Management system driven by AI is the most optimum and efficient solution for the banking sector. AI personal finance assistant manages finances better than humans as it makes decisions based on data, not emotions. A personal finance assistant is purely rational. It sticks to the savings goals and prompts the user to do so without getting driven by emotions. It also suggests the best way to spend money to meet the savings targets made by the user and gives early warnings if something is not going according to the targets. It can also easily detect any fraudulent transactions made using your bank account and immediately alert the concerned bank, as AI can track when something happens outside of the user's typical pattern of behaviour.

**Application in AML and KYC:**

The compliance teams estimate that between 1% and 2% of AML alerts become the Declaration of Suspicion (DS). Machine learning and AI will be the most transformative, helping to identify and deactivate 98% of false positives cases. This will allow more resources to be allocated for 2% of issues that are more likely to be suspect.

Among the AI techniques that can reduce the rate of false positives, we cite the following examples:

* Semantic analysis to identify correspondences triggered by redundant data.
* Statistical analysis of customer information files to identify high-risk entities likely to represent an accurate positive result. In addition, the consequences of analysts' decisions can be reintroduced into the system to pilot prioritization algorithms activated with machine learning to eliminate possible false positives during the subsequent transaction monitoring.

**Detecting the change in customer behaviour**

Machine learning models can be developed to help detect changes in customer behaviour by analysing their transactions. This technique can be implemented to enrich existing devices that are based on monitoring via rule engines. This will make it possible to detect customers with suspicious activity for an investigation stage. Indeed, what is missing in traditional behavioural analysis devices is the new patterns because money launderers are generally one step ahead.

**Analysis of unstructured data and external data**

To implement a risk-based approach to customer knowledge (KYC), Financial institutions are increasingly seeking to understand the customer's professional, institutional, political, and social context by analysing large amounts of external data, including information and media, public archives, social networks, and other open-source data sources.

A traditional name search can find matches in external data. Still, it can neither provide the context in which the name appears nor discern relationships with politically exposed persons (PEP) or high-risk entities or assess other risk indicators from these sources. Thus, natural language processing and AI techniques are necessary to analyse unstructured data and establish these connections.

Advanced analysis of unstructured data must increase efficiency by automating enhanced vigilance processes and identifies relationships and risks that could otherwise remain undetected.

**Robotic Process Automation (RPA) in AML and KYC**

RPA can be combined with AI techniques to provide intelligent automation of "Know Your Customer" tasks. Among its applications, we cite in particular the following:

* Aggregate internal customer data to create customer views across all accounts, including [data deduplication](https://dataladder.com/the-duplicate-data-dread-a-guide-to-data-deduplication/)and reconciliation across multiple back-end systems.
* Collection and assembly of information from relevant external data sources to create customer profiles.
* Enrichment of alerts using external and internal data.
* Creation of files, in the case of management devices, containing identified KYC controls, alerts, profile information, and enriching data such as geolocation data.
* Analysis and presentation of beneficial owners using data from external databases.

**Generation of Natural Language in AML Compliance**

Advanced technologies can also increase regulatory reporting efficiency, a delicate point in the AML / CFT value chain. The RPA can be used to populate regulatory reporting formats with existing data and to archive reports electronically. The automated generation of regulatory reports has long been a feature of traditional reporting modules in [**Know Your Customer**](https://sanctionscanner.com/knowledge-base/know-your-customer-46) and [**Anti-Money Laundering**](https://sanctionscanner.com/knowledge-base/anti-money-laundering-aml-49) tools. The limitation of these systems is the narration of the suspicious activity report written by analysts. Advances in natural language generation (NLG) now allow relevant information about detected cases to be gathered in a coherent narrative provided to the analyst for examination or modification, thus supporting assisted creation of reports.

On the other hand, regulators, financial intelligence units, and the board of directors or general management require many reports with different intervals to monitor AML / CFT activity. And nothing more understandable than having reported in natural language.

## Challenges:

Artificial Intelligence and other next-generation technologies can improve the efficiency and accuracy of KYC / AML processes. However, some technical, operational, regulatory, and institutional problems are likely to hinder the adoption of these technologies.

**Data Management, AML, and KYC Analytics**

Data quality and management have always presented challenges for the various KYC / AML operations. Indeed, data collection and management involves the processing of massive amounts of heterogeneous and complex data. Data management continues to represent an enormous challenge for the implementation of new generation solutions:

* Redundant data silos and back-end systems prevent the creation of holistic customer profiles.
* The integration, cleaning, and deduplication of data from several management systems are essential to obtain a 360-degree view of customers.
* The data's quality and shortcomings present challenges for the resolution of entities, detecting relationships, and assessing client risks.
* Finding specific data types, such as beneficial owner data or international KYC information, or legal person information, poses another problem, and specialized data provider have emerged to address some of these problems.
* From a regulatory point of view, the data protection law and other regulations relating to data confidentiality potentially limit the use of personal data such as social data to know the client. These regulations should be adapted to the framework of the fight against money laundering.

**Power and IT Capabilities**

Next-generation technologies may require significant data processing and storage capacities. In the KYC / AML context, this is particularly true for analyzing unstructured data, which can involve processing large volumes of external data. The development of proprietary, turnkey solutions integrating AI, machine learning, RPA, or NLG requires sophisticated technology and data processing capacities, which are generally beyond the organization's concerns.

**Regulatory dependence on rules-based approaches**

KYC / AML systems are dominated by a rules-based approach developed over several decades with significant investment from financial institutions, software publishers, and regulators. This has resulted in creating systems required by regulators for the development, refinement, and maintenance of business rules. The regulatory focus on the governance model and demonstrable results pose fundamental challenges to AI approaches for monitoring AML operations and can also be an obstacle to adopting an assessment and AI-based risk rating in the context of KYC. It is possible to solve this problem by developing advanced solutions that can be superimposed on the KYC / AML software package implemented.

**Resistance to cloud computing solutions**

Financial institutions, particularly compliance departments, are often reluctant to take risks. Indeed, there are valid reasons to fear to entrust sensitive customer data and data from KYC systems to cloud services. If data security issues are addressed, successful experiences multiplied, and regulators accustomed to AI technologies, financial institutions will see next generation approaches to AML / KYC as a stable, if not essential, alternative to improving the effectiveness of AML / CFT systems [10].

**References:**

* 1. “3 Ways AI is Revolutionising Data Capture”. Inpute Technologies. <https://inpute.com/3-ways-ai-is-revolutionising-data-capture/> (accessed July. 2, 2021)
  2. SSRN-id3341692.pdf
  3. Training Surgeons\_English.pdf
  4. Manufacturing June 2021.pdf
  5. Anukrat Bhansali and Vageesh Jain. “Using Machine Learning for Healthcare Resource Allocation in COVID-19: Opportunities and Challenges for LMICs.” CGD.com. <https://www.cgdev.org/blog/using-machine-learning-healthcare-resource-allocation-covid-19-opportunities-and-challenges> (accessed July. 5, 2021)
  6. SITI ZULAIKHA, HAZIK MOHAMED, MASMIKA KURNIAWATI. “CUSTOMER PREDICTIVE ANALYTICS USING ARTIFICIAL INTELLIGENCE.” World Scientific.com. <https://www.worldscientific.com/doi/10.1142/S0217590820480021> (accessed July. 10, 2021)
  7. “Why adopting Industry 4.0 in Manufacturing.” Infopulse.com. <https://www.infopulse.com/blog/the-main-benefits-and-challenges-of-industry-4-0-adoption-in-manufacturing/> (accessed July. 20, 2021)
  8. Rafia. “Predicting Customer Behaviour with Artificial Intelligence.” Logiai.in. <https://logicai.io/blog/predicting-customer-behaviour-artificial-intelligence/> (accessed July. 25, 2021)
  9. “The Fourth Industrial Revolution: Industry 4.0 Challenges and Opportunities for Your Business.” stefanini.com. <https://stefanini.com/en/trends/news/the-fourth-industrial-revolution-industry-4-0-challenges-and-opp> (accessed Aug. 4, 2021)
  10. “How AI and Machine Learning Help Prevent Money Laundering.” sanction scanner.com. <https://sanctionscanner.com/blog/how-ai-and-machine-learning-help-prevent-money-laundering-64> (accessed Aug. 23, 2021)