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# Impact of AI and COVID-19 on manufacturing systems: An Asia Pacific Perspective on the two Competing exigencies

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## ABSTRACT

COVID-19 pandemic underscored reliance upon technology as the singular solution to many of humanity's banes and provided impetus to Artificial Intelligence (AI). The unprecedented advent of COVID-19 posited several impediments to public health and welfare, and manufacturing systems in the Asia-Pacific (APAC) region. The primary intent of this study is to investigate the symbiotic influence of AI and COVID-19 on the job market of the APAC region and entailing volatility. This study examines the shift in demand for various technical skills with increased adoption of AI. Review of existing literature scrutinized the research questions, and the analysis revealed a significant increase in new tasks being taken over by AI. The methodology deployed in this study includes a systematic literature review protocol together with stringent inclusion and exclusion criteria to filter articles and data. An interpretivist philosophy, foregrounded in an inductive case-study approach ensemble the analysis and conclusion of the study.

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## KEYWORDS

Artificial intelligence; COVID-19; Job market; Job skills; Asia pacific

## 1. Introduction

Artificial Intelligence (AI) refers to a field of science that focuses on creating computer hardware or software capable of exhibiting characteristics associated with human intelligence (Lucci et al., 2022). With the turbulence of COVID-19, the Asia Pacific (APAC) region has witnessed a steeper and faster intervention of AI. APAC countries are factories of the world with forty-eight countries and almost sixty percent of the world population contributing to more than fifty percent of the world's GDP, APAC is seen as a significant provider to world economy (Leke et al., 2018). Currently, the region is gearing up for exploitation of opportunities created inadvertently by the pandemic and the increasing technological alteration to AI. With a \$48.45 trillion GDP output and holding 59.76% of the world population, the Asian continent is the most vulnerable part of the world in case of any economic chaos and investment turbulences (Andersson, 2022).

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COVID-19 shook the world with its unprecedented impact highlighting the unpreparedness of countries to deal with uncertainties and induced loss of employment and competition (DiVaio, Hassan, D'Amore, et al., 2022; Kramer & Kramer, 2020). Several studies have been initiated ever since, to understand this impact and to identify prescriptive ways to tackle such potential scenarios by the human community. However, there are very few studies that reflect on the macroeconomic impact or suggest a suitable pathway ahead through harnessing the technological growth of AI during COVID-19 era (Chamola et al., 2020; DiVaio, Latif, et al., 2023). AI and COVID-19 are two diametrically opposed realities that intersected during the COVID-19 crisis with a newfound meaning in the face of human confinement. AI's potential to influence the present and future behavior of countries, was exacerbated during the tenure of the pandemic, leading to a shift in focus of the policy makers around the world regarding the nature and types of skills required, to survive in an AI powered world. The densely populated countries of the Asia Pacific region, are witnessing a shift in demand for various technical skills due to the increased adaptation of AI. There is a lack of availability of published proven statistics by government indicating this strategic shift. This study attempts to address this gap by systematically undertaking an extant literature review and directing a worthwhile solution focused discussion, regarding the burgeoning AI in the APAC region and the resultant skills and competencies in demand propelling a review of the traditional employment trends and potential job losses.

### **1.1. Theoretical background**

The theories of economic development are highly related to the theories of economic resilience and re-learning (Dang & Sui Pheng, 2015). This paper investigates the contours of economic production theory and technological determinism to investigate the twin exigencies. COVID-19 tested regional resilience and the ability of the countries to accelerate recovery. Economic production theory provides an ideal framework for the analysis of resilience at the micro-level. Technology cannot be just used without transforming ways of existence and of course production for existence. The inevitable driving force of AI is inducing a technological 'revolution' in fact technological determinism (both optimistic and pessimistic) the 'impact' of which will lead to deep and 'far-reaching,' interventions and consequently changes. The need for infrastructural investments by the APAC nations to face the future in the current pandemics stirred manufacturing markets and large interventions of AI technologies around the world. It is not just production and employment but sustainable production and smart employment of young people that can solve the problems of fast developing economies around the world (Drucker, 1990). AI is the novel field that fosters a fast-development economy, combined with employability and sustainability. The best part of AI is that it embraces every single company irrespective of their size or product line (Kumar et al., 2022).

The advent of AI and COVID-19 on manufacturing systems in the Asia Pacific and the impact of the two competing exigencies, is still a new area of study with immense scope for analyzing newer paradigms. This study attempts to investigate the dynamics of manufacturing markets and their exigencies towards AI including IoT, Big Data and other similar upcoming trends. AI is evidently the faster wisdom to many of the economic and manufacturing problems in the fast-developing APAC

region. Research is increasingly proving that AI can modify the existing infrastructure framework and promote trade and commerce with increased productivity (Bag et al., 2021).

### **1.2. Conceptualization of the study**

The study is conceptualized to comprehend the various dimensions of the APAC manufacturing ecosystem with AI disruption redefining the job markets in a post-COVID-19 world. This study attempts to address the pathway towards framing newer polices for governing the manufacturing job markets of labor-intensive regions. The results guide the key areas where AI is fast in its intervention and what skill-development focus is required by the government in the APAC region. The shift in demand for the various technical skills in the manufacturing sector and the increasing exigencies of AI-based decisions are the key concerns today for the developing economies. AI in the near future may become one of the determinants of GDP of the nations around the world.

### **1.3. Research gaps**

Literature review studies form the key to essential academic research, and are fundamental to academic enquires. They provide advancement of knowledge and push the frontiers of knowledge especially in the planning field. A systematic literature review helps the researchers to understand the depth and breadth of the existing information and lacunae worth exploring in the field (Xiao & Watson, 2019). Though a lot of studies have contributed to the impact of AI, there remains a gap in the literature in bringing out the opportunities that are shadowed by the emphasis on challenges that would lead to economic growth and job prospects. There is also a gap in the literature that addresses the issue of the extent to which this balance has been tipped. Further, there is limited research on an accelerated shift in demand towards a technological skillset for employability, across specialties and niche segments of qualifications from premier institutes, due to dire conditions of the pandemic and sudden shifts that followed. The aspect of the levels of skillsets and facilities available to the current pool of employed and unemployed workers, to adapt to the change in career opportunities, needs further evaluation. This study attempts to identify such challenges and opportunities that disguise the future of the economic and job markets APAC region.

The rest of the study is distributed as follows. [Section 2](#) provides the research method considered for the study. The review and synthesis of literature is provided in [Section 3](#). In [section 4](#), results are presented. The discussion and implications is provided in [Section 5](#). [Section 6](#) highlights the provides the conclusion of the study.

## **2. Research method**

This study adapts the philosophy of interpretivism (Saunders et al., 2015) which emphasizes a holistic view of various factors such as social, cultural, demographic, technological, and economic realities in the APAC region. These factors contribute a predominant role in

defining the job-order market of the region. The study addresses the objectives through an inductive approach. The results section attempts to bring a new model addressing the advent of AI and COVID-19 into the existing exigencies of the APAC job markets. This inductive approach facilitated the development of significant inputs through systematic review of relevant literature and to develop a theoretical model on the research topic. The research is qualitative by nature and involves collection of relevant literature from authenticated sources and online research repositories. The research strategy is inclined towards a regional case study research to develop an in-depth understanding of the developments during the COVID-19 era and the AI disruption in jobs in the manufacturing sector in APAC region. The data type is mono type and includes only qualitative research details obtained through authenticated resources. The relevant studies from the time frame of year 2016 until 2023 were included at various stages of description in the study. Literature review studies form the potential to essential academic research, and they are the key for academic enquires. They provide advancement of knowledge and push the frontiers of knowledge especially in the planning field. Systematic literature review helps the researchers to understand the depth and breadth of the existing information and the existing gaps worth exploring in the field (DiVaio, Latif, et al., 2023; Xiao & Watson, 2019). Many studies were examined to understand the macroeconomic and technological factors influencing the Gross Domestic Product (GDP) contribution of the region. The insights were observed in detailed AI research articles citing the importance of the technology in business operations and job markets. Research criteria included filtering of papers published with specific keywords, specific publication period of articles, appropriateness of the discussions, study geography, etc.

The channels of literature review are from the sources of the electronic databases are majorly from 'business source ultimate' software powered by EBSCO and Elsevier's abstract and citation database Scopus. Other sources are free platforms like google scholar which were easily accessible to the researchers in the internet. Popular studies have recommended this procedure (Xiao & Watson, 2019). The electronic database as mentioned in [Exhibit 1](#) were used to obtain published studies relevant to the research topic. Scopus database and Business Sources Ultimate provided a sizable number of studies relevant to the topic. Following steps were adopted to undertake systematic literature review, viz: (i) Key word search and identification of relevant articles through cited sources;(ii) screening of relevant papers; (iii) establishing the inclusion and exclusion criteria for filtering appropriate papers; (iv) selection of final papers for analysis.

The paper adapts stringently the recommended process of systematic literature review (Rother, 2007). This systematic literature review helps the researchers to respond to specific questions of research in an organized way. The recommended steps of identifying a research question, identification of right resources to find relevant studies, applying inclusion/exclusion criteria for selection of studies, filtering to specific studies to collect relevant information, interpretation of data and synthesis of information relevant to objectives were meticulously adopted by the researchers.

The research strings were selected based on the key research questions observed in the research process. Certain research papers of high impact were taken to benchmark and adapt the entire research methodology. Systematic literature review papers (DiVaio et al., 2020) published in leading journals guided the flow and narration of research methodology.

The key research questions that surfaced to the researchers in the planning phase of research are listed as below:

**Exhibit 1. Search sources.**

Electronic Databases	Elsevier Scopus EBSCO- Business Source Ultimate IEEE Explore ResearchGate Google Scholar Wiley Online Library MDPI NIH (National Library of Medicine)
Searched Items	Journals Conferences Articles Reviews Editorial articles
Search Applied On	Full text
Language	English
Publication/Acceptance Period	March 2016 – June 2023

How are countries in the Asia Pacific region affected by unprecedented pandemics?

Being the factories of the world, what is the impact of pandemics on APAC region economies?

How did technology (AI) play a pivotal role in mitigation of economic slowdown?

How did the manufacturing job-market's resilience happening for upskilling their labor force?

Can APAC economies survive in the era of twin exigencies that influence GDP directly?

What are the ways forward to engage the young workforce productively?

What are the mechanisms to improve employability skill sets?

Which major fields of business have shown a higher favoritism towards technology and why?

Can the existing body of knowledge provide policy-level solutions to the exigencies influencing APAC economies?

DiVaio, Hassan, Chhabra, et al. (2022) uses systematic literature review methodology to deduce appropriate literature from available electronic databases. In similar vein, this paper followed search string categories to identify its data set for a consolidated review. This helped the researchers to discover relevant papers via truncated (shortened) associations between seven string categories.

Group 1: AI AND APAC

Group 2: Influence of AI AND COVID-19 AND APAC

Group 3: COVID-19 AND Business AND APAC

Group 4: COVID-19 AND Healthcare sector AND APAC

Group 5: Manufacturing sector AND APAC AND COVID-19

Group 6: AI AND Sustainability

Group 7: AI AND Service sector AND APAC

The key search words deployed for the search were, 'Asia Pacific', 'AI', 'Manufacturing', 'Job market', 'Job skills in APAC', 'COVID-19', 'economic impact' and 'Impact on manufacturing'. The final keyword research presented approximately 140 papers, of which 80 papers were filtered on the basis of inclusion and exclusion criteria adopted, and finally reduced to 35 relevant papers as enumerated in [Exhibit 2](#). This exercise enabled the researchers to stay

focused on the research questions and ensure the relevance of the data in terms of AI's impact on the Asia-Pacific region and global commerce.

A systematic literature review involves analyzing extant literature to answer questions formulated in the study. The following protocol was adopted for this study as enumerated in [Figure 1](#):

The search and selection of papers followed the search sources provided in [Exhibit 1](#).

The decisive factor used for decide on papers from these sources are as follows:

- C.1. Keywords 'APAC', 'Artificial Intelligence', 'AI', 'Digitalization', 'Job markets', 'Economic Impact in APAC'
- C.2. Keywords 'COVID-19', or 'Pandemic'
- C.3. Papers describing technical innovations introduced during the pandemic

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#### Criterion for exclusion

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E.1. Research articles those are not with the keyword 'Artificial Intelligence,' 'APAC'

E.2. Research articles that don't consider the impact of AI on jobs openly or not directly

E.3. Research articles those are not peer-reviewed

The number of research papers pertaining to the field of healthcare system was restrained to review articles due to the absolute number of studies in the field.

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#### Exhibit 2. Inclusion and exclusion criteria.

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##### **Inclusion and Exclusion Criteria**

Following inclusion and exclusion criteria were included to determine the final selection of papers:

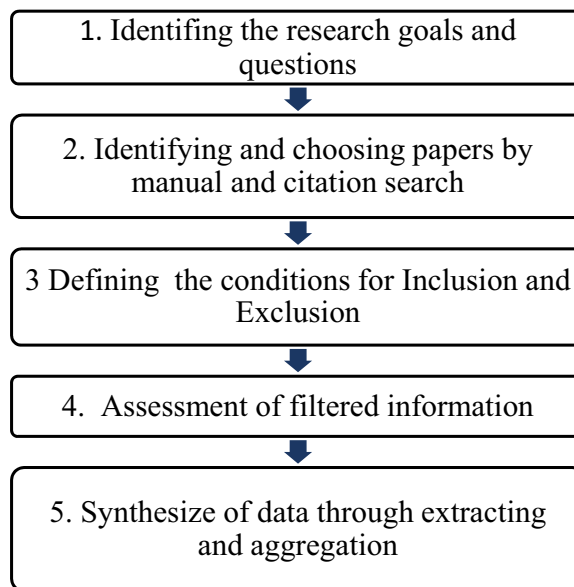
##### **Criterion for inclusion**

I.1. Research published in the COVID-19 pandemic period (March 2018 – June 2023)

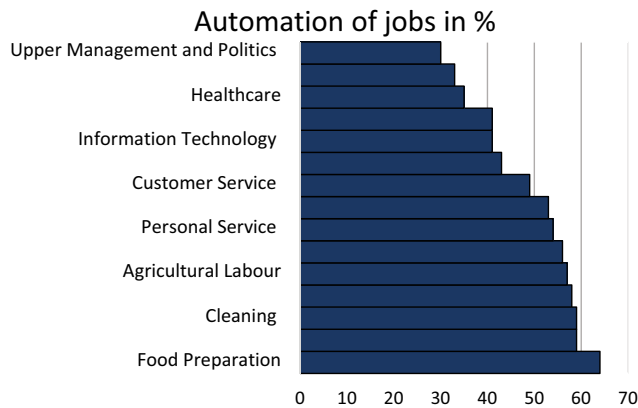
I.2. Research published only in English

I.3. Research relating to jobs that require low to elevated levels of cognitive skills, emotional skills, and/or creative skills in APAC region

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**Figure 1.** Research Strategy Steps (Source: Researcher's elucidation).



**Figure 2.** Automation of Jobs.. Source: Automation risk assessment of different jobs, The Economist (2018); Etzioni and Etzioni (2017).

To determine the fit of the papers chosen for the SLR, the following questions were exercised and satisfied with a ‘Yes’, ‘No’, and ‘Can’t Tell’.

- Q1. The presence of a clear statement of the aims of the research?
- Q2. The choice of an appropriate research methodology to the study?
- Q3. The availability of appropriate data collection in the topic of research?
- Q4. The availability of a clear statement of the findings?
- Q5. The social part of findings of research?

The final list of papers for the review was selected based on whether all the questions in the checklist were answered with a ‘Yes’.

It is also to be noted that this study is a synthesis of many German blind-reviewed articles that specify the AI wave in the APAC region and global commerce. Much attention has been given to filter the articles and collating only relevant data. However, as a research causal impact, it is noted that many of the articles included are specific about the futuristic growth of AI in the APAC region. As mentioned by Schwab (2016), a few of the studies may also overestimate the impact of AI due to the intense wave of behavioral patterns and faster adoption by manufacturing firms in the APAC region as a cost-reduction tool in the industry. Frey and Osborne (2017), indicate that technological start-up firms like ‘Ant Financials’ in China have become unicorn companies in the short-term, as compared to other similar unicorns in manufacturing or service sectors. To moderate the above bias, the papers have been chosen randomly and not specific to any industry or theme, or AI tool Key macroeconomic variables and their economic outcome with AI have been discussed in the literature review section of this study.

### 3. Review and synthesis of literature

Marvin Minsky and John McCarthy coined the concept of AI in 1956 at Dartmouth College when they invented Lisp (list processing) language. Since then, this field has witnessed phenomenal growth, especially post IBM’s entry in the year 2000 backed by



a huge research fund. AI is categorized into two forms, viz: Narrow AI and General AI. There is an increasing adoption of Narrow AI which aims at developing machine learning for specific tasks like warning systems, image processing, etc (Andresen, 2002). Applications of Narrow AI range from smartphones to Warships. However, significant research suggests that this technology is not free from pitfalls.

Haseeb et al. (2019) suggest that AI has transformed all sectors that impact the everyday life of common people worldwide. AI now rapidly dominates businesses, especially in healthcare, automobile, and retail sectors including legal, planning, and financial services, which have been, traditionally labor-intensive industries and played a significant role in job creation and market dynamics. Though AI is being perceived as a threat in the form of automation, it is also to be accepted that AI has also removed a lot of rudimentary and repeated work in the major sectors (Haseeb et al., 2019). AI has reduced the cost of operations and created new job skills and newer opportunities for the young and educated workforce. A recent report from Capgemini confirms that with just 1% of the world retailers adapting to AI tools, a whopping cost savings of \$340 billion has been recorded (Carbonero et al., 2018). Moreover, AI has improved the value chain of the sales and marketing sectors. Asian countries will increase the use of AI tools and gain economic gains. Cockburn et al. (2018) project that China would be the leader in the applications of AI and would dominate the APAC market with benefits. China is expected to be the world leader in the logistics field, with an increase in precision costing and delivery mechanisms with the current adaption rate of 70% in its logistical sector (Cockburn et al., 2018). There is a strong correlation between the adaptation of AI and the economic development of the APAC region, thereby increasing job opportunities for the young workforce (Haseeb et al., 2019). Many industries in the APAC region are increasingly focusing on the 'gig economy' opportunities, focusing on short-term contracts and freelance workforce that have contributed to significant savings in the costing area.

Research studies (Haseeb et al., 2019) validate that there has been continuous investment by corporations in AI amounting to USD 208 billion in the APAC region. Around 8500 technology-based startups have been promoted in the last few years, especially in the Asian countries led by China and India. Thus, it would be appropriate to state that China and India are beginning to harness the advantages of technology-driven businesses. The latest trend in talent acquisition in the APAC region involves an aggressive search for AI-skilled professional workforce. Australia, Hong Kong, India, China, Malaysia, Singapore, Japan, South Korea, and Taiwan are a few countries that are in the race to recruit people with new-generation skills (Frey & Osborne, 2017). ILO report (2018) indicates that changes in the employment sector of APAC are inevitable, and these dynamics will influence the level of individual firms and a global economic level. In effect, therefore, the pandemic has created a divide between 'good' and 'bad' jobs based on skill levels and the ability to adapt to sudden and unexpected changes in the work environment (Kramer & Kramer, 2020). Employees who had technical skills and were experienced in handling several types of software systems were better equipped to handle the changes brought to the workspace by the pandemic. As a result, such employees are likely to be preferred at different organizational levels. This highlights the impact of technology not only on the functioning of an organization but also on the job market in the APAC region.

Over the years, technology has helped reach unfathomable feats in business, commerce, and trade. Be it the introduction of mechanization or the invention of

the steam engine during first Industrial Revolution (IR 1.0), the adoption of electric power in the second Industrial Revolution (IR 2.0), the rise of electronics and Information Technology (IT) in third Industrial Revolution (IR 3.0), or the current fourth Industrial Revolution (IR 4.0) which focuses the adoption of automated systems in business, the role of technology in enabling a country's economic growth is undeniable (Aziz Hussin, 2018; Institute of Entrepreneurship Development, 2019; Petropoulos et al., 2018). However, whilst the intertwining of technology and commerce has yielded numerous benefits, it has also posed certain concerns. One of the major concerns concerning increased emphasis on the use of technology is the creation of a dearth of conventional jobs in the past and continues to be created in the present (Lucci et al., 2022).

AI is often perceived as a pursuit to create machines that can reason, learn, and act intelligently like humans (MIT Technology Review, 2020). Alan Turing, in the year 1950, was the first to propose a test known commonly known today as the 'Turing Test' or the 'Imitation Game' to replace the question of 'whether machines can think' with a game to measure a machine's ability to imitate human intelligence (Turing, 1950). The game tested a human interrogator's ability to distinguish a human test subject and a machine, thereby quantifying the intelligence displayed by the machine (Stanford Encyclopedia of Philosophy, 2003). Following Turing's revelations, numerous scientists and researchers have worked towards the introduction of novel intelligent machines. The developments in AI have been intricately linked to studies in psychological science, particularly in human vision, regular dialect, and learning (Ruhela & Riaz, 2019). The search for advanced and smart systems and technology has led to the introduction of Machine Learning (ML) which involves using unique algorithms to resolve and sort data, the Internet of Things (IoT) which involves an expanding network of physical objects, and Big Data (BD) which encompasses large data sets for analyses (CIS, n.d.; Lyam, 2020).

The threat of computers taking over human jobs has dated to the very beginning of the 1950s when the Turing machine was brought to the public eye and subsequently when the term 'Artificial Intelligence' was first coined. The question that arises therefore is, 'What defines human intelligence? Robert J. Sternberg defines Human intelligence as 'the potential to learn from experience, adjust to new situations, comprehend and handle abstract concepts, and employ knowledge to manipulate one's environment' (Sternberg, 2020). During the COVID-19 pandemic, the momentum of development and demand for AI tools has undeniably increased with more companies opting for AI solutions that can withstand a future pandemic (Hippold, 2020). As unemployment rates increase with the global economy taking a plunge, previous fears of AI taking over the role of human beings in businesses have increased multifold. The unprecedented COVID-19 pandemic has disrupted the balance between job redundancy and generation within AI.

For several years, AI was feared to be a threat to routine jobs that required less cognizance and could easily be performed by a computer. Given the pace at which AI tools have developed in the past decade, it has also been speculated that AI machines could potentially replace jobs that require a higher degree of awareness in the future. Despite these concerns, those in support of AI have deemed that it is highly unlikely that the current pace of development of AI would completely overtake the human workforce. Moreover, studies suggest that although AI may reduce the number of conventional jobs that follow a systematic routine, it would create new jobs in software development and IT

thereby restoring a balance. This balance in jobs, however, would be dependent on technical infrastructure development and training in a planned and systematic way. This section is divided into different segments reflecting studies related to the COVID-19 pandemic, COVID-19 and Businesses, Intervention of diagnostic techniques using AI during COVID-19 in the healthcare sector, Changes in the Manufacturing Sector Brought by AI, AI Tools for Sustainability and AI in the Service Sector.

### **3.1. COVID-19 pandemic**

APAC economy is one of the most vulnerable regions to pandemic-led inflations exemplified by the COVID-19 scenario. India is one such country where numerous efforts have been directed to curb the pandemic and its massive impact on the economy. A few of these efforts included temporarily shutting down all operations, reducing operational loads, and even cutting down on the human workforce. Most of the organizations in the country also opted for the less conventional work-from-home (WFH) arrangement to avoid or mitigate disruptions in work. The WFH arrangement enabled companies to continue operations using disruptive technological interventions while following mandatory social-distancing protocol (Bick et al., 2020). However, not all employees of such organizations could swiftly shift to working from home during the pandemic. As human and financial costs continue to rise, it was expected that the pandemic would hit worst in developing and emerging market countries (Arner et al., 2020).

The COVID-19 pandemic caused by the SARS-CoV-2 virus has had a disastrous impact on global health and the economy with millions of people across the globe being impacted by the pandemic daily (World Health Organization, 2020b). It has been described as the defining global health crisis of our time with long-lasting social, economic, health, and political implications for years to come. The novel coronavirus was first recognized on the 31st of December 2019, by the Wuhan Municipal Health Commission in Wuhan, Hubei Province, China. Later, on 11 March 2020, due to the alarming rate of the virus' spread, the WHO described it as a pandemic (World Health Organization, 2020a). The virus spread easily between people within 6 feet of each other. This was through transfer and exposure to respiratory droplets from a carrier of the disease. Cases of disease spread between individuals at distances greater than six feet were attributed to airborne transmission of the disease and in less common pathways such as contact with contaminated surfaces or animals infected with the virus (Centers for Disease Control and Prevention, 2020). Due to the rapid open out of the virus and its impact on public health and safety, countries from across the globe adopted stringent measures to 'flatten the curve' and keep the spread of the virus in check. A select few countries such as New Zealand, Fiji, Mongolia, and Taiwan have been successful in eventually eliminating the virus at the time of this report. These countries adopted a range of measures such as bans on public gatherings, restrictions on international travel, mass testing and contact tracing, quarantining, and isolating the sick, and even shutting down select trade sectors (Fernando, 2020). Although the measures were successful in flattening the curve, it was not without a cost. Global trade, tourism, commerce, and supply chains have weakened significantly with many companies either shutting down all operations or continuing with a drastically reduced workforce (Singh,

2020). It is estimated that half of the global workforce risks losing their jobs due to the grueling effects of the COVID-19 pandemic on global health and the economy (UN News, 2020). The researchers claimed that the possible advent of global unemployment linked to the tragic loss of lives during the pandemic could create significant levels of grief and trauma among many people (Blustein et al., 2020). Therefore, it has become imperative to develop strategies for a safe and resilient recovery from the pandemic, especially for those who have been most impacted by it.

### **3.2. COVID-19 and businesses**

The advent of the pandemic and the rapid succession of events that followed, including suspension of flights, forced lockdowns, and immediate shutdown of workplaces led to an abrupt pause in economic activities across the globe. This pause has had serious implications in developing countries such as India. Various sectors including tourism, hospitality, and aviation as well as start-ups that contribute largely to the economy and employment generation in India have faced losses amounting to several crores during the pandemic (Debata et al., 2020). As a result of which, governments including that of India were forced to implement policies to protect people from the deadly virus. Several of these policies were subject to scrutiny and criticized for being too fast, premature, or insufficient (Ozili & Arun, 2020). However, they paved the way for a new era of change in local and foreign businesses. Chief Executive Officers (CEOs) and business leaders have strategically maneuvered through the situation and have accelerated digital transformation, established variable cost structures, and implementing agile operations in their enterprises (Accenture, 2020).

### **3.3. Intervention of diagnostic techniques using AI during COVID-19 in the healthcare sector**

The workers in the healthcare profession in the APAC region are undoubtedly the most at risk of being infected by any pandemic. According to a study sponsored by Rutgers Biomedical and Health Sciences, healthcare personnel who reported caring for five or more suspected or confirmed COVID-19 patients, as well as those who spent more time in patients' rooms, were more likely to test positive for the infection themselves. The study further revealed that nurses were the most prone to risks involving the disease (Shi et al., 2020). To reduce the risks faced by medical workers, several researchers have developed means of contactless diagnostic processes and treatment methods. For example, AI-empowered contactless imaging workflows, AI-assisted image segmentation, and differential diagnostics were reviewed and found to not only make the image scanning process more structured but also be constructive in protecting medical workers from contracting the COVID-19 virus (Mbunge et al., 2020). These methods may however have incomplete and inaccurate labels as described in the review, which necessitates human intervention and follow-up before the final diagnosis and treatment. Such issues were augmented by the lack of a sufficiently sized COVID-19 data pool, which in turn severely impaired the performance of AI tools. Access to sizeable data while maintaining the data privacy of patients could give way to numerous applications of AI in the medical field such as in

detection, monitoring, timely diagnosis, screening, surveillance, mapping, tracking, and even creating awareness of the COVID-19 disease (Vaishya et al., 2020). Despite these limitations, AI tools for diagnostics assist in the early detection of diseases, lessen the workload of healthcare personnel, and offer the best training for students and doctors regarding diseases (Ahir et al., 2020).

AI has long been used to perform repetitive and predictable tasks on large scales. During the pandemic, a few of the biggest technical applications of AI include recording and organizing data of infected patients, as well as tracking and analyzing trends in the spread of the virus (Ahir et al., 2020). Such techniques help in curtailing the outspread of the virus by alerting officials of possible risk-prone areas where restrictions may need to be imposed. Another factor that comes into play when controlling the spread of the virus is active online as well as offline surveillance. Pham et al. (2020) details the use of AI-powered tools such as 'Calyps' which manage patient flow in hospitals to control the spread of the virus by sustaining social distancing and avoiding chaos. Similarly, unmanned aerial drones have been deployed in countries such as India and China to aid police and health workers in monitoring and handling unwarranted situations if any during the pandemic. As for online surveillance, a study conducted by (Coombs, 2020) highlights the importance of classifying rumors and misinformation to reduce panic-stricken irrational behavior which may increase the chance of the spread of the virus. Constructing a Weibo daily index including the frequency of posts with keywords related to the pandemic is highly effective in monitoring such issues. Tools such as Weibo and Calyps indeed have a positive impact on society as well as the job market as they opened a unique range of opportunities in the IT sector.

Apart from the recognition and treatment of COVID-19 patients, developments in the field of AI have also happened in fields such as medical psychiatry. COVID-19 had impacted the lives of people from all age groups, including young students. The psychological impact of the pandemic has been found to impact this age group the most (COVID-19 Increased Anxiety, Depression for Already Stressed College Students etc.). Moreover, heightened levels of anxiety, stress, and depression among college students amidst the sudden shutdown of universities and shift to virtual modes of education had been detected (Alharthi, 2020). Therefore, researchers have worked on applying AI and Machine learning techniques to identify and predict anxiety levels among students to enable early detection and treatment (Allen, 2020). Such tools are highly effective in not only helping students but also in helping adults receive the medical care they require. Especially due to the shortage of psychiatrists and therapists after the pandemic as ascertained (Allen, 2020). Malik et al. (2020) suggested that in the future, AI might not only be useful in managing mental illnesses but also to prevent them. However, it also suggested that most psychiatrists were skeptical of whether AI would be capable of making their jobs obsolete in the future.

One of the most important applications of AI during the COVID-19 pandemic has been the creation of drugs and vaccines against the virus. Although this was possible earlier without the adoption of AI, the employment of AI-based tools has aided the accelerated and timely discovery of effective drugs and vaccines based on numerous existing databases. Regarding the selection of effective drugs, the use of AI can enable scientists to select a few molecules out of thousands, following which a traditional drug

development approach needs to be succeeded to ensure the safety and efficacy of a drug (Chen & See, 2020). This however is the biggest limitation of the use of AI in drug discovery. There is a significant delay caused by the trials necessitated following the use of AI, which makes it unavailable for use when needed (Miró Pérez, 2020).

### **3.4. Changes in the manufacturing sector brought by AI**

One of the sectors of the economy that has been impacted the most by automation and AI over the years is the manufacturing sector. Recently, 'Intelligent Production' which involves the integration of AI tools in production is set to revolutionize the manufacturing sector by significantly improving the production efficiency of goods and services (Coombs, 2020). Although this may lead to a decrease in traditional manufacturing roles, it will also lead to new and tech-savvy roles in the sector. For example, the escalation in demand for AI technology has led to an increased demand experienced by robot manufacturers (Wang et al., 2020). Another example is the manufacturing of drugs and vaccines during the pandemic using AI-empowered tools and machinery. Although the manufacturing sector has been and will be heavily impacted by developments in AI, whether this will hurt the job market is a matter of contention.

### **3.5. AI tools for sustainability**

The integration of AI in different technical and engineering fields in the past decade has led to the application of several new and innovative technologies. One such application in Energy Technology could revolutionize the use of safer renewable energy sources during and after the pandemic. Agarwal et al. (2020) detail the use of AI to predict the generation capacity and generation changes of renewable energy sources to encourage the shift to renewable energy by improving the stability of the whole power system. This shift would be crucial for a quick and resilient recovery from the pandemic. Recent developments in AI and IoT (Internet of Things) have also been directed to enable more sustainable and energy-efficient smart campuses. For example, IoT-based college campuses focused on operational efficiencies such as energy savings, end-user comfort, utility, and experience are now on the rise (Agarwal et al., 2020; Ali et al., 2023). These smart campuses not only sense real time-data but also process and respond to data to meet the end energy goals while ensuring a good user experience. One example detailed by (Yigitcanlar et al., 2020) includes monitoring school or university classroom attendance to enable better classroom optimization. In the future, such developments need not be limited to classrooms and campuses. AI applications also have huge potential to transform cities into smart cities known as 'AI Cities' which can protect humans from various natural and/or man-made disasters (Jang & Lee, 2020).

### **3.6. AI in the service sector**

The service sector, specifically the travel and tourism sectors, was most impacted during the pandemic due to travel restrictions and bans on social gatherings. However, many small and large-scale enterprises in the service sector have found methods to overcome these restrictions. Ahir et al. (2020) examined a sustainable development model for

restaurants that involves serving robots and analyzed customer perception of the model. The model involved robot servers as a substitute for human servers due to a shortage of the latter during the pandemic. The subsequent analysis of customer perception found that robots were well-received and provided a smart and safe alternative to keep restaurant businesses alive during the pandemic. Similarly (Grguric et al., 2020), reviewed the use of 'Little Peanut Robot' in metro cities in China for the delivery of food, medical, and other supplies to people residing in contaminated areas.

Before the advent of the COVID-19 pandemic, the fourth Industrial Revolution (IR 4.0) was well underway with fast-paced developments in AI and automation. AI tools provide large and small-scale industries with a means of becoming future-proof and digital-ready. Developments in AI have caused its deployment to increase multifold, from 25 percent in 2018 to 37 percent in 2020 (Xiaoge Zhang, 2022). AI alone has revolutionized every sector of the economy, especially app development, travel, debt, retail, and IT industries (Schweiggart, 2022). Some of the most versatile applications of AI include personal virtual assistance such as Siri and Alexa, face recognition, buyer behavior prediction, fraud detection in banking services, personalized education, and even the execution of trade in the stock market (Dixit, 2022; Young, 2019). Developments such as these have undeniably paved the way for digital transformation at a global level and the possibility of a fully digital economy. However, in recent years, several social and ethical dilemmas have been associated with the rapid developments in AI. One of the biggest ethical dilemmas surrounding the integration of AI in businesses is the widening of the wealth gap. Since AI can perform repetitive and predictable tasks, it can also cut down on the required workforce drastically. The risks involved with this possibility include increased levels of unemployment and widened wealth gaps. With more tasks being undertaken by AI-empowered tools and more companies working towards complete automation, there could be serious implications for the labor market as well as the overall economy. Increased productivity of AI would lead to downward pressure on wages and the size of the workforce. This would in turn mean that a large share of profits made by companies would fall into the hands of an exceedingly small portion of society (Kharpal, 2016). Although AI would redefine certain jobs and create new ones in information technology and automation, lack of relevant skills would leave most of the workforce unprepared to fill the new jobs created (Daws, 2018). The details related to automation of jobs is provided in [Figure 2](#).

A study conducted by (Chamola et al., 2020) showed that during the COVID-19 pandemic, AI has not only proven to be of use in avoiding obstacles in business but also in avoiding hurdles in economic processes by predicting and responding to abrupt changes in a timely and efficient manner (DiVaio et al., 2023). One major obstacle caused by the pandemic was the sudden halting of international trade and subsequent supply chain restrictions. AI-related technology such as Blockchain has been lauded as a means of constructing the supply chain more tolerant of such crises in the future by making manufacturers aware and ready to face challenges that they may otherwise be oblivious to (Simplilearn, 2020). Blockchain is a structure that stores transactional records (blocks), in several databases (chains), in a network, linked through peer-to-peer nodes (Manalu et al., 2020). During the pandemic, it has found use in increasing diagnostic and treatment efficiency, as well as in tracking the supply chain of medicines and medical supplies across cities and even countries (Brem et al., 2020).

The exigencies created by COVID-19 and AI had a potential impact on the job market and employability skills expectations in the APAC region. The studies have established that few industries in the food production sector have gone readily for automation above 60 percent of their operations in very recent years. This would reflect heavily on employability in the specific sector where a large amount of the workforce is semi-skilled and less literate by nature. The agricultural sector is also looking forward to modernized machinery in the APAC region where there is a shortage of labor resources in the rural areas. Modernization of agriculture is the budget priority of governments in the Asia Pacific region. A large volume of subsidies is also being provided to the farming community for the purchase and utilization of modern Agri machinery. A lot of such examples can be witnessed in India, China, Malaysia, and other such primary economies. The information Technology sector and the health care sector are other such fields wherein the employability of labor is witnessing a down-trend, especially with the strong advent of AI in these fields (Etzioni & Etzioni, 2017). The banking sector and the Fintech sector have seen unprecedented growth and overwhelming acceptance of AI technologies during the recent pandemic era (Anifa et al., 2022). Conz and Magnani (2020) presented a systematic literature analysis to highlight the resilient framework for organizations. Customer services in various industries are vastly adapting to automation and this trend has pruned employment opportunities in such sectors too. The COVID-19 pandemic has increased this trend and the requirement for deployment of AI across sectors around the world at a much higher pace than it would have taken in the usual course (DiVaio, Hassan, D'Amore, et al., 2022).

**Exhibit 3** reflects the studies considered for performing the Systematic Literature Review:

This study exhibits exigencies created by the twin forces of AI and COVID-19 in the Asia-Pacific region. The discussions are based on a synthesis of review articles that recorded the impact of AI on employability in the region, during the pandemic period. Though few studies overestimated the impact of the twin exigencies in the region, such studies were moderated through the evaluation of the validity of discussions. Research by Schwab (2016) indicates that few studies have overestimated the impact of AI because few Asia-Pacific countries are witnessing a strong wave of behavioral patterns and faster adoption by manufacturing firms, as they view AI as a cost-reduction tool in the industry. While populating the core of systematic literature review, enough attention was given to evaluating and accepting only those studies which offered clarity in the research aim with relevance to this paper. Researchers also included articles for discussion only, based on qualification criteria of the appropriateness of methodology, research scope, evaluation of findings, and the usefulness of such findings for the research undertaken. This helped to moderate the potential bias of overestimating the impact of AI and COVID on the employability of the Asia-Pacific region. A study by (Matarazzo et al., 2021) presented a digital transformation and customer value creation in context of SMEs in Italy.

#### **4. Results**

This study concentrates on the impact of AI particularly during the COVID-19 pandemic on job markets in the APAC economies. The preparedness of APAC countries to adapt to this new technological advancement and ability to manage the



**Exhibit 3. Studies considered for the systematic literature review.**

Sl. No.	Paper	Type of Paper	Field (If any)	Abstract
1	(Shi et al., 2020)	Opinion Paper	N/A	Presents a debate on whether COVID-19 will be the catalyst for higher AI adoption levels
2	(Chamola et al., 2020)	Review Article	Medical	Reviews AI-empowered imaging resources to combat the pandemic
3	(Pham et al., 2020)	Review Article	N/A	Examines AI usage, IoT, and other technological resources in reducing the impact of the pandemic on public health and economy
4	(Manalu et al., 2020)	Review Article	N/A	Present an overview of AI and big data, and identifies their applications during the pandemic
5	(Ahir et al., 2020)	Qualitative Research	N/A	Explains the role of information technology in the successful handling of the pandemic
6	(Wang et al., 2020)	Review Article	Medical	Assessing the importance of fast developing technologies during the era of pandemics
7	(Allen, 2020)	Editorial	Energy	Discusses the role of AI in making energy clean, efficient, and smart in the future
8	(Yigitcanlar et al., 2020)	Opinion Paper	Medical (Psychology)	Describes how AI will enable precision psychiatry and transform the treatment of mental disorders in the future
9	(Paschkewitz & Patt, 2020)	Viewpoint	Urban Planning	Presents insights on the methodical implementation of AI in societies
10	(Alharthi, 2020)	Qualitative Research	N/A	Discusses potential after-effects of the systematic implementation of AI in cities and societies.
11	(Iqbal & Faiz, 2020)	Quantitative Research	Medical (Psychology)	Assesses the use of AI in predicting general anxiety levels in college students
12	(Grguric et al., 2020)	Qualitative Research	N/A	Proposes a model for surveillance using AI during the COVID-19 pandemic (Real-Time Speech-Recognition Techniques)
13	(Bharti et al., 2020)	Qualitative Research	Business	Theorize an analytical model to evaluate the possibilities in competitiveness and technological advancement through AI as a strategy for differentiation
14	(Agarwal et al., 2020)	Qualitative Research	Medical (Telehealth)	Proposes delivering telehealth in India using AI to increase patient's access to healthcare knowledge
15	(Jang & Lee, 2020)	Qualitative Research	Urban Planning	Discusses the viability of large campuses which are replicas of smart cities
16	(Brem et al., 2020)	Qualitative Research	Service (Restaurant)	Proposes a sustainable improvement model using AI in restaurants
17	(Miró Pérez, 2020)	Review Article	N/A	Analyses the effect of pandemic on technology
18	(Malik et al., 2020)	Qualitative Research	N/A	Discusses how artificial intelligence during the pandemic has undergone a redefinition of its theoretical foundations
19	(Mbunge et al., 2020)	Review Article	Medical	Describes how AI systems has possibility to better the disease recognition pattern of disease spread in populations
20	(Chang, 2020)	Review Article	N/A	Reviews the new technologies and their application during the pandemic
21	(Chen & See, 2020)	Review Article	Medical	Presents the dynamics of the COVID-19 and its relevance to AI technologies
22	(Vaishya et al., 2020)	Review Article	Medical	Covers the functions of AI during the COVID-19 pandemic
23	(Koetsier, 2020)	Review Article	Medical	Reviews the role of AI as a predictive technology to analyse COVID-19 impact
24	(Carbonero et al., 2018)	Review Article	Business	Analyses the utility and impact of AI based technologies on businesses
25	(Andresen, 2002)	Review Article	Business	Explains the role of AI in the business using image processing techniques
26	(Cockburn et al., 2018)	Review Article	Business	Cites the influence of china upon technological fronts in businesses
27	(Haseeb et al., 2019).	Review Article	Business	Describes the investments and job opportunities for skilled workers in the AI field.

*(Continued)*

**Exhibit 3. (Continued).**

Sl. No.	Paper	Type of Paper	Field (If any)	Abstract
28	(Berg et al., 2018)	Review Article	Labour welfare	Forecasts the required skills for the changing work dynamics and workforce
29	(Weber, n.d.)	Review Article	Technology and labour welfare	Indicates the benefits of acquiring AI skills for the APAC population
30	(Frey & Osborne, 2017)	Review Article	Technology and labour welfare	Estimates the new generation job opportunities and new-gen skill sets for the APAC region
31	(Schwab, 2016)	Review Article	Technology and labour welfare	Discusses the role of AI in the GDP of the countries and the dynamics of labour force in adapting the technological knowledge
32	(Fujii & Managi, 2018)	Review Article	Technology	Discusses the priorities of AI based technical skills in APAC region
33	(Logg et al., 2018)	Review Article	Technology and labour welfare	Describes the capacity of AI in solving socio-economic problems in the APAC region.
34	(Hui et al., 2022)	Review Article	Renewable energy	Describes the impact of Covid on the renewable energy sector and its effect on the national economy.
35	(Sithambaram & Tajudeen, 2022)	Review Article	AI and HRM	Synthesizes the impact of AI on human resources management.

diversity in living standards of its rather huge population are major points of concern emanating from the study. Many initiatives have been undertaken by APAC countries to exploit such opportunities and to enhance the job skills of their populations. A case in point is project Ayush by the Indian government to explore the opportunities of AI adoption in the traditional medical field of Ayurveda. The synonymy of economic development of countries and adaptation to AI is resolute and rather discernable. The fields of agriculture, food production, hunger management, automobiles, healthcare, robotics, and logistics are few of the fields at the crossroads of prosperity depending on the ability to exploit AI in the forthcoming years. Job markets in these fields also are important to upgrade with specific skills that can fuel this growth. With the current availability of educational courses and skills, it is difficult for APAC to manage the situation. Disruptions owing to pandemic such as COVID-19 can create impediments in the educational sector, which is the foundation for this change fast approaching the APAC world. The World Economic Forum report of 2016 (Schwab, 2016) forecasts that AI would have a definite impact on the GDP of APAC countries in the year 2030 and AI can add up to a 16 percent increase in the economic output of the region. With the above assumptions, we can predict that APAC can gain a considerable competitive advantage with AI technologies. Now the concern is upskilling and reskilling the job market accordingly in a planned and phased manner. Government policies and initiatives need to focus on these newer opportunities for their young and vibrant workforce for the benefit of their nations and the world. Application of AI in areas of logistics, transportation, automated driving, environmental protection, agricultural productivity, satellite technologies, public safety, etc. is some of the strategic areas that require a new policy approach in terms of education and job skills. Select countries like Singapore, South Korea, Taiwan, Japan, and China

are leading in their race to create prospective opportunities by exploiting AI-based industrial approaches.

While COVID-19 has undoubtedly been a bane for humanity, certain learnings and default positive outcomes of the pandemic cannot be ignored. In countries like Malaysia, where though carbon emission during the peak lockdown period was reduced, the lockdown halted several renewable energy projects which lead to delays in clean energy generation and distribution (Hui et al., 2022). Core sectors like the renewable energy sector realized the importance of utilizing AI for predictions and prescriptions through such incidents in many Asia Pacific countries like Malaysia.

AI can become one of the most intelligent tools to address global challenges, especially concerning global warming, sustainability, hunger, sanitation, literacy, etc. by integrating economic growth and technological intervention (Fujii & Managi, 2018). AI can facilitate cost reduction and increase the engagement of a skilled workforce thereby contributing to rural employment in developing nations. Logg et al. (2018) report that AI can be the panacea to solve several problems in the APAC region. Concerning the use of interactive chat-bots, classrooms can become more engaging and create skill-based workforces in the technical sector of Asian countries by improving the teaching-learning scenario. AI can improve the job markets in the field of statistics, logistics, analytics, marketing, pattern recognition, voice recognition, etc. Global dangers like the mass evacuation of people for industrialization, climate prediction, etc. can also be predicted with the adoption of AI technologies and newer job opportunities can be created in the fields of industrial sustainability. Hence, there is a positive correlation between the growth of AI and the economic development of the region Haseeb et al. (2019). AI can create a productive and happy workforce, leading to improvement in living standards in the APAC region. AI can become one of the most efficient tools in providing precise and reliable production solutions in the field of engineering.

Though AI is attributed to thousands of job losses in the APAC region by several studies, these countries have achieved balance in these losses by providing alternative employment and new employment generation opportunities (Fujii & Managi, 2018). There is a shortage of talented and qualified workforce globally with better opportunities for such workforce in developed countries.

Several studies indicate that developed nations like U.S.A. and UK have a higher number of AI professionals than fast-developing nations like India and China. A Harvard research report (2018) cites that China and India have less than 10 percent of AI specialists as compared with the US and North American countries. This indicates that although the APAC region has suffered a negative impact on the job market owing to AI intervention, especially in the fields of commerce, manufacturing, and education, there is immense potential for qualified professionals in the region.

It is pertinent to highlight that the pandemic has impacted the skillset demand. There is a requirement for a newer technical skillset in the APAC region. Most service industries have started seeking upgraded technical skills and remote working abilities from their employees. Real-time data supported with machine learning algorithms have enabled companies to organize their employees' job responsibilities in a big way. New-generation companies in the APAC region have started seeking automation solutions for most of their backend operations and remote surveillance of such processes is the new normal here. Technical employees are expected to learn AI-

based applications for their routine and critical decisions in the day-to-day work environment. Process flows are synchronized with Enterprise Resource Planning (ERP) systems and fool-proof practices are developed using AI tools. Technology has not only become cost-effective but has improved employee efficiency in a big way globally. This is more significant in the APAC region where employee competency is the key to sustainable employment in technical jobs (Smith, 2020). Many jobs that required human intervention and manual operations were replaced by AI in the COVID-19 era, forcing the APAC region workforce to be resilient with AI-based technology tools.

Figure 3 reflects the contribution of AI in APAC region:

APAC region’s AI-based businesses are forecasted to reach USD 26,023.61 million by the year 2028 from the current figure of USD 3652.85 million in the year 2021 with a CAGR rate of 32.4% between the years 2021 till 2028 (marketresearch.com, 2021).

The growth of AI-based market revenues in the APAC region is promising (Figure 4) and highlights the possibility of steady economic growth. The studies have found that fewer countries namely Japan, Taiwan, Hong Kong, South Korea, China, and Singapore are leading in their investments towards AI and are highly resilient towards filling skill-gap in the sector. As a result, AI will be the potential driver for economic growth in the APAC region.

Also, studies indicate that if properly implemented by the leading economies in the APAC region, Several studies undertaken by western scholars suggest that AI is being looked at as the panacea to eradicate hunger in the APAC region given AI’s capacity to turn around the agricultural economy and food coordination to a big level. AI can be the level player for the next decade to balance both employment and income for the APAC

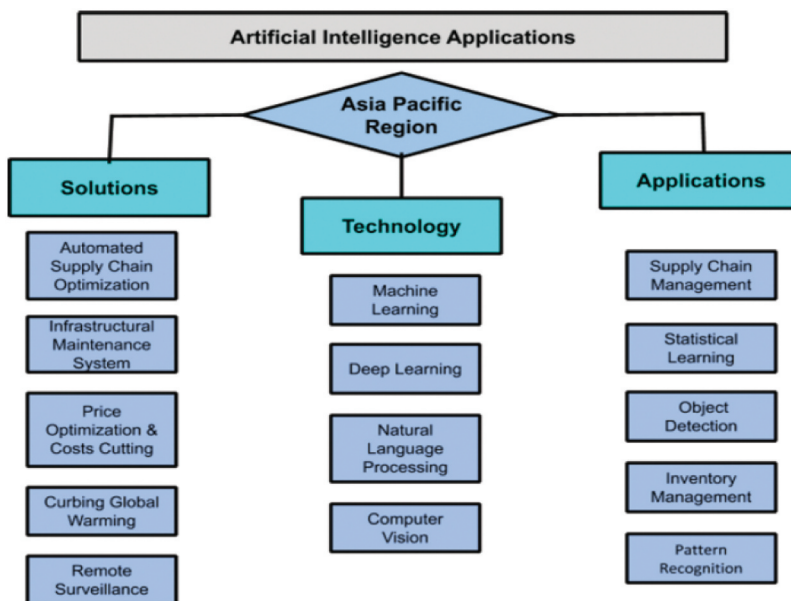
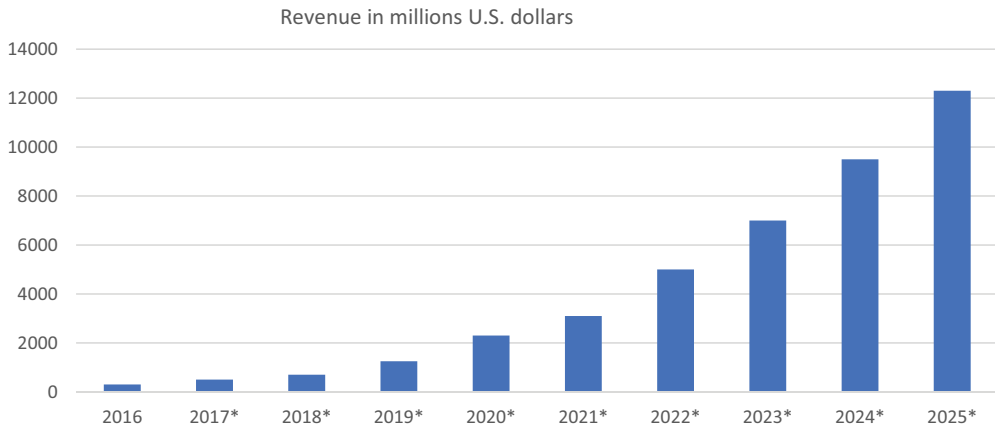


Figure 3. Chart displaying role of AI in the Asia Pacific region’s job market (Source: Haseeb et al., 2019).



**Figure 4.** Projected AI revenues for the APAC markets [Source: Agrawal et al. (2018)].

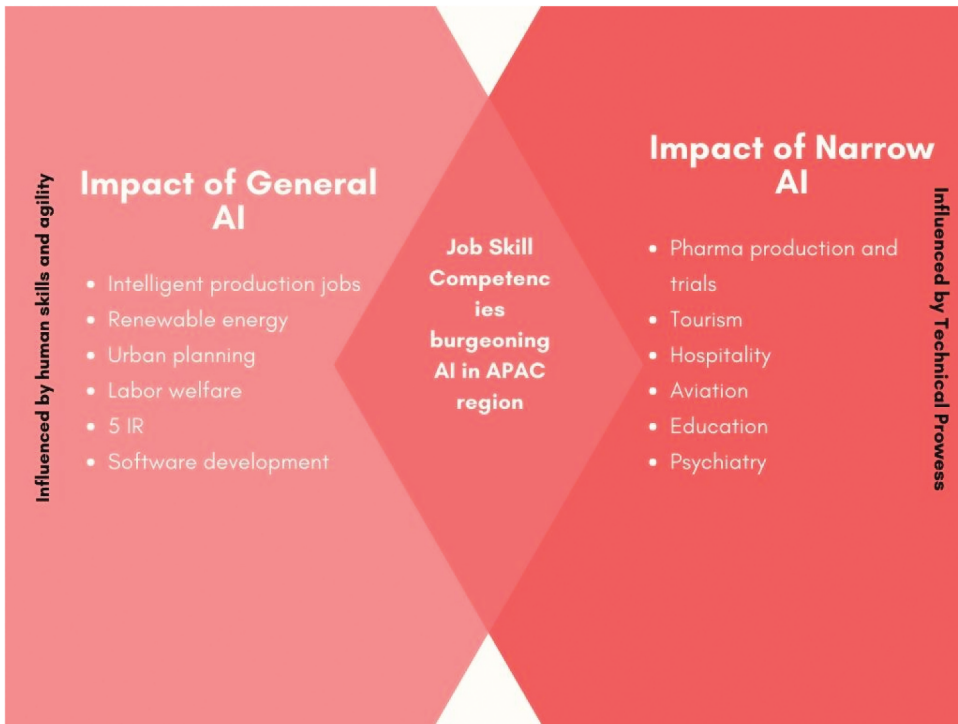
region. AI can improve both the safety and reliability of all major divisions of the economy, adding to the prosperity of the APAC region.

## 5. Discussion and Implications

This study has attempted a skillful review of the competing exigencies presented by COVID-19 and the AI aftermath. The study also decorously highlights the dexterity of AI in addressing the visible and discrete repercussions of COVID-19. The analysis regarding the shift in demand for various technical skills because of the increased adoption of AI has particularly validated that the manufacturing sector has been and will be heavily impacted by developments in AI. The sweep of the manufacturing sector by AI and its impact on the job market is a matter of contention and subject to further examination. AI-created possibilities for foreseeable sustainable smart cities are an oxymoronic classification that vouches for the longevity of technological prowess over human capacity and agility. AI's foray into the service industry has transformed the nature of expectations from the erstwhile hospitality-driven sector to a self-serving update-driven mechanism. This steady and increased pace of the incorporation and adaptability to AI in different sectors marks the embarking of a new form of crony capitalism creating yet another dimension of inequality.

Research have evidenced that sustainable development goals of trade and commerce around the world can be met better with the use of AI. AI is the fast infusing future change agent for practitioners, academicians and governments for long-term planning in their respective geographies (DiVaio et al., 2020).

The APAC market is already in the thick of AI incorporation into its workforce. AI is an embodiment of the sixth finger in terms of its organic growth and infestation in most industries. Certain jobs can be seen as driven by human skills and agility with a slow yet steady creeping in of AI tools and technology. The jobs within this domain range from automation of small tooling operations to inspection of finished products or services (Figure 5). While human effort is creating



**Figure 5.** Job Skill Competencies burgeoning AI in APAC region (Source: Researchers' elucidation).

Robots/machines that tend to walk and engage with specific tasks. Currently, there are a large group of industries that are developing the pace of human programming and moving towards learning-enabled machines.

### **5.1. Practical implications**

In terms of Narrow AI, the decision-making processes are machines wherein the human resources have become a cog in the wheel and are merely tools for the machine-driven decisions to drive themselves. A few such industries to cite are the aviation industry and the pharma industry. For example, ticketing and seat allocation programs in aviation and molecular matching clinical trials in the pharma are all driven today by ML and AI technologies for developing faster panacea for illnesses and pandemics. Narrow AI has already set its footprint on the betterment of life of common society, especially in the fields of financial security, price optimization, remote surveillance techniques, agricultural supply chain, metrological predictions, pandemic management, etc. with better information in hand, the stakeholders of the above-mentioned fields can witness a better life standard and productivity. To sum up, with the knowledge of available literature, it is evident that AI has a positive correlation with economic development and improved standard of living in the APAC region. AI is growing at an important phase in shaping the futuristic economy of APAC countries.

## 5.2. Theoretical implications

This study banks upon the theoretical juxtaposition of economic production and technological determinism. The interplay of the two frameworks may continue to be investigated in further studies. The present investigation reveals new and shrunk form of employability assortment in different jobs with niche technological skillsets being more prominently in demand. While the AI and the efficiency of its entourage including IoT, Big Data, and such like have been touted as significant game changers, this study evokes seminal statistics of rising polarization between the North and South, the erstwhile north-south divide. The consumption of AI is faster than its comprehension. This study is the first in the trail of questions that need to be addressed seeking greater wisdom and further research for a more humane indulgence with AI. Researches have shown evidences that resilience in a sector or region can be either an absorptive resilience or an adaptive resilience and both are equally effective to mitigate unpredictable manufacturing risks like the pandemic. AI may also steeply turnaround the trading trends within few years (Conz & Magnani, 2020). Hence, a deeper study into these emerging exigencies by the academic researchers and practitioners will become a potential pathway for the policy development and governance of the APAC region with a much better eco-system.

## 6. Conclusion

The APAC countries are preferred locations for large-scale manufacturing and consumption of electronic and automobile equipment from western nations. There are larger opportunities to explore AI-based manufacturing skills for improving the employment of qualified young population in such sectors. With increasing stipulations in Europe on electronic waste management, APAC countries are finding newer methods to recycle them in safer ways and improve the circular economy for the world (Davide Basile et al., 2023). AI has a new scope in this field of recycling, reusing, and reducing the usage of electronic and automobile products especially in the APAC regions where the percentage of workforce is reasonably higher than other parts of the world. Recycling technologies with high precision methods have proved to be highly beneficial in terms of extraction and utilization of precious metals at lower cost. This may turn out to be an advantage to the APAC nations for improving their domestic production. AI can improve sustainability in the production sector if combined with the right technologies and Governmental support. Sustainable production activities with the aid of AI can lead to good economic returns to the APAC region. The governments should consider policy revisions that include taxation benefits to the new generation of firms those are keen on technological advancement in the production sector. By such support, the younger generation can develop newer skills and better equip self-reliant manufacturing capabilities to serve the developed countries' job orders (Cozza et al., 2023).

Research from around the world indicates that countries should develop new resilience measures and advise their manufacturing sectors to benchmark and develop their human resources to meet the uncontrollable disruptions that may bring manufacturing activities to halt suddenly. It is crucial to note that not only technologies like AI or pandemics like COVID-19 are not the only influencing factors on manufacturing and job markets of APAC but the recent Russia–Ukraine war, the ship blockade of Suez Canal,

the volcanic eruptions of Philippines, forest fires etc. are also important disruptions affecting the APAC region. Hence, human centered cyber physical production centers are one of the key initiatives recommended for the APAC region (Aruväli et al., 2023).

The post-COVID-19 era has created many compulsions for the APAC economies. With the advent of AI and Industry 4.0, there are revolutionary changes in the interface of cyber technologies. There is a need to engage the youth work-force into training of sustainable resources, digital innovations, investigational skills and specialized knowledge especially in the upcoming computer skills required for the manufacturing job markets. The developed countries are currently investing a huge budget for improving their potential youth upon digital innovations and data-driven business ecosystems. Design innovations in production level and a good workforce that is faster in learning technologies with dynamic capabilities are the need for the densely populated APAC countries. Digital Innovation Hubs (DIH) can favor the APAC region for triggering faster understanding of market demand, develop an essential AI-based training program and better exchange of trade with the developed nations and thereby achieving a stable domestic employment rate of technically qualified youth (Sassanelli & Terzi, 2022).

It is increasingly proven that the role of government is the key in determining the growth of private firms in the Asia-Pacific countries. Unless the government are reducing the longer procedures or finding better ways to trust smaller private firms, economic development would be far slower than the projections (Zhou et al., 2023). AI is emerging as the panacea for large-scale remote and automated governance. The largest hurdle for financial approvals and speedy disbursements of budgeted funds comes from inspections and verifications from the governmental agencies. AI can serve as a useful tool to manage the same. This fact establishes the need for focusing on AI education and AI-based courses training for the existing workforce. Moreover, it is true that lower the governmental interventions and lesser the cost of capital, businesses and in-turn manufacturing jobs would find a positive growth environment. The APAC region businesses need to focus both on growth and also on their ability to be resilient to market risks. The combination of digital and human prowess can create an effective business environment for manufacturing and service firms (DiVaio, Latif, et al., 2023).

APAC economies also have the urgency to adapt the circular economy (CE) models as being proactively practiced by the developed nations. Newer technologies namely the blockchain tools are very powerful and getting popular towards restricted access of limited resources and judicious utility of people, time and resources. The studies are recommending newer techniques like Blockchain Circular Economy Index (BCEI) to manage the CE scenario. The need to save energy and at the same time reduction of cost should be the focus of APAC region businesses (Davide Basile et al., 2023) and AI is a great tool for this change management in the fast developing countries.

The APAC nations are recommended to look on the integration of logistical network to utilize their regional skills in production activities. This is necessary because the raw materials of the future may not be restricted and available only in one specific nation but in the entire regions and in different nations. Unless the countries are looking forward to integrating their strength and synergistically utilizing the commercial opportunities, the future of economic development may turn clumsy in the APAC region with each country trying to safeguard only their resources and not the development of the entire region.



This is recommended in various research as industrial symbiosis and development of sustainable communities in the APAC region (Cozza et al., 2023). The industrial supply chains of the APAC region should benchmark with the European Union (EU) solutions and should work together to avoid unnecessary short-term dominance of any nation but to focus on the development of the entire region's manufacturing job market. The buzzing social concepts in production such as extended producer responsibility (EPR) and social responsibility discipline (SRD) can be achieved only if AI is empowering the skills of individuals and corporations in the APAC region.

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AI	Artificial Intelligence
APAC	Asia Pacific Region
BD	Big Data
CEO (Chief Executive Officers)	Chief Executive Officer
COVID-19	Coronavirus Disease Of 2019
GDP	Gross Domestic Product
IEEE Explore	Institute of Electrical and Electronics Engineers
ILO	International Labor Organization
IoT	Internet of Things
MDPI	Multi Disciplinary Digital Publishing Institute
MIT	Massachusetts Institute of Technology
ML	Machine Learning
NIH	National Institute of Health
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
WHO	World Health Organization.

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## List of abbreviations

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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