

AI-Empowered IoT for Sustainable Energy Technologies

Vishal Kumar^{1*}, Dr.G.N.Vivekananda²

¹ Chandigarh University, India.

² Associate Professor, Dept. of CSE, Madanapalle Institution of Technology & Science, India.

*Corresponding Author Email: ¹ vishalkm77@gmail.com

Abstract

Sustainable energy technologies are advantageous for a company to enhance their performance significantly. Brand value and brand equity of a firm is managed by this AI process in IoT framework. In this study, the role of AI in IoT is discussed briefly. Importance of IoT framework is also mentioned in this study. Machine learning is enhanced by a firm to enhance their performance globally. In this study, qualitative research design is used by a researcher to gain in depth knowledge and information related to this study. Researcher follows a secondary research type to collect existing data from several types of journals. Benefits of these sustainable energy resources are to reduce energy spending, minimise carbon emission and maintain a green energy framework in workplace. Several types of sustainable energy sources are critically mentioned in this study. A company always tries to reduce usage of carbon footprint and inorganic products during working hours. For this reason, sustainability and environmental factors are maintained by a company significantly. Photovoltaic systems are controlled by a company with help of applications of AI technology in IoT process. Modern technology is effectively beneficial for a company to earn more profit from market.

Keywords

AI, IoT, sustainable energy, technology.

INTRODUCTION

Simulation of human intelligence processes by machines, especially computer systems, is known as artificial intelligence. Natural language processing, expert systems are managed by this AI process [1]. Specific applications of AI include machine vision and speech recognition significantly. A company can easily promote their products and services with help of these AI concepts. Machine learning is immensely beneficial for a company to manage their performance across the world. Essential component of AI is machine learning, by which an organisation can use sustainable energy technologies. Internet of things (IoT) is effectively advantageous for a company to maintain usage of sustainable energy resources. A foundation of specialised software and hardware for machine learning is controlled with help of this AI. Programming languages are not included with these AI concepts. Some essential programming languages like python, R, java is popular for maintaining AI work processes [2]. Large amounts of labelled training data are gathered by this particular process. Data is analysed and interpreted by this AI process for patterns and correlations.

This programming process mainly focuses on three cognitive skills such as: learning, reasoning and self-correction. These skills are effectively advantageous for an employee in workplace, by which these individuals can easily enhance their skills [3]. Employees of an organisation always try to gather knowledge and skills. Consequently, these individuals can provide better performance within a company. Sustainable energy technologies play an essential role during working hours in a firm. Better quality products are made by a company with help of these sustainable energy

technologies. Sustainability is maintained by an organisation for using sustainable energy sources. Renewable energy sources are included in sustainable energy technology [4]. Several types of renewable resources are available such as: solar energy, tidal energy, wind energy, geothermal energy and biomass energy. These sustainable energy technologies are beneficial for a company to improve energy utilisation and efficiency.

MATERIALS AND METHODS

Framework of research methods and techniques are chosen by a researcher for conducting a study. This framework is known to everyone as a research design. Accurate and relevant process and strategy of work is managed by a researcher with help of this research design [5]. In this study, “qualitative” research design is controlled by researcher to finish their work within a given deadline. This design allows researcher to sharpen research methods suitable for this particular subject matter. Research aims and objectives are achieved by a researcher with help of this particular research design. Essential elements of research designs are timeline, measurements of analysis, and settings for research study, type of research methodology and probable objections to research. These elements are helpful for a company to enhance their performance. Several types of research design characteristics are available such as: reliability, neutrality, generalisation and validity [6]. Results of a research work are free from bias and neutral for a study. This research design helps a researcher to understand several types of information related to this study.

Research approach refers to a framework by which every researcher can follow a suitable process and strategy of work.

For this reason, authenticity of a research work is maintained by a researcher for this particular study. Researcher uses an “inductive” research approach to manage overall process of work. Proper collection of procedures and plans are controlled by a researcher with help of this “inductive” research approach [7]. Methods for data collection, analysis and interpretation are overseen by a researcher significantly. This “inductive” research approach helps to maintain entire process of a research work. Several types of factors are available for selecting a research approach such as: research objective, audience of research study and experience of research. A specific method from start to end of a research process is maintained by a researcher [8]. Researcher uses several types of theories related to a research work by this particular approach. Specific evaluation objectives are controlled by a researcher due to this particular approach.

Research type helps researcher to gain in depth knowledge and information related to a study. Authentic and relevant process of work is managed by a researcher for each and every research work. In this study, a secondary research type is used by researcher for collecting data. Existing data are collected by researcher related to this particular study. Online journals, websites and channels are used by these individuals for collecting relevant data [9]. Time and budget related issues are not faced by a researcher due to this secondary research type. Sometimes researcher collects same data from several types of journals which are published after 2019. These individuals have a responsibility to identify their relevant data and information. For this reason, a research work can be completed within a given deadline.

RESULTS

An idea about role of AI in IoT

Benefits of IoT are overseen by these AI concepts across the world. This process is helpful for adding human-like awareness and decision making to environment. AI helps a company to enhance efficiency and improve work process and strategy. Future trends of a project work are used by this machine learning process, by which decision making process and problem solving ability is enhanced within each and every employee in workplace [10]. IoT process helps to transform data into a consistent format to learn machine languages significantly. Machine learning model is effectively beneficial for an organisation to use AI and IoT processes within a company. Machine learning models on cloud, device and edges are deployed by this machine learning for IoT. AI makes it possible for machines to learn from experience and these machines perform human like tasks within an organisation [11]. Several types of machines work in a single framework by this AI process of work. Machine language is known to everyone with help of this IoT concept.

Repetitive learning and discovery through data are automated by this AI concern within a company. Automatic manual processes are not maintained by this particular process. Frequent, computerised and high volume data are

performed by this AI process [12]. Intelligence added to existing products due to this process. Several types of products are available in market; those products are improved with AI capabilities. AI helps a company to manage automation process of work. Company management team has a responsibility to enhance their performance. For this reason, a firm implements several types of modern machines and technologies to produce better quality products. Brand value and brand equity of a company is controlled by this AI process. IoT helps to learn progressive learning algorithms to do programming [13]. More and deeper data is used by a company with help of this AI. This AI process helps to collect in depth knowledge related to data. Several types of data are advantageous for an organisation to maintain an accurate process of work.

Incredible accuracy through deep neural networks is achieved by this role of AI in the IoT process. Deep learning and object recognition can be used by a firm to enhance their value and prosperity [14]. Sustainable energy technologies are managed by a company with help of these benefits of machine learning inference for IoT. In case a firm may not be able to simplify machine learning model training during working hours, this company cannot be able to earn high profit from market. AI capabilities are used by each and every industry in market to fulfil demand of markets and customers. Healthcare, retail and manufacturing industries are benefited with help of this AI framework. The AI process helps a healthcare industry to provide better tremens to their patients. Modern treatment process is maintained by a healthcare industry to attract more customers. Manufacturing industry has a responsibility to provide better quality and quantity products in market. Consequently, customers grab those better products to maintain a healthy lifestyle on a daily basis.

Natural language processing and computer vision are managed by a firm in workplace. This process is effectively beneficial for maintaining financial services and automotive accelerated innovation. AI framework helps a company to reduce cost of products and improve customer experiences significantly. Reliable and quicker process of work is managed by an organisation by this AI framework [15]. Faster process is controlled by AI process of work within a company. Advance process of AI helps a company to maintain their organisational and financial performance in an organised manner. Gaming and entertainment process of a company is enhanced with help of this AI framework. Usage of modern machines is known to each and every employee in workplace by this AI system. AI helps a company to control security of employees.

Benefits of IoT in energy consumptions

Energy, logistics, retail, manufacturing and healthcare industries are benefited by this IoT drives process. Automatic and operational efficiency of these industries are managed by this particular procedure. Particular attention from customers, businesses and governments are gained with help of these IoT applications [16]. These applications help to manage new smarter grids. This process is advantageous for electrical

power supply chain management across the world. Security process of a firm is enhanced by this IoT application. IoT process helps a company to enhance efficiency of work strategy. Power supply chain is an essential segment of a company for maintaining IoT drives process. Smart energy management process is controlled by using IoT process. Several types of key benefits are available for a firm to enhance their performance such as: reducing energy spending, integrating green energy, better comply with regulations, minimise carbon emission and automate processes [17]. Apart from this, optimising asset maintenance, cutting operational expenses and predicting consumption, planning and spending accordingly are helpful for an organisation to increase rate of production.

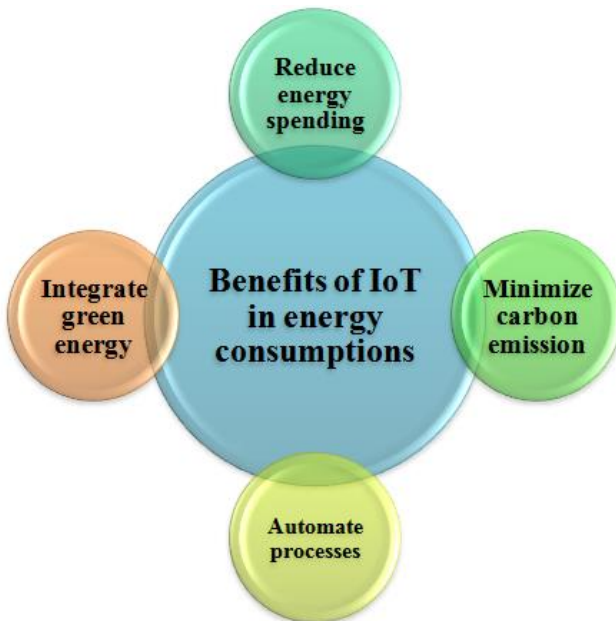


Figure 1: Benefits of IoT

Economic benefit is one of essential reasons for a company to reduce energy spending. Capabilities of IoT for energy efficiency are overseen by this IoT framework. Real time power usage monitoring and smart metering process is also beneficial for an organisation to enhance their brand value. Better control spending and investment in supply chain management is benefited by this particular process in workplace [18]. For this reason, a firm can easily earn high profit from market and also provide better quality products to their customers. Waste management process is an essential segment of a firm to enhance their economic growth. In case a company maintains proper waste management, this firm can easily maintain environmental health in an organised manner. Waste management process helps to protect environmental factors significantly. Safety of employees within a workplace is managed by a company with help of this waste management procedure. Potential negative health effects are controlled by this particular process of a company. Every company has a responsibility to minimise carbon emission during working hours. Usage of carbon content is reduced by a company in workplace, by which sustainability

is maintained [19]. This process helps a company to control environmental factors in a simple way.

Usage of carbon footprint is mitigated by a company by this IoT energy consumption, management software and other solutions to their operations. An organisation can easily optimise use of resources, measure and analyse their environmental impacts in a simple way. Sustainable energy management is helpful for better compliance with current environmental regulations [20]. Specific analytics tools are provided by modern SaaS platforms that help an industry to fulfil demand of markets and customers. Green energy is an essential segment for maintaining sustainable energy sources. Green practices help an organisation to enhance their organisational and financial performance significantly. Several types of sensors are available such as: temperature and vibration sensor. These sensors create a positive impact on financial health of a firm. Renewable energy resources are used to minimise usage of energy consumption [21]. Every customer tries to grab low cost electricity from market. These renewable energy resources are immensely beneficial to provide cheap electricity to their customers across the world.

Role of AI for sustainable energy technologies

Big data handling, massive computational power, information technology and improved machine learning is managed with help of recent boom in AI technologies. Deep mind AI technology helps a company to achieve more traditional approaches [22]. Growing opportunity of an organisation is increased by this AI technology and IoT process. Every company has a responsibility to maintain smart energy industry; hence this firm can enhance their rate of production and profitability in the world. Smart energy systems are beneficial for an organisation to manage work processes and strategy in an organised way. Modern infrastructure is needed for a company to control smart energy industry. Several types of modern infrastructures are available such as: supercomputers, cyber technologies, power electronics, information and bi directional communication between equipment and control centres [23]. In recent days, modern equipment is implemented by a company in workplace to produce several types of products. However current power grid infrastructure is effectively old and inefficient, unreliable and out of date. This particular infrastructure may not be able to protect severe fault conditions.

Global economy depends upon energy production, distribution, planning and financial sustainability. In recent days, power grid infrastructure is effectively modern and sustainable. For this reason, energy production and distribution process is maintained by a company significantly. Integration of renewable energy resources is not controlled by conventional power grids [24]. Variable loads of power grids are overseen by these changing characteristics of renewable energy resources. Several types of renewable resources are available such as: solar, wind, tidal and geothermal energy. In recent days, various kinds of advanced AI technology are available such as: machine

learning, deep learning, big data and IoT. This advanced technology is immensely beneficial for an organisation to enhance their organisational and financial performance [25]. Different types of tasks are available to perform such as: forecasting, controlling and efficient power system operations. These tasks are done by a company with help of this AI technology.

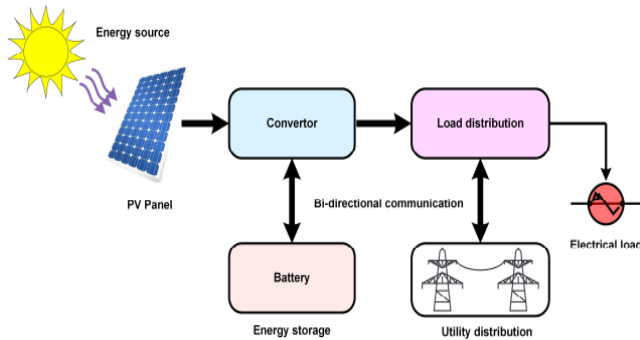


Figure 2: Illustration of typical PV framework

Usage of AI helps a company to maintain efficient inverter control of photovoltaic systems (PV). Solar energy is one of the most promising sustainable energy resources due to its virtual inexhaustibility. Several types of PV devices are available, by which sunlight can easily convert into electricity. Consequently, the cost of electricity is also lower for this particular process. AI technology helps a company to track ability of power point operations in a simple way. Traditional and artificial power point tracking help a company to enhance their performance significantly. Key innovations and dimensions in AI applications include business model, energy market design, system operations and enabling technologies. Enabling technologies include power plants flexibility, AI, block chain technology, utility scale barriers and big data. Mini smart and renewable grids are also included in these particular technologies [26]. Business models include peer to peer energy trading, virtual power lines, community ownership models and online payment models.

Dynamic line rating, corporation between distribution, transmission and generation, energy forecasting and renewable power production is included in the system operations. Energy market design includes rising granularity in electricity markets, different time of use tariffs, net billing schemes, regional markets, and integration of markets with distributed resources [27]. Talent development, scientific research, private and public sector adoption are focused by a company with help of this AI technology across the world. Every company has a responsibility to maintain digital infrastructure in workplace. For this reason, work process and strategy is maintained by an organisation in a simple way. Research and development strategic goals of national AI strategy are controlled by a company to enhance their brand value and brand equity.

Applications and benefits of AI in IoT

AI and IoT are effectively beneficial for a company to enhance their operational efficiency. Boosting operational efficiency plays an essential role in workplace to maintain their work process and strategy. Constant streams of data help a company to maintain their organisational and financial performance. Machine learning process of a company is controlled by this AI process. Operational conditions create a positive impact on economic growth, by which an organisation can easily earn high profit from market [28]. Time consuming and redundant insights are maintained by a company with help of this operational efficiency. Better risk management creates a positive impact on growth of an organisation. Consequently a company can easily identify their strengths and weaknesses with help of this risk management process. In case a firm understands their risk factors, this company can easily mitigate those factors in a significant way. For this reason, profitability and rate of production is enhanced by this particular AI process.

A broad range of risks and automation for prompt response are managed by a company with help of this better risk management process. This process allows a company to provide better handle financial loss, cyber threats and employee safety. For this reason, employees can easily provide better performance to produce modern quality products. Quality and quantity of products are controlled by a company with help of this application of AI in IoT. Application of AI helps a company to increase IoT scalability within a workplace [29]. However, a firm can easily learn machine languages in an organised manner. Modern machines and technologies are implemented by an organisation to provide better quality products to their customers. Most common IoT ecosystem includes low end sensors, by which company management teams can easily gather, analyse and summarise all data in a significant way. Large volumes of data are reduced to a handy level of IoT devices with help of AI application.

DISCUSSION

Human-like awareness and decision making processes are increased by a company with help of role of AI in IoT process. Every company has aims to improve their work process by this role of AI in IoT. Several types of machines and technologies are implemented by an organisation in the workplace such as: speech recognition, virtual agents and peer to peer network, by which a company can easily maintain AI and IoT processes within a workplace. . IoT process is beneficial for a company to understand machine languages. Machine learning process creates a positive impact on performance of a firm. IoT process is effectively beneficial for an organisation to transform data into a constant format of machine learning process. Repetitive learning and discovery through data are controlled by applications of AI in workplace. Automatic process of work is advantageous for an organisation to increase their value across the world. Several types of industries are benefited by

this process such as: manufacturing, energy, retail and healthcare. Company management team has a responsibility to manage natural language processing and computer vision.

Sustainable energy resources create a positive impact on economic growth and condition of a company. Benefits of IoT in energy consumption are smart energy management and reducing the cost of energy spreading. A smart process of work is effectively advantageous for a firm to manage applications of AI in IoT process. Modern strategy helps an organisation to enhance their value and equity in an organised manner. Usage of inorganic products is mitigated by a company across the world. For this reason, sustainability and environmental factors are managed by an organisation. Company management team has a responsibility to use green and sustainable raw materials in workplace. Consequently, a smooth process and strategy of work is maintained by a firm. Usage of carbon content materials is totally reduced by a company. Emission of carbon within a workplace is controlled with help of this AI process in IoT. Every company always tries to use green energy sources to maintain sustainability. Proper maintenance strategy is immensely advantageous for a company due to integrating green sustainable energy sources.

Massive computational power, big data handling, information technology and machine learning are maintained by an organisation across the world. Traditional and modern approaches are known to each and every one with help of these applications of AI and IoT processes. Traditional approaches are immensely advantageous for an organisation for maintaining the role of AI in sustainable energy technologies. Supercomputers, cyber technologies, power electronics and information are known to everyone as modern infrastructure of a company. In order to maintain modern infrastructure in workplace a certain amount of money is required to install these sustainable energy technologies. Communication between equipment and control centres are immensely beneficial for a firm to enhance their performance. AI application helps power grid corporations to maintain modern infrastructure. Every company has an aim to implement modern structure in workplace. Initial cost of installation process of modern structure is immensely high. Sometimes small companies may not be able to install modern structures within a company. For this reason, process and strategy of work is hampered.

Applications of AI help to analyse, manage and obtain meaningful insights from data. Company management team has a responsibility to ensure a fast and quick process of work. Consequently accurate data analysis procedures are managed by a firm with help of this AI application. Several types of requirements are available for centralised and localised intelligence. These requirements are balanced by these particular AI applications in IoT process. Boosting operational efficiency, better risk management and enhanced quality of products and services are applications of AI enabled IoT within an organisation.

CONCLUSION

Human intelligence process is managed by various types of machine languages. Machine languages are known to everyone with help of this IoT process. A company always tries to maintain machine vision and speech recognition. AI helps a firm to promote modern types of products in a new market. In case customers of a new market are attracted by these new types of products, this firm can easily earn high profit from that market. Programming languages are known to everyone by this AI application. These programming languages are effectively beneficial for an organisation to maintain their economic growth. AI process helps a company to manage reliable and quicker work strategies.

AI plays an important role in the simulation and improvement process of a company, markets, investments strategy, maintaining sustainability and safety of employees in workplace. For this reason, employees are attracted by this company and retention of employees is managed by an organisation. Every company has a responsibility to provide customer oriented services in market. Importance of AI and IoT are discussed critically in this study. Applications of AI in IoT process are mentioned here by which a company can easily manage sustainable energy resources significantly.

REFERENCES

- [1] Sarker, Iqbal H., Md Hasan Furhad, and Raza Nowrozy. "Ai-driven cybersecurity: an overview, security intelligence modeling and research directions." *SN Computer Science* 2 (2021): 1-18.
- [2] Giorgi, Federico M., Carmine Ceraolo, and Daniele Mercatelli. "The R language: an engine for bioinformatics and data science." *Life* 12.5 (2022): 648.
- [3] Vasanthakumari, S. "Soft skills and its application in work place." *World Journal of Advanced Research and Reviews* 3.2 (2019): 066-072.
- [4] Qazi, Atika, et al. "Towards sustainable energy: a systematic review of renewable energy sources, technologies, and public opinions." *IEEE access* 7 (2019): 63837-63851.
- [5] Rashid, Yasir, et al. "Case study method: A step-by-step guide for business researchers." *International journal of qualitative methods* 18 (2019): 1609406919862424.
- [6] Daniel, Ben K. "Using the TACT framework to learn the principles of rigour in qualitative research." *Electronic Journal of Business Research Methods* 17.3 (2019): pp118-129.
- [7] El Khatib, Mounir, Abdalla AlMaeeni, and Waheeb Alkamali. "The Relation between Effective Digital Program Governance and Program Success." *American Journal of Industrial and Business Management* 12.9 (2022): 1402-1418.
- [8] Ferguson, Sarah L., E. Whitney G. Moore, and Darrell M. Hull. "Finding latent groups in observed data: A primer on latent profile analysis in Mplus for applied researchers." *International Journal of Behavioral Development* 44.5 (2020): 458-468.
- [9] Guo, Yajun, et al. "The provision of patron services in Chinese academic libraries responding to the COVID-19 pandemic." *Library Hi Tech* 39.2 (2021): 533-548.
- [10] Akyazi, Tugce, et al. "A guide for the food industry to meet the future skills requirements emerging with industry 4.0." *Foods* 9.4 (2020): 492.

- [11] Makarius, Erin E., et al. "Rising with the machines: A sociotechnical framework for bringing artificial intelligence into the organization." *Journal of Business Research* 120 (2020): 262-273.
- [12] Liyanage, Harshana, et al. "Artificial intelligence in primary health care: perceptions, issues, and challenges." *Yearbook of medical informatics* 28.01 (2019): 041-046.
- [13] Mishra, Shashvi, and Amit Kumar Tyagi. "The role of machine learning techniques in internet of things-based cloud applications." *Artificial intelligence-based internet of things systems* (2022): 105-135.
- [14] Grari, Mounir, et al. "Early wildfire detection using machine learning model deployed in the fog/edge layers of IoT." *Indones. J. Electr. Eng. Comput. Sci* 27.2 (2022): 1062-1073.
- [15] Holmström, Jonny. "From AI to digital transformation: The AI readiness framework." *Business Horizons* 65.3 (2022): 329-339.
- [16] Susanto, Heru, et al. "Revealing social media phenomenon in time of COVID-19 pandemic for boosting start-up businesses through digital ecosystem." *Applied system innovation* 4.1 (2021): 6.
- [17] Gawusu, Sidique, et al. "The dynamics of green supply chain management within the framework of renewable energy." *International Journal of Energy Research* 46.2 (2022): 684-711.
- [18] Patrucco, Andrea Stefano, et al. "Can you grow your supply chain without skills? The role of human resource management for better supply chain management in Latin America." *The International Journal of Logistics Management* 33.1 (2022): 53-78.
- [19] Rachmawati, Rini, et al. "Work from Home and the Use of ICT during the COVID-19 Pandemic in Indonesia and Its Impact on Cities in the Future." *Sustainability* 13.12 (2021): 6760.
- [20] Tien, Nguyen Hoang, Dinh Ba Hung Anh, and Nguyen Minh Ngoc. "Corporate financial performance due to sustainable development in Vietnam." *Corporate Social Responsibility and Environmental Management* 27.2 (2020): 694-705.
- [21] Shahbaz, Muhammad, et al. "The effect of renewable energy consumption on economic growth: Evidence from the renewable energy country attractive index." *Energy* 207 (2020): 118162.
- [22] Akinosho, Taofeek D., et al. "Deep learning in the construction industry: A review of present status and future innovations." *Journal of Building Engineering* 32 (2020): 101827.
- [23] Ahmad, Tanveer, et al. "Artificial intelligence in sustainable energy industry: Status Quo, challenges and opportunities." *Journal of Cleaner Production* 289 (2021): 125834.
- [24] Fernández-Guillamón, Ana, et al. "Power systems with high renewable energy sources: A review of inertia and frequency control strategies over time." *Renewable and Sustainable Energy Reviews* 115 (2019): 109369.
- [25] Rehman Khan, Syed Abdul, et al. "The role of block chain technology in circular economy practices to improve organisational performance." *International Journal of Logistics Research and Applications* 25.4-5 (2022): 605-622.
- [26] Cuesta, M. A., T. Castillo-Calzadilla, and C. E. Borges. "A critical analysis on hybrid renewable energy modeling tools: An emerging opportunity to include social indicators to optimise systems in small communities." *Renewable and Sustainable Energy Reviews* 122 (2020): 109691.
- [27] Haider, Rabab, et al. "Reinventing the utility for distributed energy resources: A proposal for retail electricity markets." *Advances in Applied Energy* 2 (2021): 100026.
- [28] Li, Lei, et al. "The impact of e-commerce capabilities on agricultural firms' performance gains: the mediating role of organizational agility." *Industrial Management & Data Systems* 120.7 (2020): 1265-1286.
- [29] Tschang, Feichin Ted, and Esteve Almirall. "Artificial intelligence as augmenting automation: Implications for employment." *Academy of Management Perspectives* 35.4 (2021): 642-659.