The Future of Automation: Integrating AI and Quality Assurance for Unparalleled Performance

Venu Madhav Aragani
Eliassen Group
Principal Software Engineer
NC, USA

[1]*Received: 30 May 2024; Accepted: 20 August 2024; Published: 23 August 2024*

ABSTRACT

Probabilistic knowledge is fundamental for present-day innovation and executives. At the point when a supervisor or specialist gives related difficulties impartial measurable information, persuading readers is simpler. The appraisal of the actual status is upheld by measurable proof, and circumstances and logical results can be laid out. The reasoning is supported by deductive reasoning, statistical data verification, and induction. Practitioners of quality should develop statistical thinking skills to fully comprehend the three quality concepts of "psychology," "essence of substance," and "process of business." Conventional quality data are gathered through data collection, data processing, statistical analysis, root cause analysis, and other methods. They contain factors, credits, absconds, interior and outside disappointment costs, etc. Good practitioners used to rely on these supposed professional qualities to get a job. If quality practitioners keep up with current practices, collecting, organising, analysing, and monitoring quality data will be easier. Precision tool machines are being integrated into many IoTs to collect data on machine operation, component diagnostics and life estimation, consumables and usage monitoring, and other data analysis. Data science, which is gradually combining data mining and forecasting, is the future of high-quality fields.

INTRODUCTION

Artificial Intelligence (AI) aims to emulate human intelligence, yet it falls short of truly replicating human cognitive abilities and typically excels in solving single, specific problems. From an academic standpoint, an illustrative comparison might be drawn between AI and the combination of Western magic and Eastern martial arts, as suggested by Kuan and Perng (2019). AI could be seen as the "Lord of the Rings" in the realm of Information Science (Ragi et al., 2021). Scholars in Information Science have dedicated generations to tackling these complex issues, driven by both ambition and determination. Many have devoted their lives to the field, only to find themselves unable to make substantial progress (Adusumalli, 2018). For newcomers to AI theory, the path often becomes bewildering before they even gain entry. Once inside, the complexity can feel like a maze with no clear exit.

Confucius once said, “Gazing up is high, drilling is powerful, looking forward, abruptly behind,” and this sentiment could be applied to the field of Artificial Intelligence. Researchers often discover that their previous solutions were nothing more than illusions. What appears straightforward may conceal a fairy or monster waiting behind the door (Ahmed, 2021)—a hidden threat that can mislead rather than destroy. Many who delve into AI find themselves enchanted by its complexities, only to realize that what seemed like paradise was, in fact, a challenging realm (Adusumalli, 2019). Much like the characters in Jin Yong's Xia Ke Island, who are lured by the promise of martial arts secrets and end up futilely devoting their lives to them, AI researchers may become so absorbed in individual algorithms that they miss the broader picture of how overall wisdom is generated. This could lead to a situation where researchers are trapped in a maze of complexity, unable to see beyond the immediate challenges (Pasupuleti, 2016b). The evolution of AI through its three waves may illustrate this scenario, as depicted in Figure 1.

[1] *How to cite the article:* Aragani V.M.; The Future of Automation: Integrating AI and Quality Assurance for Unparalleled Performance; *International Journal of Innovations in Applied Sciences and Engineering;* Special Issue No 1 (2024), Vol 10, No. 1, 19-27

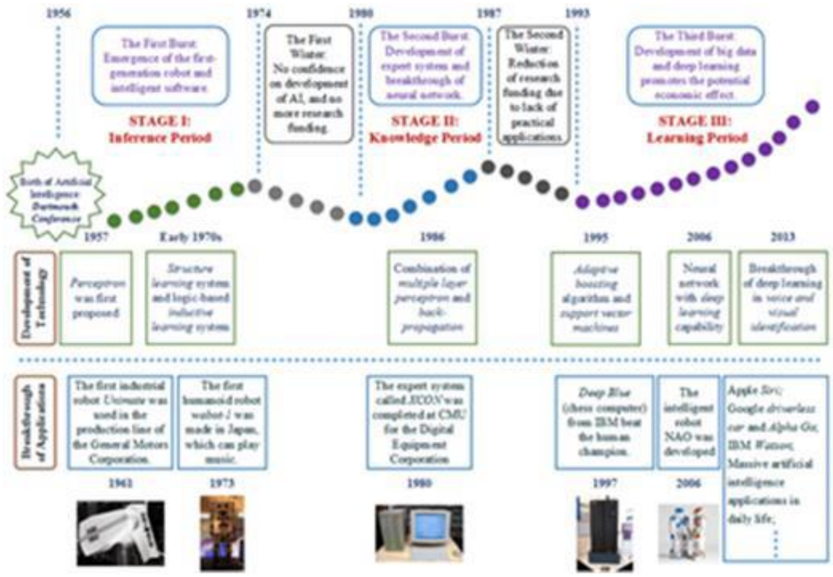

Figure 1: The Artificial Intelligence three waves.

INTELLIGENCE OF BIG DATA

Statistical reasoning is essential to contemporary technology and management. When managers or engineers convey problems with objective statistical facts, readers are more easily persuaded. Such information aids in determining cause-and-effect links in addition to providing clarity on the current state of affairs. The logic is strengthened by deductive reasoning, backed by statistical validation and induction. Effective quality practitioners should develop a firm foundation in statistical reasoning and a comprehensive understanding of the three fundamental concepts of quality: "essence of substance," "process of business," and "psychology." Big Data thinking is one crucial component of which suggests that businesses will shift from being providers of goods and services to providers of data. Although customer behavior data may appear chaotic, it often reveals underlying patterns. By leveraging Big Data, companies can assess market trends and adjust their products and operations accordingly (Adusumalli, 2016).

Organizations use the network's data, behaviours, and relationships to make predictions and decisions (Azam et al., 2021). Data has emerged as an essential asset, if not essential, for businesses in the age of big data. The capacity of Big Data to be mined and utilized for forecasting makes it valuable. Today, data assets provide significant advantages to competitors; even small businesses must utilize Big Data. Variables, attributes, flaws, and costs associated with internal and external failures are included in traditional quality data gathered through data collection, processing, statistical analysis, and root cause analysis (Pasupuleti, 2016b). In the past, skilled practitioners relied on these tried-and-true techniques to do their jobs well. If data collection, organization, analysis, and monitoring stay the same with the times, there may be clarity and difficulties. Nowadays, modern precision instruments embedded in various Internet of Things devices gather metrics like machine operation data, component diagnosis, lifespan estimation, and consumables monitoring (Pasupuleti et al., 2019). The growing importance of data mining and forecasting in data science makes them an important area of future research for quality management.

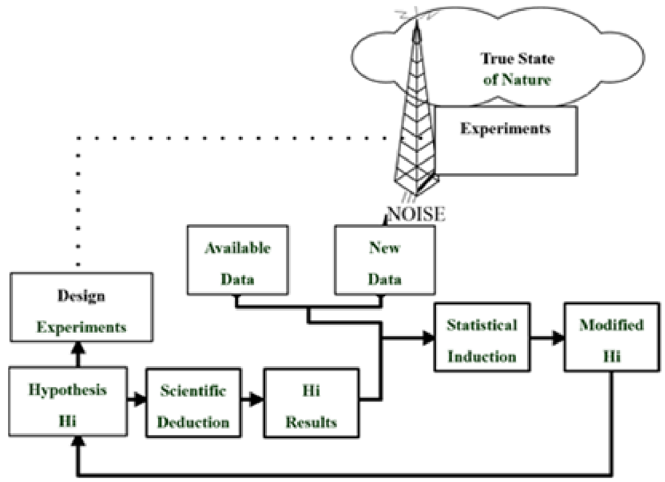

Figure 2: creation and evaluation of data for scientific studies.

THE QUALITY TRILOGY AND DATA SCIENCE

In November 1997, Dr. Chien-Fu Jeff Wu, who was named the H. C. Carver Chair Professor of Anthropology, delivered a commencement address at the University of Michigan. He described a three-pronged approach to statistical work in his talk, "Statistics = Data Science": data collection, modeling, analysis, and making decisions (or solving problems) Dr. Wu asserts that "data science" ought to take the place of "statistics" and that statisticians ought to transform into data scientists. In 1998, as part of the P.C. Mahalanobis Memorial Talk Series, he gave a lecture titled "Statistics = Data Science" in honor of Prasanta Chandra Mahalanobis, a well-known Indian statistician and founder of the Indian Statistical Institute.

Dr. Chien-Fu, Despite their limited statistical background, the authors view Jeff Wu's views from two decades ago as a forward-looking perspective. Wu predicted that statistics would become an essential tool in many other domains, considering the development of the traditional statistical triad. This triangle includes data collection, data modeling and analysis, and decision-making (Pasupuleti, 2017). In a similar vein, J. M. Juran's Quality Trilogy, which consists of planning for quality, controlling for quality, and improving for quality, has emerged as a well-known model for quality management since its introduction in 1986. This approach laid the groundwork for modern Quality Management (Figures 3, 4).

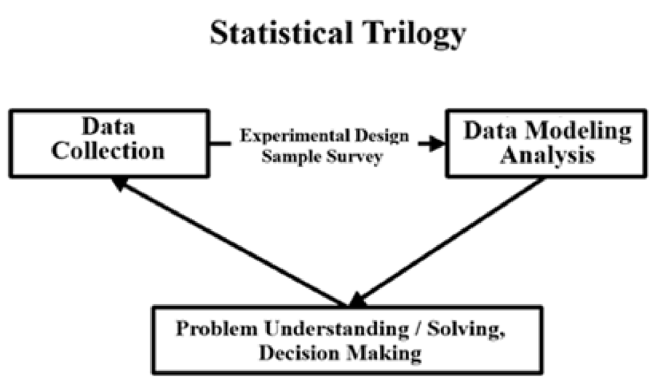

Figure 3: Trilogy of Statistics

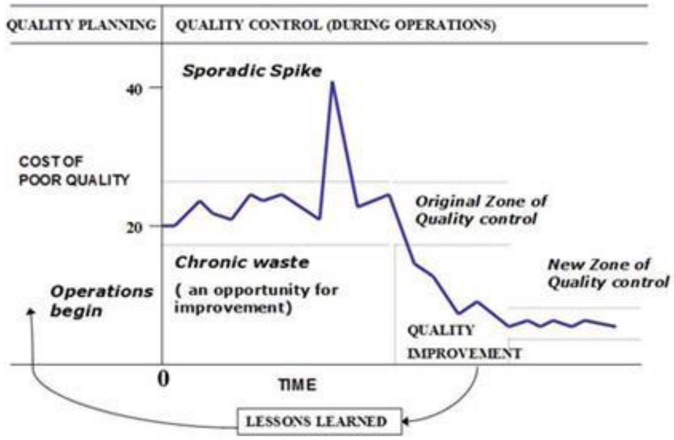

Figure 4: Trilogy based on Quality.

Data science is now a field of study that focuses on finding new insights in data in recent years. It aims to extract important data from large databases in order to produce data products. Applied Math and Insights, Example Acknowledgment and AI, Information Perception, Information Warehousing, and Elite Execution Processing are only a couple of spaces from which information science incorporates speculations and innovation (Adusumalli, 2017b). Technology of statistics is a key component within this field. Known applications of Data Science span various fields, helping both professionals and laypeople better understand complex problems through diverse data sources. Data Science and its associated technologies enable precise data processing and contribute to research and analysis in engineering, biology, social sciences, anthropology, and other areas. It plays a crucial role in corporate competition, similar to Quality Management, which intersects with fields such as education, sociology, law, engineering, and management (Pasupuleti, 2016a). The comprehensive nature of both Data Science and Quality Management is highlighted by the fact that they are wide subjects that cut across many academic domains.

Knowledge in this context can be categorized into professional expertise and general course knowledge. Professional knowledge must be highly specialized, while general knowledge should be well-rounded. Data Science has become a prominent topic, with millions of searches on Google and numerous articles and advertisements, including the well-known piece "Data Scientist: The Sexiest Job of the 21st Century." Despite its growing prominence, discussions on emerging technologies like Data Science, Big Data, and Artificial Intelligence are often limited, even though they are the natural outcomes of the advancement in information and communication technology. The following section will summarize and reiterate the teachings of Dr. Chien-Fu Jeff Wu (Figure 5).

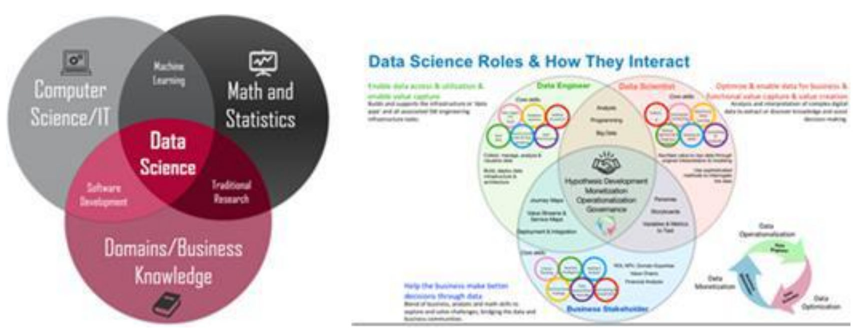

Figure 5: Images and ads for articles related to data science.

Scientific inquiry is an iterative and dynamic learning process. To conclude, it uses both induction and deduction. The goal of statistical approaches is to increase the effectiveness of this learning process. Statistical inference concludes closer to the truth by utilising information from experiments or observable occurrences. The three steps in this process—estimation, comparison, and prediction—combine to form the "induction method."

On the other hand, the deductive approach uses theories, models, and conjectures that already exist to develop hypotheses that are closer to reality. To ensure correctness, this method is carried out in a controlled setting and according to scientific logic (Adusumalli, 2017a). All things considered, this iterative method advances not only the breadth of knowledge but also the production and examination of scientific evidence in research (Figure 5).

INTEGRATION OF SCIENCE-TECHNOLOGY-UTILIZATION

To explore the evolution of modern quality management, we reference a paper aligned with Management Sciences. As it investigates the interaction between management science's sciences, technologies, and applications, this section focuses on quality-related research, technological breakthroughs, and application promotion.

The field of modern quality management has been developing for almost a century. The emergence of "Management Science" and the fusion of sciences, technology, and applications are strikingly similar. Early developments in the field of statistics, including sampling acceptance, control charts, and orthogonal experiments gave rise to Engineering and Industrial Statistics, which became crucial in modern quality management (Pasupuleti & Amin, 2018).

While statistical approaches and methods are vital for addressing quality issues, they must be complemented by principles related to content essence, business processes, and psychology. Over years of interdisciplinary integration, A multifaceted organisational strategy that prioritises leadership, goal-oriented management, full involvement, shared language, technology interchange, problem-solving, adaptability, cultural heritage, and people-centeredness has replaced the quality management system. This adaptable approach ensures that the strategy can evolve to meet changing needs and circumstances.

The field blends statistics, management, engineering, systems science, information science, and psychology to improve human quality of life. Enhancing quality is a team effort impacted by the technological and socioeconomic environments of local communities, nations, and international arenas. According to Adusumalli and Pasupuleti (2017), essential research fields include the defence industry, global trade, management systems, business models, production systems, communications, computing, data processing, and living circumstances.

Looking ahead, quality professionals should assess future projects within the "third wave of AI" to identify worthwhile initiatives.

ARTIFICIAL INTELLIGENCE FOR PRODUCTIVITY AND QUALITY ASSURANCE

Regarding "The Applications of Artificial Intelligence in Quality Technology," once again, the writers have updated their "Quality Philosophy" and "Core Values," which they believe are essential to success. The "Quality Philosophy" strongly emphasises problem resolution, adaptability, cultural heritage, leadership, management by objectives, full involvement, a common language, and a people-centred approach. In contrast, the "Core Values" emphasise that the ultimate aim should be practical application; the approach should be system integration; the motivation should come from concrete advantages; and sustainable development should be done for long-term effects and a healthy environment (Fadziso et al., 2018). The development of these concepts involves significant consideration and effort from participants. With "Industry 4.0" now a prominent topic in the field, the authors have been able to dedicate their focus to advancing individual development within the quality sector.

The professional field has yet to develop countermeasures to address these challenges (Rahman et al., 2019). In response to global manufacturing trends, the Taiwan Administration introduced productivity 4.0. Industrial computerization (Productivity 3.0), industrial automation (Productivity 1.0), and production automation) are the steps in the historical path that this effort builds upon. Productivity 4.0 combines the ideas of lean management with intelligent automation, big data, and technologies like the Internet of Things and smart robotics. This strategy aims to make it easier for domestic manufacturing industries to modernise and transition (Figure 6).

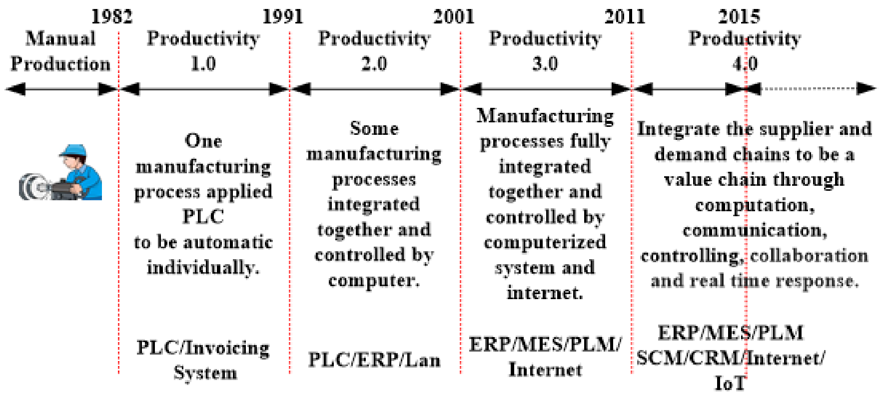

Figure 6: Productivity 1.0 to Productivity 4.0's historical long-term plans.

Table 1: The AI application

Simulation behavior	Related applications
Perception	Voice Recognition (ears), Image Recognition (eyes) (Hossen et al., 2021), Handwriting Recognition (eyes), Fingerprint Recognition (eyes)
Reasoning	Expert System, Computer Games, Computer Chess, Medical Diagnosis (brain)
Understanding	Machine Translation, Conversation System (brain)
Learning	Computer chess, expert system, medical diagnosis, identification (brain)
Action	Robot Soccer Game, Autonomous driving, Commercial robot, Smart Controller (hands, feet and body)

The following briefly captures the author's guiding concept for the "Industry 4.0" discussion: "From the perspective of micro-industry development, Industry 4.0 will foster diverse new business models through personalised design and marketing." The supplier chain, which includes purchasing, production control, material handling, production, and shipping, is linked to the demand chain, which includes ordering, logistics, retail, and maintenance services using this system, which unifies all processes into a unified value chain (Hossen et al., 2021). This cross-company information system allows customers to request relevant engineering information directly from suppliers, facilitating two-way interaction between customers and suppliers through the combination of computation, communication, control, cooperation, and real-time responses. This interaction shortens the time between pilot runs and mass production and speeds up the procedures of quality analysis, quality improvement, and design enhancement (Yannan et al., 2021). The system offers a clear and complete information interface for customer-supplier collaboration in logistics, including everything from lot status and shipping to customer orders and production schedules. Customers can access and analyze this information in advance, enabling immediate resolution of common issues between parties. This scenario represents Industry 4.0's vision for managing production activities. While some advanced firms have achieved this level of self-improvement, small and medium-sized enterprises (SMEs) often lack the capability. The MESA / ISA-95 standard outlines the manufacturing management system hierarchy. SMEs can realize the vision of Industry 4.0 by gradually following the steps outlined in the Smart Factory Operation Schematic (Figure 7), progressively enhancing the quality of internal operational information (Figures 6, 7).

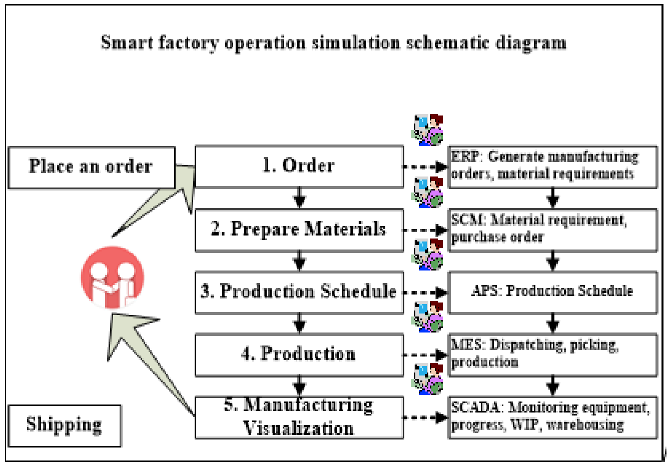

Figure 7: Diagram showing the schematic operation of a smart factory

Whether theoretical or applied, the quality professional sector usually has yet to have a mainstream place in the Manufacturing Operation Management system (Pasupuleti & Adusumalli, 2018). Incoming Quality Control (IQC) functions as a voucher for accounts payable in the ERP system or is connected to the SCM system. Processing customer complaints is a voucher for sales returns and allowances inside the ECM system (Madding et al., 2020). Comparably, Outgoing Quality Control (OQC) is a voucher for accounts receivable in the ERP system or is linked to the CRM system, whilst In-Process Quality Control (IPQC) serves as a voucher for salaries in the ERP system or is connected to the MES system. Therefore, having a standalone Quality Information System (QIS) that operates independently is neither practical nor useful. However, in the quality professional field, adopting the quality management system model (such as the ISO 9000 series) to integrate with other systems, using system integration technology, can enhance the digitization of quality control processes. This integration is essential for the digital transformation journey from productivity 1.0 through productivity 2.0 and 3.0, and ultimately to productivity 4.0, making it a more practical and feasible approach in the field of quality management.

CONCLUSION

The author argues that quality assurance and productivity assurance—which go beyond artificial intelligence—should be tailored to each organization's unique requirements. Enterprise modernisation and transformation are supported by the evolution from production automation (Productivity 1.0) to industrial automation (Productivity 2.0) to industrial computerisation (Productivity 3.0). Using computation, communication, control, cooperation, and real-time responsiveness, for example, integrating processes from the supplier chain—such as purchasing and production control—through to the demand chain—which includes ordering, logistics delivery, retail, and maintenance service—can result in a cohesive value chain. The visibility of quality requirements inside the Productivity 4.0 value chain will grow as the demand chain develops, necessitating improved goods and services.

REFERENCES

[1]. Adusumalli, H. P. (2016). How Big Data is Driving Digital Transformation? *ABC Journal of Advanced Research*, *5*(2), 131-138. https://doi.org/10.18034/abcjar.v5i2.616

[2]. Adusumalli, H. P. (2017a). Mobile Application Development through Design-based Investigation. *International Journal of Reciprocal Symmetry and Physical Sciences*, *4*, 14–19. Retrieved from https://upright.pub/index.php/ijrsps/article/view/58

[3]. Adusumalli, H. P. (2017b). Software Application Development to Backing the Legitimacy of Digital Annals: Use of the Diplomatic Archives. *ABC Journal of Advanced Research*, *6*(2), 121-126. https://doi.org/10.18034/abcjar.v6i2.618

[4]. Adusumalli, H. P. (2018). Digitization in Agriculture: A Timely Challenge for Ecological Perspectives. *Asia Pacific Journal of Energy and Environment*, *5*(2), 97-102. https://doi.org/10.18034/apjee.v5i2.619

[5]. Adusumalli, H. P. (2019). Expansion of Machine Learning Employment in Engineering Learning: A Review of Selected Literature. *International Journal of Reciprocal Symmetry and Physical Sciences*, *6*, 15–19. Retrieved from https://upright.pub/index.php/ijrsps/article/view/65

[6]. Adusumalli, H. P., & Pasupuleti, M. B. (2017). Applications and Practices of Big Data for Development. *Asian Business Review*, *7*(3), 111-116. https://doi.org/10.18034/abr.v7i3.597

[7]. Ahmed, A.A.A. (2021). Event Ticketing Accounting Information System using RFID within the COVID-19 Fitness Etiquettes. Academia Letters, Article 1379. https://doi.org/10.20935/AL1379

[8]. Azam, M. A., Mittelmann, H. D., & Ragi, S. (2021). UAV Formation Shape Control via Decentralized Markov Decision Processes. *Algorithms*, *14*(3), 91. https://doi.org/10.3390/a14030091

[9]. Fadziso, T., Adusumalli, H. P., & Pasupuleti, M. B. (2018). Cloud of Things and Interworking IoT Platform: Strategy and Execution Overviews. *Asian Journal of Applied Science and Engineering*, *7*, 85–92. Retrieved from https://upright.pub/index.php/ajase/article/view/63 Chisty and Adusumalli: Applications of Artificial Intelligence in Quality Assurance and Assurance of Productivity (23-32) Page 32 Volume 11, No 1/2022 | ABCJAR

[10]. Hossen, M. A., Diwakar, P. K. & Ragi, S. (2021). Total nitrogen estimation in agricultural soils via aerial multispectral imaging and LIBS. *Scientific Reports, 11,* 12693. https://doi.org/10.1038/s41598-021-90624-6

[11]. Hossen, M. A., Zahir, E., Ata-E-Rabbi, H. M., Azam, M. A., and Rahman, M. H. (2021). Developing a Mobile Automated Medical Assistant for Hospitals in Bangladesh. 2021 IEEE World AI IoT Congress (AIIoT), 0366-0372, https://doi.org/10.1109/AIIoT52608.2021.9454236

[12]. Kuan, S. P. and Perng, H. L. (2019). Knowledge should be owned by quality practitioners in the IT age. *J Traffic Transportation Engg. 7*.

[13]. Madding, C., Ansari, A., Ballenger, C., Thota, A. (2020). Topic Modeling to Understand Technology Talent. *SMU Data Science Review*, *3*(2), 1-18.

[14]. Pasupuleti, M. B. (2016a). Data Scientist Careers: Applied Orientation for the Beginners. *Global Disclosure of Economics and Business*, *5*(2), 125-132. https://doi.org/10.18034/gdeb.v5i2.617

[15]. Pasupuleti, M. B. (2016b). The Use of Big Data Analytics in Medical Applications. *Malaysian Journal of Medical and Biological Research*, *3*(2), 111-116. https://doi.org/10.18034/mjmbr.v3i2.615

[16]. Pasupuleti, M. B. (2017). AMI Data for Decision Makers and the Use of Data Analytics Approach. *Asia Pacific Journal of Energy and Environment*, *4*(2), 65-70. https://doi.org/10.18034/apjee.v4i2.623

[17]. Pasupuleti, M. B. (2020). Artificial Intelligence and Traditional Machine Learning to Deep Neural Networks: A Study for Social Implications. *Asian Journal of Humanity, Art and Literature*, *7*(2), 137-146. https://doi.org/10.18034/ajhal.v7i2.622

[18].Pasupuleti, M. B., & Adusumalli, H. P. (2018). Digital Transformation of the High-Technology Manufacturing: An Overview of Main Blockades. *American Journal of Trade and Policy*, *5*(3), 139-142. https://doi.org/10.18034/ajtp.v5i3.599

[19].Pasupuleti, M. B., & Amin, R. (2018). Word Embedding with ConvNet-Bi Directional LSTM Techniques: A Review of Related Literature. *International Journal of Reciprocal Symmetry and Physical Sciences*, *5*, 9–13. Retrieved from https://upright.pub/index.php/ijrsps/article/view/64

[20].Pasupuleti, M. B., Miah, M. S., & Adusumalli, H. P. (2019). IoT for Future Technology Augmentation: A Radical Approach. *Engineering International*, *7*(2), 105-116. https://doi.org/10.18034/ei.v7i2.601

[21].Ragi, S., Rahman, M. H., Duckworth, J., Kalimuthu, J., Chundi P. and Gadhamshetty, V. (2021). Artificial Intelligence-driven Image Analysis of Bacterial Cells and Biofilms. ACM Transactions on Computational Biology and Bioinformatics, https://doi.org/10.1109/TCBB.2021.3138304

[22].Rahman, M. M., Pasupuleti, M. B., & Adusumalli, H. P. (2019). Advanced Metering Infrastructure Data: Overviews for the Big Data Framework. *ABC Research Alert, 7*(3), 159-168. https://doi.org/10.18034/abcra.v7i3.602

[23].Yannan, D., Ahmed, A. A. A., Kuo, T., Malik, H. A., Nassani, A. A., Haffar, M., Suksatan, W., & Iramofu, D. P. F. (2021). Impact of CSR, innovation, and green investment on sales growth: new evidence from manufacturing industries of China and Saudi Arabia, Economic Research-Ekonomska Istraživanja, https://doi.org/10.1080/1331677X.2021.2015610