Journal of Economic Theory and Business Management
Journal Home: https://jetbm.suaspress.org/ | CODEN: JETBAU
Vol. 1, No. 6, 2024 | ISSN 3006-4953 (Print) | ISSN 3006-4961 (Online)

Investigating the Impact of AI-Driven Voice Assistants on User Productivity and Satisfaction in Smart Homes

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Abstract: Artificial Intelligence (AI)-driven voice assistants, such as Amazon's Alexa and Google Assistant, have become essential components in modern smart home ecosystems, revolutionizing the way users interact with their environments. These voice assistants enable hands-free control over various home automation systems, offering unprecedented levels of convenience and enhancing daily productivity. By integrating with a wide range of smart devices—from lighting and temperature control to security systems and entertainment—AI-driven voice assistants simplify the management of daily routines, allowing users to perform tasks more efficiently with minimal effort.

This study aims to explore the influence of AI-driven voice assistants on user productivity and overall satisfaction within smart homes. Employing both quantitative data collection methods, such as usage statistics and automation completion rates, alongside qualitative insights gathered from user feedback, we conduct a comprehensive analysis of how voice-controlled smart home interactions affect daily activities. The research examines aspects such as task completion speed, automation accuracy, and the seamlessness of multi-device integrations, in addition to the subjective user experience, including perceived ease of use, convenience, and general satisfaction with the system.

Our findings suggest that AI-driven voice assistants offer considerable improvements in user productivity, reducing the time and effort required to complete tasks by streamlining processes and enabling multi-tasking. Additionally, users reported higher satisfaction levels due to the simplicity and efficiency introduced by these technologies. However, the study also highlights ongoing challenges, particularly regarding the assistants' limited ability to understand complex contextual information and the growing concerns over privacy and data security. Despite these issues, the positive impact of AI-driven voice assistants on smart home ecosystems is clear, with potential for further enhancements as the technology evolves.

Keywords: Human-Computer Interaction, AI-Driven Voice Assistants, Natural Language Processing, Voice Recognition Accuracy, Privacy and Data Security.

Disciplines: Business and Management. **Subjects:** Smart Home Market.

DOI: https://doi.org/10.70393/6a6574626d.323333 **ARK:** https://n2t.net/ark:/40704/JETBM.v1n6a02

1 INTRODUCTION

With the rapid advancement of smart home technology, AI-driven voice assistants have become indispensable tools for managing day-to-day tasks and improving user convenience. These voice-enabled systems, such as Amazon Alexa, Google Assistant, and Apple's Siri, seamlessly integrate with a variety of smart devices, including lighting systems, thermostats, security cameras, and entertainment hubs, allowing users to control their home environment through simple voice commands. Whether it's adjusting the thermostat, turning off lights, setting alarms, or streaming media, these voice assistants offer a hands-free, intuitive way to interact with technology, making them central to the modern smart home experience[1,2,4].

While the convenience provided by these voice assistants is widely recognized, there remains a significant gap in quantifying their true impact on user productivity and overall satisfaction within smart home ecosystems[3,5,6]. Existing literature often focuses on the technical capabilities of AI-driven voice assistants or their role in individual use cases, but there is a lack of comprehensive studies that measure how effectively they streamline household management, reduce manual effort, and optimize daily routines. This paper seeks to fill that gap by investigating the role AI-driven voice assistants play in enhancing productivity and user satisfaction[7-9].

The core of our study examines how voice commands simplify routine tasks, minimize the need for direct interaction with multiple devices, and reduce cognitive load by automating previously manual processes. By allowing

users to operate their smart home systems more efficiently, voice assistants can improve time management and free users from the need to perform repetitive or complex tasks, such as manually adjusting lighting settings throughout the day or juggling different remotes for entertainment systems. We also assess how these systems contribute to the overall user experience by providing a sense of ease and control in managing their environment[10-13].

In addition to the benefits, we also address several challenges and limitations faced by users when interacting with AI-driven voice assistants. Voice recognition errors, for instance, can cause frustration, especially in scenarios where the assistant misinterprets commands or fails to recognize certain accents or speech patterns. Furthermore, privacy concerns have emerged as a major issue, as users become increasingly aware of the data these devices collect and how it is used. Lastly, despite advancements in natural language processing (NLP), voice assistants still struggle with understanding complex, multi-step commands or context-sensitive instructions, which can limit their functionality in more advanced use cases[14].

By exploring both the advantages and challenges of AI-driven voice assistants, this paper aims to provide a holistic understanding of their role in smart homes. Through a combination of quantitative data analysis and qualitative user feedback, we offer insights into how these voice-controlled systems impact user productivity and satisfaction, while also highlighting areas where further development is needed to overcome existing limitations[15,16].

2 RELATED WORK

Voice assistants, powered by artificial intelligence (AI) and advanced natural language processing (NLP) technologies, have gained significant traction in the realm of Human-Computer Interaction (HCI). These systems, including popular platforms like Amazon Alexa, Google Assistant, and Apple Siri, enable users to interact with their devices through voice commands, creating a more seamless and intuitive user experience. The rise of AI-driven voice assistants reflects the growing demand for hands-free, frictionless methods of controlling and managing technology, particularly in environments like smart homes where convenience and efficiency are prioritized[17,18].

Research in HCI has increasingly focused on the advantages of voice assistants, particularly in terms of reducing the cognitive and physical effort required to perform certain tasks[19]. Hands-free voice interaction, as opposed to traditional methods such as using touchscreens, keyboards, or physical controls, can significantly reduce the friction associated with executing commands. Studies have demonstrated that users are able to complete tasks more quickly and efficiently by issuing simple voice commands, rather than navigating multiple steps through a graphical user interface (GUI)[20-24]. This reduction in complexity becomes especially valuable in multitasking scenarios, where users can manage multiple activities simultaneously, such as adjusting home lighting while cooking or asking for the weather while driving[25].

Beyond enhancing individual task efficiency, voice assistants also excel in multitasking situations, where their ability to process sequential or parallel commands allows users to perform several actions concurrently. For instance, users can ask a voice assistant to turn on the lights, play music, and set a timer, all within a single session. These systems, therefore, offer substantial time savings and convenience, making them a crucial tool in modern smart homes, workplaces, and even public spaces[26,27].

However, despite the clear benefits, previous research also highlights a number of limitations associated with voice-controlled systems. One major drawback is their reduced accuracy in noisy environments, where background sounds or interference can compromise the system ' s ability to accurately interpret voice commands. This issue is particularly pronounced in open or shared spaces, where multiple voices or external sounds can confuse the AI, leading to frustration and inefficiency for users. Another prominent concern is related to privacy and security, as these devices typically rely on continuous listening in order to be responsive to voice activation cues such as "Hey Alexa" or "OK Google." The always-on nature of these assistants has raised concerns about data security, unauthorized recording, and potential misuse of sensitive information.

In addition to environmental and privacy challenges, voice assistants also face technical limitations, particularly in their ability to understand complex commands or manage contextual continuity across interactions. While advancements in NLP have improved their capability to process natural language, many voice assistants still struggle to handle commands that involve multiple steps, intricate phrasing, or ambiguity. For example, asking a voice assistant to "dim the lights only in the living room and turn off the kitchen lights after 30 minutes" may result in errors or incomplete execution. Moreover, the ability to remember the context of a conversation over multiple interactions—such as knowing which room's lights were discussed in a prior command — remains underdeveloped in many systems, limiting their effectiveness in more advanced or nuanced situations[28,30].

Despite these limitations, relatively few studies have investigated the long-term impact of AI-driven voice assistants on user satisfaction and productivity in smart home environments[29]. Most research focuses on short-term assessments, evaluating the immediate benefits and drawbacks of these systems, without delving into their sustained impact on daily life. As AI technology continues to evolve and integrate more deeply into home automation systems, understanding the long-term implications of voice assistants is critical for shaping the future of HCI and AI development. This research aims to address this gap by exploring how voice assistants influence user productivity,

convenience, and overall satisfaction over extended periods of use, while also examining potential solutions to overcome existing limitations such as noise interference, privacy concerns, and command complexity[31].

By conducting a comprehensive analysis of voice assistant usage in smart homes, this study provides valuable insights into how these technologies enhance or hinder the user experience, ultimately informing the design and development of next-generation AI-driven home automation solutions[32,33].

3 LITERATURE REFERENCES

This study integrates both quantitative and qualitative methodologies to evaluate the influence of AI-driven voice assistants on user productivity and satisfaction within smart home environments. By combining measurable task performance data with subjective user experiences, we aim to gain a comprehensive understanding of how these voice assistants—such as Amazon Alexa, Google Assistant, and Apple Siri—enhance or hinder the user experience in a smart home context[34-36].

3.1 PARTICIPANTS

The study was conducted with a sample of 50 participants, all of whom had been using AI-driven voice assistants regularly in their smart homes for a minimum of six months. This time frame ensured that participants were familiar with the technology and had integrated it into their daily routines. To capture a broad range of user experiences, the participant pool represented diverse demographic groups, including variations in age, technological proficiency, and household size. The diversity of participants allowed the study to assess how different user backgrounds and lifestyles might influence the perceived effectiveness of voice assistants. For example, we included individuals from different age brackets (young adults, middle-aged users, and seniors), varying degrees of technical expertise (ranging from novice users to tech-savvy individuals), and household compositions (single occupants, families, and shared living arrangements). This diversity ensured that the study's findings would be applicable to a wide audience, highlighting how factors such as age, tech familiarity, or household dynamics could impact user satisfaction and productivity[37-39].

3.2 EXPERIMENTAL SETUP

The experimental phase of the study spanned two weeks, during which participants were asked to perform a predefined set of daily tasks in their smart homes under two distinct conditions: once using voice assistants and once using manual methods of control (such as apps, remotes, or physical switches). This setup allowed us to make direct comparisons between the convenience and efficiency of voice-command-based interaction and traditional manual control systems. The tasks selected for this study were representative of common activities performed in smart homes, ensuring that the findings would be relevant to typical smart home usage scenarios. The tasks included:

Adjusting home lighting: Participants were asked to control lighting systems, including turning lights on or off, dimming them, or changing colors in smart lighting setups.

Setting timers and reminders: Users were instructed to create reminders and set timers for various purposes, such as cooking or scheduling household chores.

Managing media: Participants were tasked with using voice assistants to play or control music and television, including adjusting volume or switching between devices.

Controlling smart thermostats and security systems: Participants were asked to adjust the temperature using smart thermostats and manage their home security systems, such as locking doors or checking camera feeds through voice commands.

Throughout the study, we recorded several key performance metrics, such as the time taken to complete each task (task completion time), how many attempts were needed to successfully complete the task (task success rate), and any errors encountered, such as failed voice recognition or incorrect command execution. In addition to the quantitative data, participants provided qualitative feedback via post-task surveys after each session. These surveys gathered insights into their experiences, perceived convenience, and any frustrations they encountered while using voice assistants. Furthermore, participants were asked to provide suggestions for potential improvements to the functionality and usability of these systems, offering a user-centered perspective on areas that could benefit from refinement.

3.3 METRICS

To assess the overall impact of AI-driven voice assistants on productivity and user satisfaction, we employed a combination of objective performance metrics and subjective user feedback. The following metrics were used:

Task Completion Time: This metric measured the amount of time participants took to complete each task, comparing the time required to perform a task using voice commands with the time required to complete the same task manually. By analyzing the differences, we could quantify how much time, if any, was saved by using a voice assistant[39,40].

Task Success Rate: This metric tracked the percentage of tasks that were successfully completed on the first attempt, without the need for reissuing commands or troubleshooting. A high task success rate would indicate that voice assistants were reliable and efficient, while a lower success rate would point to issues such as incorrect command recognition or execution errors.

User Satisfaction: After each task, participants were asked to rate their satisfaction with the voice assistant's

performance using a 5-point Likert scale. The scale assessed multiple aspects, including the accuracy of the system's responses, ease of use, overall functionality, and how intuitive the voice assistant was. This data helped us understand how users felt about the technology in terms of their overall experience.

Productivity Gain: In addition to measuring time savings and task success rates, we aimed to capture the broader impact on users' perceived productivity. Participants were asked to rate their perceived productivity gain on a self-reported productivity scale. This metric evaluated how the use of voice assistants affected their cognitive load—whether the system made them feel more productive and less mentally burdened while managing household tasks. By asking participants to reflect on their level of mental effort and efficiency while using the voice assistants compared to manual controls, we were able to measure the reduction in cognitive load and identify whether voice assistants genuinely contributed to a more streamlined and productive environment[41-43].

By combining these metrics, the study provides a holistic view of how AI-driven voice assistants impact daily life in smart homes, from their effect on task efficiency and user satisfaction to their potential limitations. These insights will be crucial in guiding the future development of smarter, more intuitive home automation systems[44]

4 RESULTS

The results of the study provide a detailed insight into how AI-driven voice assistants influence productivity and user satisfaction in smart homes.

H	*Path*	*Coef.*	*t-test, sig*
H1	Performance expectancy → Satisfaction with digital assistants	0.327	(7.860***)
H2	Effort expectancy → Satisfaction with digital assistants	0.046	(1.142^{ns})
H3	Perceived enjoyment → Satisfaction with digital assistants	0.276	(5.613***)
H4	Trust → satisfaction with digital assistants	0.184	(5.952***)
H5	Perceived social presence → Satisfaction with digital assistants	0.123	(3.093**)
H6	Anthropomorphism → Satisfaction with digital assistants	0.005	(0.129^{ns})
H7	Intelligence → Satisfaction with digital assistants	0.167	(4.332***)
H8	Satisfaction with digital assistants → Job engagement	0.775	(17.830***)
H9	Satisfaction with digital assistants → Productivity	0.827	(19.180***)

FIG. 1 FACTORS AFFECTING SATISFACTION WITH DIGITAL ASSISTANTS

4.1 TASK COMPLETION TIME

Tasks performed using voice assistants were completed significantly faster than those completed manually. On average, participants experienced a 40% reduction in task completion time when using voice commands. The most notable improvements were observed in tasks such as adjusting lighting and setting timers, where participants saved considerable time compared to navigating a smartphone app or manually operating switches.

4.2 TASK SUCCESS RATE

The overall task success rate was 92% for tasks performed with voice assistants, compared to 100% for manual tasks. Common reasons for failed attempts included voice recognition errors, misunderstood commands, or ambiguous phrasing. Participants also noted occasional difficulty in issuing precise commands for multi-step processes, such as adjusting lighting and temperature simultaneously.

4.3 USER SATISFACTION

Participants reported high satisfaction when using voice assistants, with an average satisfaction score of 4.5 out of 5. Users praised the convenience of hands-free control, particularly in multitasking situation. However, satisfaction scores dropped when voice recognition errors occurred, particularly in noisy environments or when attempting to issue complex commands. Privacy concerns were also frequently mentioned, with some participants expressing discomfort with the voice assistant's always-on listening feature.

4.4 PRODUCTIVITY GAIN

In terms of perceived productivity, participants reported feeling more efficient when using voice assistants. The hands-free nature of interaction allowed users to complete tasks while engaged in other activities, leading to an average productivity gain score of 4.3/5. However, some participants expressed frustration with the system's inability to handle complex or context-dependent commands, which they felt hindered productivity in certain scenarios.

5 DISCUSSION

The results of this study suggest that AI-driven voice assistants significantly improve user productivity in smart homes by reducing task completion time and allowing for multitasking. The ease of issuing voice commands for routine tasks, such as adjusting home lighting or setting timers, contributed to higher user satisfaction. However, certain limitations persist.

5.1 VOICE RECOGNITION AND COMMAND COMPLEXITY

While voice assistants performed well for simple tasks, their effectiveness diminished for more complex or multi-step instructions. Voice recognition errors were more likely in noisy environments or when users issued commands that required contextual understanding. This indicates that, although AI-driven voice assistants enhance productivity for straightforward tasks, further improvements in NLP and contextual awareness are needed to handle more sophisticated interactions effectively.

5.2 PRIVACY AND SECURITY CONCERNS

One of the most frequently mentioned concerns was user privacy, particularly regarding the always-on listening capabilities of voice assistants. Some participants expressed

hesitation in using voice assistants for tasks involving sensitive information (e.g., controlling security systems or accessing personal data). Future developments in voice assistants should focus on transparent privacy controls, giving users more confidence in the security of their smart home systems.

5.3 Long-Term Adoption and User Trust

Although participants reported positive experiences, long-term adoption and user trust are heavily influenced by the system's reliability and perceived security. Developing more robust AI that can handle complex commands and better mitigate recognition errors will be key to sustaining user trust and satisfaction in the long run.

6 CONCLUSION

This study demonstrates that AI-driven voice assistants significantly enhance productivity and user satisfaction in smart homes, particularly for routine tasks that benefit from hands-free operation. While current voice assistants excel in simple command execution, they face challenges with more complex tasks and privacy concerns. Continued advancements in natural language processing and AI-driven context awareness will be essential to fully realize the potential of voice assistants in smart home environments.

ACKNOWLEDGMENTS

The authors thank the editor and anonymous reviewers for their helpful comments and valuable suggestions.

FUNDING

Not applicable.

INSTITUTIONAL REVIEW BOARD STATEMENT

Not applicable.

INFORMED CONSENT STATEMENT

Not applicable.

DATA AVAILABILITY STATEMENT

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Not applicable.

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REFERENCES

[1] Sheng, Z., Wu, F., Zuo, X., Li, C., Qiao, Y., & Hang, L. (2024). LProtector: An LLM-driven Vulnerability Detection System. arXiv preprint arXiv:2411.06493.

[2] Yan, H., Xiao, J., Zhang, B., Yang, L., & Qu, P. (2024). The Application of Natural Language Processing Technology in the Era of Big Data. Journal of Industrial Engineering and Applied Science, 2(3), 20-27.

[3] Zhang, W., Huang, J., Wang, R., Wei, C., Huang, W., & Qiao, Y. (2024). Integration of Mamba and Transformer--MAT for Long-Short Range Time Series Forecasting with Application to Weather Dynamics. arXiv preprint arXiv:2409.08530.

[4] Yi, X., & Qiao, Y. (2024). GPU-Based Parallel Computing Methods for Medical Photoacoustic Image Reconstruction. arXiv preprint arXiv:2404.10928.

[5] Sun, Y., & Ortiz, J. (2024). Machine Learning-Driven Pedestrian Recognition and Behavior Prediction for Enhancing Public Safety in Smart Cities. Journal of Artificial Intelligence and Information, 1, 51-57.

[6] Song, C., Wu, B., & Zhao, G. (2024). Applications of Novel Semiconductor Materials in Chip Design. Journal of Industrial Engineering and Applied Science, 2(4), 81–89.

[7] Li, W. (2024). Transforming Logistics with Innovative

Interaction Design and Digital UX Solutions. Journal of Computer Technology and Applied Mathematics, 1(3), 91-96.

[8] Zhong, Y. N. (2024). Optimizing the Structural Design of Computing Units in Autonomous Driving Systems and Electric Vehicles to Enhance Overall Performance Stability. International Journal of Advance in Applied Science Research, 3, 93-98.

[9] Zhong, Y. (2024). Enhancing the Heat Dissipation Efficiency of Computing Units Within Autonomous Driving Systems and Electric Vehicles.

[10] Yan, Y., Guo, F., Mo, H., & Huang, X. (2024, March). Hierarchical Tracking Control for a Composite Mobile Robot Considering System Uncertainties. In 2024 16th International Conference on Computer and Automation Engineering (ICCAE) (pp. 512-517). IEEE.

[11] Guo, F., Mo, H., Wu, J., Pan, L., Zhou, H., Zhang, Z., ... & Huang, F. (2024). A hybrid stacking model for enhanced short-term load forecasting. Electronics, 13(14), 2719.

[12] Zhao, G., Li, P., Zhang, Z., Guo, F., Huang, X., Xu, W., ... & Chen, J. (2024). Towards sar automatic target recognition multicategory sar image classification based on light weight vision transformer. arXiv preprint arXiv:2407.06128.

[13] Qiao, Y., Li, K., Lin, J., Wei, R., Jiang, C., Luo, Y., & Yang, H. (2024, June). Robust domain generalization for multi-modal object recognition. In 2024 5th International Conference on Artificial Intelligence and Electromechanical Automation (AIEA) (pp. 392-397). IEEE.

[14] Sheng, Z., Li, Y., Li, Z., & Liu, Z. (2019, August). Displacement Measurement Based on Computer Vision. In 2019 International Conference on Sensing, Diagnostics, Prognostics, and Control (SDPC) (pp. 448-453). IEEE.

[15] Wang, H., Wang, G., Sheng, Z., & Zhang, S. (2019). Automated segmentation of skin lesion based on pyramid attention network. In Machine Learning in Medical Imaging: 10th International Workshop, MLMI 2019, Held in Conjunction with MICCAI 2019, Shenzhen, China, October 13, 2019, Proceedings 10 (pp. 435-443). Springer International Publishing.

[16] Xu, C., Yu, J., Chen, W., & Xiong, J. (2024, January). Deep learning in photovoltaic power generation forecasting: Cnn-lstm hybrid neural network exploration and research. In The 3rd International Scientific and Practical Conference (Vol. 363, p. 295).

[17] Zhu, M., Zhang, Y., Gong, Y., Xu, C., & Xiang, Y. (2024). Enhancing Credit Card Fraud Detection A Neural Network and SMOTE Integrated Approach. arXiv preprint arXiv:2405.00026.

[18] Sun, Y., & Ortiz, J. (2024). Data Fusion and Optimization Techniques for Enhancing Autonomous Vehicle Performance in Smart Cities. Journal of Artificial Intelligence and Information, 1, 42-50.

[19] Sokolov, A., Sabelli, F., Li, W., & Seco, L. A. (2023). Towards Automating Causal Discovery in Financial Markets and Beyond. Behzad and Li, Wuding and Seco, Luis A., Towards Automating Causal Discovery in Financial Markets and Beyond (December 27, 2023).

[20] Wu, J., & Xiao, J. (2024). Application of Natural Language Processing in Network Security Log Analysis. Journal of Computer Technology and Applied Mathematics, 1(3), 39-47.

[21] Xiao, J., & Wu, J. (2024). Transfer Learning for Cross-Language Natural Language Processing Models. Journal of Computer Technology and Applied Mathematics, 1(3), 30-38.

[22] Wu, B., Song, C., & Zhao, G. (2024). Applications of Heterogeneous Integration Technology in Chip Design. Journal of Industrial Engineering and Applied Science, 2(4), 66–72.

[23] Song, C., Wu, B., & Zhao, G. (2024). Optimization of Semiconductor Chip Design Using Artificial Intelligence. Journal of Industrial Engineering and Applied Science, 2(4), 73–80.

[24] Li, W. (2024). User-Centered Design for Diversity: Human-Computer Interaction (HCI) Approaches to Serve Vulnerable Communities. Journal of Computer Technology and Applied Mathematics, 1(3), 85-90.

[25] Wu, J., Qu, P., Zhang, B., & Zhou, Z. (2024). Sentiment Analysis in Social Media: Leveraging BERT for Enhanced Accuracy. Journal of Industrial Engineering and Applied Science, 2(4), 143-149.

[26] Zhang, B., Xiao, J., Yan, H., Yang, L., & Qu, P. (2024). Review of NLP Applications in the Field of Text Sentiment Analysis. Journal of Industrial Engineering and Applied Science, 2(3), 28-34.

[27] Dang, B., Ma, D., Li, S., Qi, Z., & Zhu, E. (07 2024). Deep learning-based snore sound analysis for the detection of night-time breathing disorders. Applied and Computational Engineering, 76, 109–114. doi:10.54254/2755-2721/76/20240574

[28] Chen, Q., & Wang, L. (2024). Social Response and Management of Cybersecurity Incidents. Academic Journal of Sociology and Management, 2(4), 49-56.

[29] Song, C. (2024). Optimizing Management Strategies for Enhanced Performance and Energy Efficiency in Modern Computing Systems. Academic Journal of Sociology and Management, 2(4), 57-64.

[30] Chen, Q., Li, D., & Wang, L. (2024). Blockchain Technology for Enhancing Network Security. Journal of Industrial Engineering and Applied Science, 2(4), 22-28.

[31] Chen, Q., Li, D., & Wang, L. (2024). The Role of Artificial Intelligence in Predicting and Preventing Cyber Attacks. Journal of Industrial Engineering and Applied Science, 2(4), 29-35.

[32] Chen, Q., Li, D., & Wang, L. (2024). Network Security in the Internet of Things (IoT) Era. Journal of Industrial Engineering and Applied Science, 2(4), 36-41.

[33] Li, D., Chen, Q., & Wang, L. (2024). Cloud Security: Challenges and Solutions. Journal of Industrial Engineering and Applied Science, 2(4), 42-47.

[34] Zhang, N., Xiong, J., Zhao, Z., Feng, M., Wang, X., Qiao, Y., & Jiang, C. (2024). Dose My Opinion Count? A CNN-LSTM Approach for Sentiment Analysis of Indian General Elections. Journal of Theory and Practice of Engineering Science, 4(05), 40-50.

[35] Wang, X., Qiao, Y., Xiong, J., Zhao, Z., Zhang, N., Feng, M., & Jiang, C. (2024). Advanced network intrusion detection with tabtransformer. Journal of Theory and Practice of Engineering Science, 4(03), 191-198.

[36] Li, D., Chen, Q., & Wang, L. (2024). Phishing Attacks: Detection and Prevention Techniques. Journal of Industrial Engineering and Applied Science, 2(4), 48-53.

[37] Song, C., Zhao, G., & Wu, B. (2024). Applications of Low-Power Design in Semiconductor Chips. Journal of Industrial Engineering and Applied Science, 2(4), 54–59.

[38] Zhao, G., Song, C., & Wu, B. (2024). 3D Integrated Circuit (3D IC) Technology and Its Applications. Journal of Industrial Engineering and Applied Science, 2(4), 60–65.2

[39] Wang, L., Xu, Z., Stone, P., & Xiao, X. (2024). Grounded curriculum learning. arXiv preprint arXiv:2409.19816.

[40] Kholmatov, S. (2024). Multimodal Sentiment Analysis: A Study on Emotion Understanding and Classification by Integrating Text and Images. Academic Journal of Natural Science, 1(1), 51-56.

[41] Lin, W., Xiao, J., & Cen, Z. (2024). Exploring Bias in NLP Models: Analyzing the Impact of Training Data on Fairness and Equity. Journal of Industrial Engineering and Applied Science, 2(5), 24-28.

[42] Dang, B., Zhao, W., Li, Y., Ma, D., Yu, Q., & Zhu, E. Y. (2024). Real-Time Pill Identification for the Visually Impaired Using Deep Learning. 2024 6th International Conference on Communications, Information System and Computer Engineering (CISCE), 552–555. doi:10.1109/CISCE62493.2024.10653353

[43] Xiong, J., Jiang, C., Zhao, Z., Qiao, Y., Zhang, N., Feng, M., & Wang, X. (2024). Selecting the Best Fit Software Programming Languages: Using BERT for File Format Detection. Journal of Theory and Practice of Engineering Science, 4(06), 20-28.

[44] Ni, F., Zang, H., & Qiao, Y. (2024, January). Smartfix: Leveraging machine learning for proactive equipment maintenance in industry 4.0. In The 2nd International scientific and practical conference "Innovations in education: prospects and challenges of today"(January 16-19, 2024), Sofia, Bulgaria, International Science Group (p. 313).