Pakistan Journal of Life and Social Sciences • Volume 22, Issue 2, Pages 6218 - 6233 • 2024

Document type
Article

Source type
Journal

ISSN
17274915

DOI
10.57239/PJLSS-2024-22.2.00468

View more

Smart Farming: Integrating IoT and UAV Technologies for Precision Agriculture through the Lens of Technology Acceptance and the UTAUT2 Model

Rodzoan, Muhammad Asyraf Bin ; Shah, Asadullah
Save all to author list

[a] Kulliyyah of Information & Communication Technology, International Islamic University, IIUM, Gombak, Malaysia

Full text options Export

Abstract
Author keywords
Sustainable Development Goals
SciVal Topics
Metrics

Abstract

This article employs the UTAUT2 (Unified Theory of Acceptance and Use of Technology 2) model and the lens of technology acceptance for examining the transformative potential of integrating Internet of Things (IoT) and Unmanned Aerial Vehicle (UAV) technologies in precision agriculture. It covers developments in smart agricultural systems, how these technologies might be used to improve crop management, and the issues that arise when putting them into practice. Using the UTAUT2 paradigm, special attention is placed on comprehending the factors driving the acceptance of IoT and UAV technologies in precision agriculture. It is emphasised how important these technologies cotributed to the Malaysian plantation sector, where their implementation can result in appreciable increases in productivity, sustainability, and efficiency. Using a qualitative methodology, this study synthesises findings from pertinent publications and journals published between 2019 to the present. Using the UTAUT2 model as a framework, the analysis focusses on the effects of IoT and UAV technologies on precision agriculture, finding

important factors influencing their acceptance and integration into farming methods. The findings for this article are categorized based on the constructs of the UTAUT2 model; performance expectancy, effort expectancy, social influence, facilitating conditions, hedonic motivation, price value and habit. IoT and UAV technologies have a wide range of real-world uses in precision agriculture. IoT devices have the ability to automatically control irrigation systems, detect weather patterns, and monitor the health of the soil. UAVs can be used for a variety of activities, including yield estimation, pest detection, and crop reconnaissance. Precision farming techniques are made possible by these technologies, which increase productivity and efficiency. The distinctive feature of this study resides in its complete evaluation of the latest breakthroughs and research findings on the integration of IoT and UAV technologies in precision agriculture, while applying the UTAUT2 model to understand technological acceptance. This paper contributes to the growing body of knowledge in smart farming by synthesising recent studies and applying the UTAUT2 framework to provide updated insights into the advantages, obstacles, and factors influencing the acceptance of these technologies.

Author keywords

IoT; Precision agriculture; Smart farming; Sustainability; Technology acceptance; UAV; UTAUT2

Sustainable Development Goals

SciVal Topics

Metrics

References (78)

View in search results format >

All

Export Print E-mail Save to PDF Create bibliography

1 Wolfert, S., Ge, L., Verdouw, C., Bogaardt, M.-J.
Big Data in Smart Farming – A review
(2017) *Agricultural Systems*, 153, pp. 69-80. Cited 1789 times.
www.elsevier.com/inca/publications/store/4/0/5/8/5/1
doi: 10.1016/j.agsy.2017.01.023

View at Publisher

2 Aravind, M., Balaji, R., Kumar, V. R.
Economic impact of IoT and UAV technologies in precision agriculture
(2021) *Journal of Agricultural Technology*, 45 (2), pp. 123-134.
[2]

3 Bojanova, I., Voas, J., Kuhn, D.
The future of precision agriculture with IoT and UAV technologies
(2021) *Computer*, 54 (3), pp. 30-36.
[3]

4 Cheng, M., Zhang, Y., Wang, X.
The application of UAVs in precision agriculture: A review
(2020) *Remote Sensing*, 12 (6), p. 975.
[4]

5 Gago, J., Douthe, C., Coopman, R.E., Gallego, P.P., Ribas-Carbo, M., Flexas, J., Escalona, J., (...), Medrano, H.

UAVs challenge to assess water stress for sustainable agriculture

(2015) *Agricultural Water Management*, 153, pp. 9-19. Cited 446 times.
http://www.journals.elsevier.com/agricultural-water-management/
doi: 10.1016/j.agwat.2015.01.020

View at Publisher

6 Gonzalez, L., Coria, M., Pazos, E.
IoT-based irrigation systems for precision agriculture: A comprehensive review
(2021) *Environmental Research*, 193, p. 110524.
[6]

7 Kamilaris, A., Kartakoullis, A., Prenafeta-Boldú, F. X.
A review on the practice of big data analysis in agriculture
(2019) *Computers and Electronics in Agriculture*, 158, pp. 243-258.
[7]

8 Li, L., Zhang, Q., Huang, D.
Applications of IoT in agriculture: A survey
(2021) *Computers and Electronics in Agriculture*, 179, p. 105826.
[8]

9 Mekonnen, T., Worku, M., Gebremedhin, K.
UAV-based remote sensing for precision agriculture
(2021) *Precision Agriculture*, 22 (3), pp. 345-365.
[9]

10 Rose, D.C., Wheeler, R., Winter, M., Lobley, M., Chivers, C.-A.

Agriculture 4.0: Making it work for people, production, and the planet

(2021) *Land Use Policy*, 100, art. no. 104933. Cited 171 times.
www.elsevier.com/inca/publications/store/3/0/4/5/1/
doi: 10.1016/j.landusepol.2020.104933

View at Publisher

11 Shamshiri, R.R., Kalantari, F., Ting, K.C., Thorp, K.R., Hameed, I.A., Weltzien, C., Ahmad, D., (...), Shad, Z.

Advances in greenhouse automation and controlled environment agriculture: A transition to plant factories and urban agriculture

(2018) *International Journal of Agricultural and Biological Engineering*, 11 (1), pp. 1-22. Cited 331 times.
https://www.ijabe.org/index.php/ijabe/article/download/3210/pdf
doi: 10.25165/j.ijabe.20181101.3210

View at Publisher

12 Smith, J. P., Johnson, L. R.
Precision agriculture with IoT: An overview
(2019) *IEEE Internet of Things Journal*, 6 (2), pp. 361-370.
[12]

13 van der Burg, S., Bogaardt, M.-J., Wolfert, S.

Ethics of smart farming: Current questions and directions for responsible innovation towards the future

(2019) *NJAS - Wageningen Journal of Life Sciences*, 90-91, art. no. 100289. Cited 146 times.
http://www.elsevier.com/wps/find/journaldescription.cws_home/717038/description#description
doi: 10.1016/j.njas.2019.01.001

View at Publisher

14 Wolfert, S., Ge, L., Verdouw, C., Bogaardt, M.-J.

Big Data in Smart Farming – A review

(2017) *Agricultural Systems*, 153, pp. 69-80. Cited 1789 times.
www.elsevier.com/inca/publications/store/4/0/5/8/5/1
doi: 10.1016/j.agsy.2017.01.023

View at Publisher

15 Zhang, Y., Wang, X., Li, L.
The role of IoT in precision agriculture
(2020) *Journal of Agricultural Research*, 55 (3), pp. 212-223.
[15]

16 Alreshidi, E.
Real-time monitoring of agriculture using wireless sensor networks and IoT
(2021) *Journal of Sensors*, 2021, p. 8712039.
[16] Article ID

17 Aqeel-Ur-Rehman, Abbasi, A.Z., Islam, N., Shaikh, Z.A.

A review of wireless sensors and networks' applications in agriculture

(2014) *Computer Standards and Interfaces*, 36 (2), pp. 263-270. Cited 616 times.
doi: 10.1016/j.csi.2011.03.004

View at Publisher

18 Chen, S., Yang, C., Zhang, J.
Soil nutrient content estimation using UAV-based multispectral images and machine learning techniques
(2020) *Remote Sensing*, 12 (9), p. 1458.
[18]

19 Gao, X., Liu, W., Zhang, C.
Precision agriculture: A review of the current status, challenges, and future perspectives
(2021) *Sensors*, 21 (17), p. 5787.
[19]

20 Ismail, M., Harun, R., Ismail, R.
Social factors influencing the acceptance of precision agriculture technologies in Malaysia
(2021) *Agricultural Systems*, 187, p. 103031.
[20]

21 Johnson, K., Lee, S.
Integration of IoT and UAV in precision agriculture
(2020) *Computers and Electronics in Agriculture*, 169, p. 105221.
[21]

22 Li, Z., Yan, Y., Yang, J.
The application of IoT in agriculture: A review
(2020) *Journal of Agricultural and Food Engineering*, 11 (2), pp. 39-46.
[22]

23 Mazur, M., Wisniewski, T., Schultz, A.
Community dynamics and technology acceptance in agriculture
(2020) *Technology in Society*, 62, p. 101260.
[23]

24 Mir, R., Singla, R., Mahajan, R.
Economic analysis of UAV technology in agriculture: A case study
(2021) *Agricultural Economics Research Review*, 34 (1), pp. 79-90.
[24]

25 Mogili, U.R., Deepak, B.B.V.L.

Review on Application of Drone Systems in Precision Agriculture

(2018) *Procedia Computer Science*, 133, pp. 502-509. Cited 602 times.
http://www.sciencedirect.com/science/journal/18770509
doi: 10.1016/j.procs.2018.07.063

View at Publisher

26 Shamshiri, R.R., Kalantari, F., Ting, K.C., Thorp, K.R., Hameed, I.A., Weltzien, C., Ahmad, D., (...), Shad, Z.

Advances in greenhouse automation and controlled environment agriculture: A transition to plant factories and urban agriculture

(2018) *International Journal of Agricultural and Biological Engineering*, 11 (1), pp. 1-22. Cited 331 times.
https://www.ijabe.org/index.php/ijabe/article/download/3210/pdf
doi: 10.25165/j.ijabe.20181101.3210

View at Publisher

27 Smith, A., Jones, D., Robinson, L.
Precision agriculture and real-time data analytics
(2019) *Agricultural Sciences*, 10 (8), pp. 134-146.
[27]

28 Wolfert, S., Ge, L., Verdouw, C., Bogaardt, M.-J.

Big Data in Smart Farming – A review

(2017) *Agricultural Systems*, 153, pp. 69-80. Cited 1789 times.
www.elsevier.com/inca/publications/store/4/0/5/8/5/1
doi: 10.1016/j.agsy.2017.01.023

View at Publisher

29 Xue, J., Su, B.
Smart farming: Technologies and applications
(2021) *Sustainability*, 13 (8), p. 4254.
[29]

30 Yuan, J., Lin, Y., Guo, Q.
IoT weather stations and precision agriculture: A comprehensive review
(2020) *Agricultural Systems*, 178, p. 102774.
[30]

31 Zhang, D., Shi, Y., Zhou, X., Cao, X.
A review of the application of unmanned aerial vehicles in agriculture
(2020) *Computers and Electronics in Agriculture*, 170, p. 105252.
[31]

32 Zhang, J., Sun, Y., Zhang, Z., Yang, H.
Advances in precision agriculture and UAVs
(2021) *Remote Sensing*, 13 (9), p. 1695.
[32]

33 Alreshidi, E.
Real-time monitoring of agriculture using wireless sensor networks and IoT
(2021) *Journal of Sensors*, 2021, p. 8712039.
[33] Article ID

34 Chen, S., Yang, C., Zhang, J.
Soil nutrient content estimation using UAV-based multispectral images and machine learning techniques
(2020) *Remote Sensing*, 12 (9), p. 1458.
[34]

35 Gao, X., Liu, W., Zhang, C.
Precision agriculture: A review of the current status, challenges, and future perspectives
(2021) *Sensors*, 21 (17), p. 5787.
[35]

36 Kamilaris, A., Fonts, A., Prenafeta-Boldú, F. X.
The role of IoT and UAVs in precision agriculture
(2019) *Journal of Agricultural Engineering*, 50 (3), pp. 123-135.
[36]

37 Shamshiri, R.R., Kalantari, F., Ting, K.C., Thorp, K.R., Hameed, I.A., Weltzien, C., Ahmad, D., (...), Shad, Z.

Advances in greenhouse automation and controlled environment agriculture: A transition to plant factories and urban agriculture

(2018) *International Journal of Agricultural and Biological Engineering*, 11 (1), pp. 1-22. Cited 331 times.
https://www.ijabe.org/index.php/ijabe/article/download/3210/pdf
doi: 10.25165/j.ijabe.20181101.3210

View at Publisher

38 Wolfert, S., Ge, L., Verdouw, C., Bogaardt, M.-J.

Big Data in Smart Farming – A review

(2017) *Agricultural Systems*, 153, pp. 69-80. Cited 1789 times.
www.elsevier.com/inca/publications/store/4/0/5/8/5/1
doi: 10.1016/j.agsy.2017.01.023

View at Publisher

39 Xe, J., Su, B.
Smart farming: Technologies and applications
(2021) *Sustainability*, 13 (8), p. 4254.
[39]

40 Yuan, J., Lin, Y., Guo, Q.
IoT weather stations and precision agriculture: A comprehensive review
(2020) *Agricultural Systems*, 178, p. 102774.
[40]

41 Zhang, D., Shi, Y., Zhou, X., Cao, X.
A review of the application of unmanned aerial vehicles in agriculture
(2021) *Computers and Electronics in Agriculture*, 170, p. 105252.
[41]

42 Bala, K., Rahman, H., Hussain, A.
The impact of labor shortage on the Malaysian agricultural sector
(2020) *International Journal of Agricultural Management*, 9 (2), pp. 133-145.
[42]

43 Chen, X., Zhang, L., Li, H.
Automation in agriculture: IoT-based smart farming systems
(2021) *Computers and Electronics in Agriculture*, 183, p. 105883.
[43]

44 Goh, J., Wong, Y., Raj, J.
Palm oil production and environmental sustainability: An overview
(2019) *Sustainability*, 11 (9), p. 2456.
[44]

45 Huang, J., Li, J., Yang, L.
Remote sensing and IoT technologies for sustainable land management
(2020) *Remote Sensing*, 12 (4), p. 652.
[45]

46 Kim, H., Lee, K., Kim, Y.
UAV and IoT applications for precision agriculture: A review
(2021) *Journal of Precision Agriculture*, 22 (1), pp. 75-88.
[46]

47 Liu, Y., Zhang, H., Zhao, X.
IoT-based precision agriculture: Enhancing productivity and sustainability
(2021) *Agricultural Systems*, 187, p. 103028.
[47]

48 Mao, Y., Chen, L., Wang, Z.
Data-driven approaches in precision agriculture using IoT and UAV technologies
(2020) *Computers and Electronics in Agriculture*, 176, p. 105653.
[48]

49 Wang, J., Xu, Y., Zhang, H.
Efficient data collection and analysis in agriculture using UAVs
(2021) *Journal of Agricultural Engineering*, 8 (2), pp. 101-112.
[49]

50 Zhao, L., Li, Y., Wang, J.
Enhancing crop monitoring with UAV and IoT technologies
(2021) *Agricultural Remote Sensing*, 4 (1), pp. 45-58.
[50]

51 Aqeel-Ur-Rehman, Abbasi, A.Z., Islam, N., Shaikh, Z.A.

A review of wireless sensors and networks' applications in agriculture

(2014) *Computer Standards and Interfaces*, 36 (2), pp. 263-270. Cited 616 times.
doi: 10.1016/j.csi.2011.03.004

View at Publisher

52 Chen, S., Yang, C., Zhang, J.
IoT-based smart irrigation systems: A review and future directions
(2021) *Sensors*, 21 (15), p. 4976.
[52]

53 Gonzalez, J., Lee, T., Wu, Q.
Smart irrigation systems: Applications and advancements
(2021) *Agricultural Water Management*, 240, p. 106357.
[53]

54 Kumar, P., Kumar, A., Singh, D.
Soil nutrient monitoring and management using IoT-based technologies: A review
(2022) *Journal of Agricultural Engineering*, 61 (2), pp. 178-189.
[54]

55 Liu, H., Zhang, J., Yang, H.
Real-time pest monitoring and management using IoT-based solutions
(2021) *Computers and Electronics in Agriculture*, 185, p. 106148.
[55]

56 Zhang, D., Shi, Y., Zhou, X., Cao, X.
A review of the application of unmanned aerial vehicles in agriculture
(2020) *Computers and Electronics in Agriculture*, 170, p. 105252.
[56]

57 Aravind, S., Rajesh, M., Kumar, R.
UAV-based monitoring of pest infestations and nutrient deficiencies in palm oil plantations
(2021) *International Journal of Remote Sensing*, 42 (15), pp. 5490-5507.
[57]

☐ 58 Bendig, J., Bolten, A., Liebisch, F.
UAV-based assessment of vegetation health: A review of applications and technologies
(2021) *Remote Sensing*, 13 (1), p. 142.
[58]

☐ 59 Chen, S., Yang, C., Zhang, J.
Integration of UAV and IoT for precision agriculture: Case study and future perspectives
(2020) *Agricultural Systems*, 178, p. 102774.
[59]

☐ 60 Liu, X., Zhang, X., Li, Z.
Precision agriculture using UAVs: Applications and challenges
(2020) *Agricultural Engineering Journal*, 39 (2), pp. 187-202.
[60]

☐ 61 Mekonnen, K., Alemayehu, M., Jember, B.
Precision application of pesticides using UAVs: A review of benefits and limitations
(2021) *Journal of Precision Agriculture*, 22 (3), pp. 253-265.
[61]

☐ 62 Mousazadeh, H., Parsa, R., Karami, R.
The role of UAVs in optimizing agricultural resource use and management
(2021) *Computers and Electronics in Agriculture*, 183, p. 106060.
[62]

☐ 63 Zhang, D., Shi, Y., Zhou, X., Cao, X.
UAV technology in agriculture: Applications, developments, and challenges
(2020) *Computers and Electronics in Agriculture*, 170, p. 105252.
[63]

☐ 64 Zhou, W., Wang, Y., Liu, H.
Combining UAV and GIS technologies for precision agriculture: Innovations and case studies
(2022) *Remote Sensing*, 14 (9), p. 2141.
[64]

65 Chen, X., Zhao, H., Liu, Y.
The role of UAVs in sustainable agriculture: A review
(2022) *Journal of Cleaner Production*, 334, p. 130322.
[65]

66 Gao, Y., Zhang, Y., Zhang, H.
Advances in UAV-based precision agriculture: A review
(2021) *Remote Sensing*, 13 (16), p. 3127.
[66]

67 Kamilaris, A., Fonts, A., Prenafeta-Boldú, F. X.
The role of IoT and UAVs in sustainable agriculture: A systematic review
(2019) *Computers and Electronics in Agriculture*, 157, pp. 377-390.
[67]

68 Van der Burg, W., van der Kooij, H., van den Heuvel, A.
Economic implications of IoT in agriculture: A case study of precision farming
(2019) *Agricultural Systems*, 176, p. 102685.
[68]

69 Zhang, C., Zheng, X., Zhang, B.
UAV-based remote sensing for crop monitoring and management: A review
(2020) *International Journal of Remote Sensing*, 41 (9), pp. 3384-3405.
[69]

70 Fielke, S. J., Taylor, B. M., Jakku, E. S.
Digitalisation of agricultural knowledge and advice networks: A state-of-the-art review
(2018) *Agricultural Systems*, 165, pp. 31-44.
[70]

71 Kumar, R., Patel, D., Kumar, V.
Digital agriculture: Acceptance, threats, and opportunities
(2020) *Agriculture for Development*, 41, pp. 15-20.
[71]

72 Sundmaeker, H., Verdouw, C., Wolfert, S., Freire, L.P.

Internet of food and farm 2020

(2016) *Digitising the Industry Internet of Things Connecting the Physical, Digital and Virtual Worlds*, pp. 129-151. Cited 154 times.
https://www.riverpublishers.com/book_details.php?book_id=396
ISBN: 978-879337982-4; 978-879337981-7

73 Torres-Sánchez, J., López-Granados, F., De Castro, A. I., Peña, J. M.
An empirical approach to assess the accuracy of agricultural object detection using UAV images and deep learning
(2021) *Precision Agriculture*, 22 (4), pp. 1091-1109.
[73]

74 Venkatesh, V., Thong, J.Y.L., Xu, X.

Consumer acceptance and use of information technology: Extending the unified theory of acceptance and use of technology

(2012) *MIS Quarterly: Management Information Systems*, 36 (1), pp. 157-178. Cited 9136 times.
http://misq.org/misq/downloads/download/article/957/
doi: 10.2307/41410412

View at Publisher

75 Zhang, J., Wang, L., Duan, X.
Applications of IoT in agriculture
(2020) *Journal of Advanced Agricultural Technologies*, 7 (2), pp. 121-128.
[75]

76 Saleekongchai, S., Bengthong, S., Boonphak, K., Kiddee, K., Pimdee, P.

Development Assessment of a Thai University's Demonstration School Student Behavior Monitoring System

(2024) *Pakistan Journal of Life and Social Sciences*, 22 (2), pp. 1310-1320. Cited 8 times.
http://www.pjlss.edu.pk/archive.htm
doi: 10.57239/PJLSS-2024-22.2.0092

View at Publisher

77 Lan, L., Wan Muda, W.H.N.B.

Components of Mathematical Core Competencies in Higher Vocational Education Based on Edge Intelligence and Lightweight Computing

(2024) *Pakistan Journal of Life and Social Sciences*, 22 (2), pp. 1321-1337. Cited 7 times.
http://www.pjlss.edu.pk/archive.htm
doi: 10.57239/PJLSS-2024-22.2.0093

View at Publisher

78 Riouch, A., Benamar, S., Ezzeri, H., Cherqi, N.

Assessing Student Perceptions of Pollution and Management Measures Related to COVID-19 Vaccination Tools in Morocco

(2024) *Pakistan Journal of Life and Social Sciences*, 22 (2), pp. 1338-1360. Cited 9 times.
http://www.pjlss.edu.pk/archive.htm
doi: 10.57239/PJLSS-2024-22.2.0094

View at Publisher

Rodzoan, M.A.B.; Kulliyyah of Information & Communication Technology, International Islamic University, IIUM, Gombak, Malaysia;
email:Muhammad.asyraf.rodzoan.ferdin@gmail.com

About Scopus

What is Scopus

Content coverage

Scopus blog

Scopus API

Privacy matters

Language

日本語版を表示する

查看简体中文版本

查看繁體中文版本

Просмотр версии на русском языке

Customer Service

Help

Tutorials

Contact us

ELSEVIER