Exploring the Perceptions and Experiences of Precision Agriculture Technology Adopters: A Multi Case Study of Taiwan and the USA

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Introduction

Precision Agriculture Technology [PAT] revolutionizes agriculture worldwide. PAT uses GPS, drones, sensors, and data analytics to efficiently manage and optimize crop production (Zhao & Huang, 2017). According to Lowenberg-DeBoer and Swinton (2005), precision agriculture [PA] uses information technology to manage spatial and temporal variability in field crop production (p. 262). Specifically, PAT has evolved from yield mapping and variable-rate application to data management, decision-making, and automation. PAT adoption has been reported to improve crop yields, reduce input costs, and improve environmental outcomes. However, the level of adoption varies between countries due to differences in culture, policies, and socio-economic factors. In Taiwan, the adoption of PAT was influenced by factors such as the availability of government subsidies, access to information, and farmers' attitudes toward technology (Lin & Lee, 2015). While the adoption of PAT in the USA was influenced by factors such as farmers' age, farm size, and educational level (Kadanali & Kizilaslan, 2018). Increasing awareness, providing education, and understanding the demographic differences between countries can help overcome barriers to PAT adoption. These indicated a need for further research to explore the differences in adoption challenges between the two countries.

This study was intended to explore the perceptions and experiences of precision agriculture technology adopters in Taiwan and the USA. In particular, the study was aimed to understand the perspectives and experiences of farmers who have adopted PAT in Taiwan and the USA and are currently using these technologies on their farms. Given these circumstances, this study attempts to answer the following research questions: 1) What are the perceptions of precision agriculture technology adopters in Taiwan and the USA? 2) What are the experiences of precision agriculture technology adopters in Taiwan and the USA? 3) What factors influence the adoption and use of precision agriculture technology in Taiwan and the USA? 4) How do the perceptions and experiences of precision agriculture technology adopters differ between Taiwan and the USA?

Theoretical Framework

The Unified Theory of Acceptance and Use of Technology [UTAUT] was used to guide the study. According to Venkatesh and Davis (2000), UTAUT can be used to understand and predict how individuals will adopt and use new technologies in various contexts. This theory is an extension of the Technology Acceptance Model [TAM], which has been widely used to explain individuals' acceptance and adoption of technology including PAT (Davis, 1989). UTAUT presumes that four key factors influence individuals' intention to use technology, which includes performance expectancy, effort expectancy, social influence, and facilitating conditions. First, performance expectancy refers to the degree to which an individual believes that using technology will help them perform their tasks or achieve their goals. Second, effort expectancy refers to the degree to which an individual believes that using technology will be easy and convenient. Third, social influence refers to the degree to which an individual perceives that others who are important to them believe they should use technology. Fourth, facilitating conditions refer to the degree to which an individual believes that the organizational and technical infrastructure supports the use of the technology.

Methodology

To accomplish the purpose of this study, an instrumental multiple case study design was implemented (Eisenhardt, 1989). A qualitative approach and snowball sampling procedures were leveraged to collect 21 interviews (Naderifar et al., 2017). The target population was farmers in

Taiwan and the USA who have adopted precision agricultural technologies on their farms. Semi-structured interviews were conducted both in-person and virtually. Virtual interviews were conducted using LINE app voice calls and phone calls. The interview questions were originally in English and then translated into participants' native language to ensure language particularities. Participants were asked about their perspectives and experiences as precision agriculture technology adopters. The researchers conducted the interviews using a predesigned piloted interview protocol. The protocol had twelve major guiding questions and several probing questions depending on participants' responses to the major questions. Creswell and Poth (2018) observed that probing questions keep participants talking while expertly guiding them to the study's purpose. Multiple sources of data were used to triangulate and enhance the credibility of the study including researcher's memos, document analysis, and thematic analysis (Lochmiller, 2021). Subsequently, the gathered data was compiled and categorized within a document based on distinct attributes related to technology adoption. To enhance the overall trustworthiness of the study, we also imbued rigor into the study by embedding within the qualitative standards of quality: (1) credibility, (2) confirmability, (3) dependability, and (4) transferability (Houghton et al., 2013).

Findings

A total of 21 farmers participated in the study and all of them were men (Taiwan = 10, USA = 11). Quotes from Taiwan participants are denoted as PT while US participants are denoted as PU. By answering research questions one and two, PAT adopters commonly experience high productivity levels attributed to the utilization of technology. PT4 said, "The system is quite positive to improve the efficiency of our crop production and production system so that we can have a decent improvement in terms of economic benefits". PU7 supported these sentiments by saying: "Yes, honestly, we're using less equipment, meaning fewer tractors and fewer plows". To answer research question three, convenience and efficiency emerged as the primary factors motivating farmers to adopt PAT. PU2 said, "I can't imagine life without it." Similarly, PT4 said, "The autopilot is more accurate, user friendly, and interesting." Finally, the last research question was found to differentiate in the scale of farming operations, the types of farming activities, the use of self-driving equipment, the adoption timeline, the sources of information, and funding mechanisms. These findings align with the four factors that UTAUT posits, particularly performance expectancy and effort expectancy as they were key drivers to influence PAT adoption among the participants.

Conclusions/Recommendations

The participants' varied experiences with PAT indicate that the study involved individuals with different degrees of familiarity and interaction with the technology. Acknowledging this diverse range of familiarity and exposure to PAT underscores the importance for professionals to create and execute thorough training and educational initiatives tailored to the varying levels of expertise among farmers. Furthermore, the study highlights differences in obtaining PAT information as Taiwanese farmers predominantly depend on the government and extension services, while American farmers rely more on dealers and the Internet. Overall, participants held positive perceptions about the adoption and future of PAT, indicating that they found value and benefits in incorporating PAT into their agricultural practices. Future research should deepen the understanding of PAT adoption and its impact on different countries to address emerging challenges and identify strategies for maximizing benefits through extension services and educational development.

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