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Digital Technology Adoption in Agriculture: Success Factors, Obstacles and Impact on Corporate Social Responsibility Performance in Thailand's Smart Farming Projects

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Abstract

Technological growth is fueling the global economy in every sector, including agriculture. This study's objectives are (1) to examine how the Internet of Things (IoT), Artificial Intelligence (AI) and big data technology can improve agricultural productivity for small-scale farmers in Thailand, (2) to investigate the success factors and impediments to this technology adoption in Corporate Social Responsibility (CSR) projects, and (3) to explore the link between technology adoption in two CSR projects in Thailand with the CSR performance. This study adopts an inductive qualitative approach with in-depth face-to-face interviews with two leading Thai IT companies that successfully helped local small-scale farmers to implement smart farming solutions. Both firms employed smart technology, such as IoT, using sensors, AI-enabled mobile device applications, and big data to help farmers plan, operate, and monitor their crops and paddy fields. The study's findings add new knowledge to both academic theory and business practice by showing how corporations not only can help small producers to successfully adopt smart technology to scale their social impact but also promote implementing more proactive CSR strategies in their industry.

Keywords

Digital technology adoption, IoT, AI and big data, Agriculture, Smart farming solutions, Corporate CSR performance

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Introduction

Bill Gates is famous for saying “We are changing the world with technology” when he could only imagine the role digital technology would play today, as a key engine of both economic growth and societal growth (Ugochukwu & Phillips, 2018). Digital technology is so widespread today that it now serves societal and environmental sustainability goals by improving the lives of impoverished farmers in remote areas (Ducatel, 2001; Mottaleb, 2018). Technology, such as IoT, AI, and big data, has been leveraged in many sectors, including agriculture, where it helps increase the productivity of crop harvests, facilitates planting processes, and provides a commercial platform for farmers to communicate with their customers. Biel (1999) warned that technology is a double-edged sword: although it can yield positive impacts in developing countries by helping farmers with weather forecasting and crop yields, it also poses challenges and obstacles. Despite this, technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and big data have been widely and effectively adopted among rural farmers in Asia’s developing countries. Farmers in Kedah, Malaysia have adopted smart technology to improve the efficiency of their organic farms (Hoang et al., 2014). In Vietnam, farmers are adopting water harvesting technology (Sa’ari et al., 2017).

In nearby Thailand however, where agriculture and aquaculture are fundamental for economic growth, small-scale farmers face perpetual poverty because they lack the IT knowledge and management skills required for innovation. This lack of skills is one of the biggest barriers to sustainable growth in this farming sector.

This paper aims to (1) examine IoT, AI, and big data technology as a means for improving agricultural productivity, (2) identify the success factors and obstacles that corporations and farmers encounter when adopting smart technologies, and (3) explore the impact of smart farming technologies on CSR performance in this sector. This research adopted a qualitative study of two Thai IT corporations by conducting in-depth, face-to-face interviews with managers in charge of smart farming projects that these firms pursued as part of their corporate CSR mission. Thailand was chosen because it represents a middle-income economy in which agriculture is a major driver for economic growth. In 2019, 31.43 percent of the Thai population (The World Bank, 2019) was engaged in mostly small-scale farming. In addition, the country’s IoT, AI, and big data technology in farming had surpassed the introductory stage and reached the stage of infrastructure development and growing network readiness.

Literature Review

IoT, AI, and Big Data Technology in Smart Farming

Technology is a means to achieve an environmental and social equilibrium (Ducatel, 2001). Brey (2018) noted that technology can be used to achieve social justice for people from all walks of life and income levels. This is particularly true in agriculture in developing countries, where farming is a major source of income for many small-scale producers. Smart farming has emerged as a term to describe this sector and has attracted interest from academia and practitioners. Smart farming refers to a mix of digital technology and digital information that are applied to operate machinery, systems, and wireless sensors to maximize efficiency in agricultural production and farm management (Blok & Gremmen, 2018; Schönfeld & Bittner, 2018). In the simplest sense, technology is used to make farming-related activities smarter (Nayyar & Puri, 2016). Digital technology on farms helps to generate weather, soil, and rain data, monitor crop growth, detect diseases, and control machinery (Muangprathuba et al., 2019; Regan, 2019).

Technology in smart farming includes IoT, AI, and big data. Firstly, IoT provides the platform for collating time-series data from various sources through sensors, computers, GPS systems, Radio Frequency Identification tags, and smart phone applications (Wolfert et al., 2017). Applications are designed to communicate and learn the data patterns through what is known as Machine to Machine learning (Blok & Gremmen, 2018). Data processed from IoT helps farmers to plan, manage, and continuously control their crops, such as by monitoring the soil's Ph levels and the movement of livestock (Baumüller, 2017; Jayaraman, et al., 2016). Nayyar and Puri (2016) suggested that farmers could increase food production by 70% by 2050 by adopting these methods. IoT also helps farmers track their produce in the supply chain more precisely (Baumüller, 2017; Ben-Daya, Hassini, & Bahroun, 2017).

AI is an emerging technology that performs tasks that require some degree of human intelligence. Examples of AI technology include drones (for image-based insight generation), robotics, and chat bots. In the latter, the AI-ruled chatbot is a virtual interactive tool that can address any farmer queries in real time. Such technology is currently used in agriculture for predictive tasks such as predicting farmland droughts, estimating soil moisture in paddy fields, and market demand information and prices. It is also applied to cognitive tasks such as identifying rapid and non-destructive maize varieties and high-yield soybean crops that are more resistant to pests (Han et al., 2017). Farmers in India, France and Mexico used AI technology in a variety of agricultural processes to farm tea, wheat, rice, mangoes, and cassava (Ghosh and Sumanta, 2003; Hernandez-Perez et al., 2004, as cited in Jha et al., 2019).

Big data has become the most recent tool in smart farming. It achieves the best results when combined with IoT and AI (Herschel & Miori, 2017; Khanna & Kaur, 2019;

Neethirajan, 2020). By extracting massive amounts of data and generating insights, big data helps farmers manage supply chains, monitor production facilities and equipment, and it can also help firms exploit opportunities for offering new products, services or farming methods to support the farmers (Jakku et al., 2018). Marshall, Mueck and Shockley (2015) studied how the Monsanto corporation relied on big data analytics to determine ideal soil and water conditions for each type of Monsanto seed. They found that this IT-enabled prescriptive-planting and data-driven farming system improved a corn harvest by up to 20 percent per acre.

Knowledge Applications and Cross-Sectoral Partnerships: Success Factors from the Perspective of Corporations

Applying knowledge to project implementation is crucial. Knowledge applications in this study refers to digital technology knowledge, agricultural knowledge, particularly as related to specific crops, and commercial knowledge. CSR smart farming project managers should familiarize themselves with technological knowledge such as how location-specific technology, such as sensors, which are embedded in mobile devices, collect data and generate insights from diverse sources, genres and physical locations, and how GPS technology should be implemented to transfer knowledge to farmers (Richardson et al., 2015). Seenuankaew et al. (2018) discussed how agricultural information, such as crop care techniques, is useful for firms to disseminate to farmers. Such knowledge includes how to choose seed varieties to increase rice productivity and even help farmers become GAP (Good Agricultural Practices) certified. The same study points to commercial knowledge as another key success factor for farmers who are offered new skills and information through workshops and study trips.

Furthermore, it is almost impossible to succeed on a large scale, alone. Osburg and Schmidpeter (2013) found that sustainability projects only have a positive impact on society when they depend on close collaboration among multi-sectoral organizations and stakeholders, which must include government, private firms, and non-profits. Multi-stakeholder partnerships can help to share the knowledge and resources that social innovation projects need to achieve their goals.

Obstacles in Implementing Smart Farming Projects: From the Perspective of Corporations

Introducing new technology to conservative farmers in developing economies is particularly challenging and needs to be properly handled to avoid project failure. According to the literature, digital knowledge gaps or skill level disparities are major barriers to maximizing technology usage (Katz, 2019). Similarly, age is a key factor in technology usage and resulting productivity (Livshits et al., 2008). Older farmers tend to resist the adoption of unfamiliar technologies. Farmers' cautious attitudes and aversion to risks and uncertainties are key obstacles to technology adoption (Akinwunmi et al., 2015; Regan, 2019). Likewise, the information asymmetry phenomenon might prevent potential users from relying on a single source of information, and thus they will need to test the usage and confirm the results by themselves (Ugochukwu & Phillips, 2018). Particularly in the adoption of technology in agriculture, impediments could be farm size, labour and land availability, and access to credit and extension services (Mwangi & Kariuki, 2015). Other obstacles encountered by some firms include poor technology infrastructure and the complexity of the technologies, such as the lack of incorporating user experience into application design (Annosi et al., 2020; Aonngernthayakorn & Pongquan, 2017; Knierim et al., 2019).

Success Factors and Obstacles Farmers Encounter When Adopting Digital Technologies for Smart Farming

Most farmers recognize that technology can offer benefits, and as soon as they are aware of the benefits, they are driven and inspired to learn and use the technology. Knierim (2019) found that among 27 German farmers studied, most of the farmers who were successfully running their farms using smart farming technology recognized the benefits. However, the farmers did face major obstacles in adopting technologies to run their farms. First, they needed to learn new skills to operate new devices. It takes time for farmers to develop the technological readiness to apply new methods to their farms (Kwanmuang et al, 2020; Sayruamyat & Nadee, 2019). In addition to learning new skills, farmers also face the challenge of accessing the technology. This became evident in New Zealand dairy farms where few farmers adopted AI options for robotic milking, even though this option cost less than conventional practices (Eastwood et al., 2019). Farmers also become overwhelmed by information overload when they are presented with new agricultural methods and applications (Sayruamyat & Nadee, 2019).

Implementing Smart Farming Solutions as a CSR Strategy and The Relationships of Developing Smart Farming Technologies to CSR performance

There are two main approaches to CSR projects. Reactive CSR involves minimizing any negative effects on society and the environment as the rules and regulations require (Szutowski & Ratajczak, 2016). Proactive CSR aligns business strategies with the stakeholders' needs and incorporates social and environmental initiatives. Investing in modern technologies to help the beneficiaries is an example of a proactive CSR approach. Proactive CSR performance relates to the organization's business performance in three criteria. First, it strengthens the brand image and the brand's competitive position. (Powell et al., 2013; Shen et al., 2016). Second, it has an impact on employees' CSR awareness and their empowerment with the firm's proactive CSR activity (Carlini & Grace, 2021). A proactive

CSR project also uses the project as an opportunity for the firm to capture novel market opportunities by addressing environmental and social issues. For instance, it can lead to innovative ideas for products and services from the knowledge and technology used to run the project (Ji et al., 2019; Shen et al., 2016).

Eastwood et al. (2019) found a positive link between technological innovation in the farming context and corporate CSR performance when smart farming technologies were introduced. Wolfert et al. (2017) found a positive impact on brand positioning and that smart farming can be a catalyst for improving market positions. Another study showed how firms implementing smart farming technologies had the capacity to innovate, propelling them to create and maintain a competitive position in the global market (Bentivoglio, 2022). This is what Glover (2007) discovered about Monsanto, when it used IoT, AI, and big data technology to help small-scale farmers to better manage crops, fertilizer usage and tillage practice, and also found it enhanced the firm's brand positioning as a leader in cutting-edge technology and sustainability. The impact of developing smart farming technologies on employee and customer perceptions of a firm's proactive CSR approach, nonetheless, has not been extensively explored so far. Most of the literature considers the impact of a proactive CSR approach, such as how corporations are using technology to help society.

Conceptual Framework

This paper draws upon the smart farming literature, particularly on the success factors, obstacles to corporations and farmers and the impact on CSR performance. The extant literature reveals that there has been a lack of comprehensive research that discusses both success factors and obstacles from two perspectives: the firms running smart farming projects and the farmers as technology adopters, as well as the impact of smart farming technology adoption on the corporation's CSR performance.

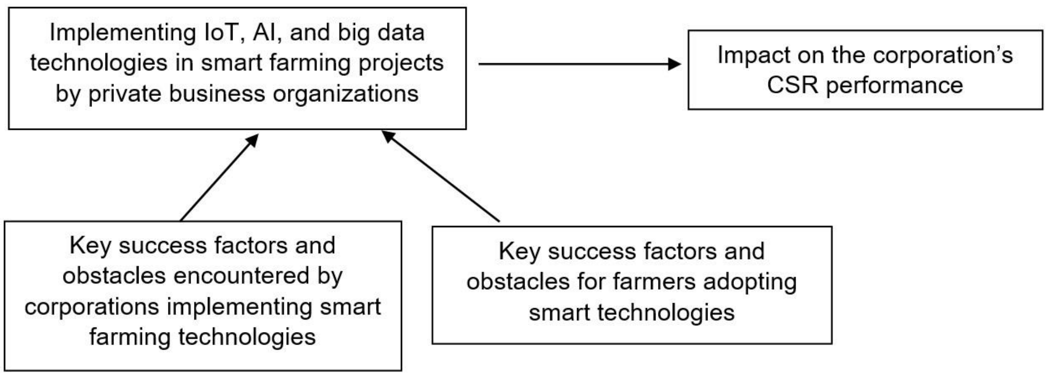

Figure 1 Conceptual Framework

Methodology

This research employs a qualitative approach with in-depth interviews. Purposeful sampling, which involves choosing the sample based on its alignment with the themes of the research question, helped identify two large Thai corporations with a successful history implementing smart farming projects. These two firms were selected because both are pioneers in supporting small-scale farmers in Thailand in smart digital technology adoption (e.g., the implementation of short-messaging services (SMS), mobile applications and technical equipment connected with IoT, and generating data for AI applications). With dedicated corporate departments responsible for smart farming projects, these firms earned a good reputation for their CSR work as reviewed in both the Thai and international media, and in academic journals (Kwanmuang, 2020; Sudtasan, 2017).

This study consists of three exploratory stages: the literature review, the interview stage, and the analysis stage. First, the researcher conducted a comprehensive literature review from diverse sources, such as annual reports, public documentation, and seminar reports to elicit key themes to formulate the interview questions. Second, interviews were conducted with one representative from a telecommunications firm, and three representatives from an agricultural firm. The interviews focused on sustainability, business development, and corporate social responsibility (CSR). The results were recorded, transcribed verbatim, and analyzed via a content analysis which considered the repetition of words and phrases and major theme categorization from the content analysis procedure.

The Two Firms

DTAC's Smart Farmer Project

As one of the premier telecommunications firms in Thailand, DTAC has strived to develop and create mobile networks and technologies that not only accommodate the needs of consumers but also alleviate social and environmental problems.

In 2016, DTAC initiated and successfully launched a CSR project called 'Smart Farmer'. The campaign was intended to help Thai farmers improve agricultural yields, reduce expenses, and increase income. The Smart Farmer application includes fresh market prices, buying prices, farmer videos, and cost calculations. Another mobile platform was developed in collaboration with Thailand's National Electronic and Computer Technology Center (NECTEC) and the social enterprise, Ricult. The application consists of a weather forecast service, farm satellite imaging via EU-Sentinel and NASA-Land, and a farmer assistant providing infographic consultations.

Kubota (Agri) Solutions

As an established leader in Thailand's agricultural machinery industry, Siam Kubota (SKC) is a pioneer in not only offering innovative products, but also providing effective solutions to help Thai farmers. To achieve this level of leadership, SKC launched Kubota (Agri) Solutions (KAS) to ensure the sustainable and maximized growth of agricultural outputs.

KAS consists of two major elements: machinery solution management (e.g., machinery solutions, applications to minimize seasonal disruptions and labor shortages) and agricultural knowledge solutions (cultivating, cropping, and harvesting methods). KAS is accessible using its mobile application and website. Using the mobile application, farmers can harness the power of seamless technology with its useful features, such as a cultivation calendar, weather forecasts, and farm condition alerts.

Findings

1.Technology Choice Starts with the Farmer's Problem

For both firms, technology can help farmers prepare for problems that arise from changes in weather, temperature, humidity, and pest control. Both firms also used their strengths and expertise to try to reduce societal inequalities caused by poverty. Digital technologies that both firms employed were IoT (through sensors and satellite image processing), AI (using precision farming), and big data. DTAC applied its mobile technology and IoT technology through the use of sensors and GPS. The sensor equipment can observe, track, and alert the farmer to any changes in their crops, such as weather, temperature, light, pest infestations, and soil conditions. Moreover, DTAC makes use of big data analytics incorporating data from various sources to drive on-farm precision agriculture into reality. Originating from the SMS farmer information pathway, DTAC developed a 'Farmer Info' application featuring agricultural videos, on-demand weather updates, crop market prices, and direct access to a call center. Meanwhile, Siam Kubota is known for its machinery and agricultural solutions. A telematic GPS technology device was developed to attach to machines for on-demand machine control.

The need to address the problems small-scale farmers face is the raison d'etre of these social innovation projects. Executives from both DTAC and SKC highlighted the recognition of small-scale farmers, saying:

> *The big question that raised the idea of the Smart Farmer project is why Thai farmers are poor, despite the fact that their agricultural products feed the world. A major cause of farmer poverty is inaccessibility to technology and insufficient knowledge in farm management. Thus, we believe that our strength, which is mobile technologies and networks, can help them out of the poverty trap and better manage their crops.*
>
> *KAS originated from the need to know why Thai farmers produce so few crops. As we are the leading firm in agricultural machinery, we attempt to find a sustainable solution to help Thai farmers increase the yields and boost their income. Bridging machinery expertise with agricultural knowledge, KAS is now one of our main resources to help Thai farmers in managing their farms.*

Malek et al. (2017) found that digital technology should maximize productivity and be cost-effective. The same was true in this study's interviews, where technology needed to be affordable at little-to-no cost to the beneficiaries. DTAC explained that the reason for charging a small fee for application usage in the future would only be for the purpose of the project's operational and social impact scaling. Concerning the selection of a technological platform, the executives from each firm explained:

> *Technology comes with expenses and costs. So, we need to decide which one works best with the farmers at a reasonable cost. As a leader in technology, we strive to work closely with the related parties to develop and provide the most suitable technological solutions to meet farmer demands.*
>
> *Here at Kubota Thailand, our technology platform still relies on technology like machinery, sensor technology and data intelligence, and innovative ways of planting crops. Nonetheless, we still work on and are open to new approaches such as drone technology that can be applied to our KAS solutions in the near future.*

2. Knowledge Application is a Project Success Factor

Both firms applied technological knowledge, agricultural knowledge and commercialization knowledge to run their smart farming projects. For technological knowledge applications, the firms consulted with NECTEC and Ricult. They also both acquired knowledge pertinent to particular crops, such as rice, cassava, corn and tomatoes. This knowledge was integrated into the features of their mobile applications (i.e., precision farming applications (DTAC), and the Crop Calendar Feature in KAS Agri-solutions). They consulted professional agricultural experts and conducted field visits with local farmers. For example, KAS worked with Japanese rice experts to find out about fertilizers and how to keep track of optimal rice-growing temperatures. KAS also worked with local cassava farmers and found the techniques of soil bombing plough pan plowing as effective in increasing starch percentage in cassava. With such hands-on knowledge, KAS developed the machinery technology in its tractors.

As for agricultural and commercial knowledge applications in the mobile application channel, DTAC provided tips and information via its mobile ‘Precise Farming’ application. This application reports real-time tracking of the farmer’s paddy fields, such as weather and soil conditions, and allows farmers to continuously track their farm around the clock.

> *If you are a farmer, you could seek knowledge and on-demand reports from anywhere at any time. For example, you can browse market prices, read agricultural news, watch videos, and even shop for seeds and equipment online.*

For Siam Kubota’s knowledge sharing roadmap, it invested in a pilot 200-rai farm project in Cholburi province to test its machinery and digital technology applications. Subsequently, a network of 80 farmer alliances and distributors were invited to take a field trip to the experimental farm. The firm also created a prototype farmer community using the company’s technology and expertise in different parts of Thailand, including Srisaket (Uncle Boon Mee Organic Agriculture Group), Prae, and Petchabul provinces. Siam Kubota’s Corporate Sustainability Management Manager said:

> *We rely on specific knowledge as we count on many parties to achieve a project’s outcome. The KAS Crop Calendar mobile application allows farmers to access a vast portal of agricultural knowledge. We also set up the SKCE Learning Roadmap, which includes tips for the farming community about packaging, online marketing and new product development.*

Small-scale farmers in the DTAC and KAS projects took advantage of knowledge sharing, particularly through the prototype farmer community portal that was part of KAS Agri-Solutions. That community serves as a role model for smart farmers as they showcase not only success factors but also lessons learned for other community groups. DTAC set up the Rakbaankerd Awards for smart farmers who are not only successful in developing their farms using the new technology, but also to spread knowledge and skills to other farmers in the network. DTAC also set up a ‘train the trainer’ program, a skill enhancement program, to promote knowledge sharing from one group of farmers to others. This is the kind of knowledge sharing model that Sayruamyat and Nadee (2019) mentioned in their study of potential pilot groups of trained or successful farmers who would then motivate other larger groups.

3. Success Requires Continuous Cooperation from Partners

Both firms emphasized the power of collaboration in achieving their social goals. They said the major reason for their collaborations with other organizations was to leverage knowledge and expertise. DTAC partnered with NECTEC and Ricult to develop an IoT-enabled sensor system to monitor weather and farm conditions and a GPS system. Other partners include the Ministry of Agriculture and Cooperatives and the Department of Agricultural Extension.

> *What we do is we try to make everything benefit the country. We chose NECTEC as our key partner for two key reasons. Firstly, we would like to support the work of Thai researchers. For example, the IoT solutions could be sold to other countries with similar agricultural problems, such as Pakistan and Bangladesh in the future. Secondly, NECTEC is likely to understand the context of Thailand and its agriculture better than other foreign IT ventures.*

Kubota, which has already excelled in machinery technology, stressed the importance of cross-partnerships, saying:

> *From day one when we started the project, we had to admit that we needed more knowledge to drive this project. For instance, the team had to learn how to grow corn, maize, sugar cane, and rice so that we could devise a total solution that best meets farmer demands. We cooperated with the Department of Agricultural Extension, the Rice Department, the Royal Irrigation Department, and Kasetsart University. The knowledge we received from these partnerships was precious and helped us achieve the project's objectives.*

Partnerships encompassed the production process at the initial part of the supply chain as well as for the commercialization process with customers at the end of the supply chain. DTAC joined forces with Freshket, a start-up venture from the DTAC Accelerate program to find buyers for smart farmers. Meanwhile, Siam Kubota set up selling platforms with the cooperation of government and private vendors.

4. The Future is to Scale Social Outcomes

These two projects exemplify socially responsible projects that have a positive impact on local communities. According to Musa and Basir (2021), positive social outcomes for smart farming include resource management efficiency, such as managing resources such as irrigation, fertilizer inputs and environmental costs. DTAC's precision farming applications and Kubota's KAS Agri-Solutions allow farmers to plan their production by using mobile devices that automatically monitor water use and soil nutrients. Another positive social outcome can be measured by the number of farmers that receive benefits from the projects. For instance, DTAC assisted more than 3,000 farmers by improving farm productivity, transferring equipment and skills in IT, digital marketing, packaging and product development. DTAC plans to sell sensor devices and systems to interested farmers nationwide for approximately 15,000 Thai Baht per installation, which is comparatively cheaper than foreign vendors. Farmers also have the option of paying only 30 Baht per month to access the farm precision application to monitor soil conditions, the weather and temperature at any time. A DTAC executive said:

> *The key reason is that we want to expand opportunities for farmers to access useful technology. We also have to admit that this is not our main business, so we do need to leverage the cost burden. The bottom line for this project is to create and promote corporate shared value (CSV) for the maximized benefit to society. Farmers have a better quality of life because they can have more time to do other activities such as spending time with their families.*

As for Siam Kubota, the firm has created a network of 150-200 farmers in the KAS project. This figure, however, excludes a non-farmer group who also joined the KAS projects. The firm has continuously strived to find new machinery solutions to solve challenging environmental problems, such as the PM 2.5 air pollution crisis. An executive from Siam Kubota said:

> *We used our expertise in machinery technology to come up with zero-burn solutions to mitigate the burning process of agricultural waste, such as from corn, rice, and sugar cane to achieve an almost 70% ratio. We are currently working on a straw-compressing machine to reduce waste and generate supplementary income for farmers.*

5. Obstacles to Technology Adoption: Lessons Learned

The main obstacle to new technology adoption among farmers was that many farmers were uncomfortable learning how to use new digital technologies and were overwhelmed by how much they had to learn. Sometimes there was resistance to learning new skills because of age. DTAC, for instance, recognized this barrier and responded by only including farmers between 18 and 45 years old in its smart farmer campaign. Meanwhile, SKC ignored this restriction. The KAS project was open to both farmer groups and non-farmer groups. The firm assigned other criteria in its SKCE learning path instead, by for example limiting groups to only 30 farmers per group. Farmer attitudes and distrust prevented some farmers from recognizing the real benefits of the new technology at first. A resistance to changing their mindset was a common impediment in both case studies. As Sayruamyat and Nadee (2019) discovered, farmers who are older than 45 years old are less likely to be willing to adopt new farming practices because they don’t want to invest in smart technologies, such as buying a smartphone or a tablet or even paying for an agricultural information application. Thus, farmer education, training, and relationship building with farmers helped the firms establish the trust required to encourage farmers to be more open to innovation. Access to credit and financial loans for farmers was also an important obstacle in these projects. DTAC planned to partner with the Bank of Agriculture and Cooperatives to offer loans that would fund farm management practices, such as buying a sensor-equipped device. This initiative to make the device more accessible for farmers will be a future DTAC project.

To illustrate these obstacles, a representative from DTAC commented on the age barrier to technology adoption:

> *We think a farmer's age can be a hindrance to technology adoption. In our Smart Farmer project, our research revealed that the optimal age range for the most receptive farmers was 18-45. Farmer attitudes and beliefs were another obstacle. Many farmers rely exclusively on traditional cultivation methods and local wisdom. They don't see the benefits of technology as key tools to reduce labor and costs that could also boost their income.*

SKC also discussed obstacles in the KAS project, by saying:

> *What we found as the challenges of Thai farmers was the resistance to change from traditional cultivation to modern methods that apply the power of IT and innovation. Farmers also have difficulty in accessing loans to develop their farms. Farming infrastructure, such as rocky soil conditions, can get in the way because this can make it difficult for machines to work more effectively.*

Both firms also mentioned the need for an adequate IT infrastructure to support the use of IoT, AI and big data in smart farming. Unfortunately, Thailand's IT infrastructure has lagged behind other middle-income countries. As a DTAC executive noted, farmers tend to rely on SMS technology to receive information. DTAC is trying to improve mobile technology by setting up an information express-way and 5G-enabled mobile networks. Similarly, at SKC, the technology level is still at the development stage using sensors, AI as well as machine technology. In Japan, Kubota has developed more advanced technologies that include using robots and drones to develop farmland.

6. The Impact of Smart Farming Projects on an Organization's CSR Performance

Interviews with both firms confirmed that IoT, AI, and big data technology in smart farming yields a competitive edge in terms of brand image and positioning. A DTAC executive observed that there is a growing acceptance and support for DTAC's smart farmer projects among the Thai public, from the media, universities, Thailand's National Science and Technology Development Association (NSTDA) and NECTEC. Helping young smart farmers in Thailand creates goodwill as the public sees the firm's commitment to a good social cause, and this improves DTAC's brand image as a leading telecommunications firm with cutting-edge technology. KAS Agri-solutions also enhances Kubota's positioning as a leading agricultural machine manufacturer. A DTAC representative said:

> *DTAC has worked hard to use our core competency in the telecommunications industry to help society. We have helped more than 10,000 Thai local smart farmers plant rice and other crops, such as cherry tomatoes, Japanese melons, coconuts, durians and mushrooms. For example, with our precision farming application, these farmers increased their profits by more than 30 percent through IoT and AI, and also prevented productivity losses by more than 40 percent.*

These two smart farming projects also improved employee CSR awareness and empowerment at both firms. A representative from Siam Kubota observed that their project has promoted goodwill among the staff as they felt proud to be working on the project and to be working for a firm they think is doing something good for society.

However, it was not clear that the firms found any new market opportunities from their investments in smart farming. In DTAC's case this might be because the company had never focused on agriculture before.

Interestingly, both firms stressed the importance of new ways of doing CSR projects since they actively ran the smart farming projects with an allocated team, resource investment, deliverables and knowledge from the firm's expertise and partnerships. This was intended to serve the long-term goal of improving farmers' lives and encourage them to shift from the traditional way of farming, in which farmers had to rely only on guessing data, such as weather and temperature by themselves, and could not guarantee markets for their crops.

Discussion and Conclusion

Academic contribution

This article's findings both complement and challenge the extant theory and concepts in digital technology adoption by firms, small farmers, and CSR theory. The results of the study align with most of the literature discussing the adoption of digital technology in smart farming (Han et al., 2017; Jayaraman et al., 2016; Jha et al., 2019; Khanna & Kaur, 2019; Marshall et al., 2015). In addition, the findings are congruent with the findings of Rose & Chilvers (2018) who said that firms do not currently employ state-of-the-art smart technology, such as robotics or virtual reality but simply choose the most appropriate technology to effectively solve the problems of their beneficiary. The smart farming technology which they choose aligns with their core product competency. For example, DTAC uses mobile and sensor technology, whereas Kubota uses machinery technology. Hence, the interviews suggest that firms should consider which technology best accommodates their societal concerns without transferring excessive financial costs to end-users.

Other similarities between the literature and this study's findings are that key success factors include knowledge applications (Baiyegunhi et al., 2018), cross-partnerships (Osburg & Schmidpetr, 2013), and that common obstacles are technology infrastructure (Aonngernthayakorn & Pongquan, 2017), farmer's conservative attitudes (Akinwunmi, Olajubu, & Aderounmu, 2015) and the age of the farmers (Livshits et al., 2008). Both firms realized the importance of knowledge applications related to resource and farming management for crops such as corn, cassava and tomatoes. This knowledge was shared among experts, the firms themselves and the networked farmers. Most farmers did perceive the benefits of technology adoption in terms of boosting farm productivity. This was confirmed by both firms after they set up a group of model smart farmers and a prototype of a successful smart farm community so that other smart farmers could use them as a model to follow. A farmer's age and skills were discussed and DTAC in particular found that the optimal age range for participating smart farmers was between 18 and 45 years old. This age group was most receptive to learning digital literacy and to adopting new technology options.

Finally, both case studies revealed that adopting digital technology in smart farming projects improved corporate brand positioning (Glover, 2007; Wolfert et al., 2017). This means that each firm was widely accepted by the public as benefitting society as well as being a market leader in using IT and their core competency to help drive social innovation. The literature and this study conclude there was a link between proactive CSR and employee perceptions (Carlini & Grace, 2021), in the way that both firms integrated digital technology in their CSR-driven smart farming projects. The projects enhanced the image of the firm among their employees and increased awareness and pride about working for a firm that was committed to these CSR projects.

Both Thai case studies revealed similar challenges to the literature. Project managers in both case studies mentioned difficulties for farmers when starting the project. Both firms agreed that the big problem for Thai small-scale farmers is they have to farm without sufficient data when trying to anticipate changes in weather, e.g. rainfall, and temperature. Thus, the firms came up with ways to fill these knowledge gaps for the farmers. Another difference between the literature and these case studies was in terms of the characteristics of partnerships. The interviews revealed that both firms sought partnerships in the first stage of the supply chain (i.e., universities from Thailand for disseminating agricultural knowledge specific to the crops) to the last stage of the supply chain (i.e., finding markets for farmers to sell their crops). For instance, in the case of KAS, the project manager consulted with academic cassava experts to learn about cassava farming before they could integrate this knowledge into a mobile application for farmers. In the case of DTAC, the project manager partnered with Freshket, a firm that offered an online platform to sell crops. This was part of the DTAC Accelerate program, which was a social innovation campaign to allow smart farmers to network with each other and have immediate access to critical crop data at any time.

The proactive CSR strategy was another discrepancy between the research findings and the literature. Unlike the findings of Shen et al. (2016) and Ji et al. (2019), neither case study found that using IoT, AI or big data helped the firms capture novel market opportunities. This might be because both firms wanted these smart farming projects to create shared value (CSV). Seeking profits was not the goal in running these projects. DTAC's core business is telecommunications. Hence, running a smart farm project had little to do with capturing new products or service opportunities to attract a new market.

Given the research findings from the entrepreneur's point of view, future research might attempt to explore the farmers' attitudes and perceptions towards smart farming projects to improve smart farming implementation and learn more about their impediments, such as IT adoption readiness.

Practical Recommendations

The findings also pose additional insights that can be applicable to government policy makers. For example, the Thai government could apply the study's findings to promote smart farming and support private firms that want to implement smart farming projects for local farmers and improve the national digital development plan. DTAC and SKC representatives observed that choosing appropriate technologies still requires a national context, such as farming and technological infrastructure. They unanimously agreed that agricultural management in Thailand is complex and requires a national roadmap to urgently revamp the current situation, such as gathering data about soil quality and land management. This is aligned with what Baiyegunhi et al. (2018) discovered when studying rural farmers in developing countries who faced consistent obstacles, such as improper land management practices, limited access to credit and loan programs, limited access to production factors, and a poorly developed digital infrastructure. When compared to developed countries in Asia such as Japan, South Korea, and Singapore, Thailand has lagged behind. For instance, smart farming technology, such as fully-autonomous agriculture, robotic technology (robots that help farmers in paddy fields), and vertical farming, have not yet been implemented in Thailand. Thailand needs to keep pace with emerging technologies and platforms such as technology in the 5.0 Industry, which developed countries, such as China and Japan, have invested in. In addition to this, given the low innovation levels in Thai agriculture, the government should invest in more research and development to foster innovation in the agricultural sector. This could include rice research and funding agricultural innovations. Since Sayruamyat & Nadee (2019) and Annosi et al. (2020) found obstacles to adopting smart farming technology among farmers, it might be a good idea for government policy makers to conduct more user-centric solutions, such as design thinking sessions with farmers and stakeholders. This could include listening to farmer's grievances, brainstorming ideas with stakeholders, proposing creative solutions to reduce impediments to technology adoption and investing in experimental prototypes where farmers could train and offer feedback. Once the results are drawn, policymakers should set up a digital technology plan with concrete timelines and outcome measurements that align with a national digital development plan.

The insights from this study's interviews revealed barriers to technology and innovation adoption in the agriculture industry. First, the mindset of farmers needs to shift from being producers to becoming producers cum entrepreneurs and marketers. This is one of the key challenges to upgrading the careers and income prospects for local Thai farmers. Mottaleb (2018) noted that farmers in developing countries do not tend to adopt new agricultural technologies or take a long time to do so despite the foreseeable benefits the technology and management practices yield. The insights from both case studies reveal that the best way to influence farmers is through technology trials and training workshops where farmers can experience the benefits from innovations on their own. When farmers recognize the benefits of such technology and knowledge, they are happy to use them in their own farms. This challenge is also similar to the findings of Zheng et al. (2019), who studied farmers in Jilin province, China, and their willingness to use new technology and realize ease-of-use and usefulness of technology on their own farms. The challenge for policymakers is to learn how best to communicate and educate farmers about the advantages of adopting technology so that they can enjoy technological benefits at a faster pace.

Better access to loans might encourage farmers to adopt and invest in new technology and innovation on their farms. Technological devices, such as sensors and drones, come with a cost and thus require financial support. Providing financial aid and incentives helps lower barriers and avoid risks for small-scale farmers when they want to adopt smart farming technology (Siedenburg et al., 2012). The Bank of Agriculture and Cooperatives and the Ministry of Agriculture and Cooperatives could play a role by offering special low interest rates for farmers who are willing to invest in smart technology.

As the literature and the findings from this study revealed, a new generation of farmers is the prospective segment of farmers who are enthusiastic about the use of technology in agriculture and want to integrate new skills and technology into their farm management at a faster pace (Irungu et al., 2015). Entrepreneurs, state agencies, and partners should work together to find ways to invest more in educating and supporting this segment of farmers in the future. They should also persuade a new generation of farmers to serve as a bridge to communicate with the older generation to recognize the importance of technology and innovation on farms.

Encouraging farmers to become more entrepreneurial by launching agricultural start-ups is important. DTAC in Thailand is trying to instil a business mindset among farmers. To keep pace with global advancements, the role of farmers should shift from farmer to marketer, entrepreneur and innovation incubator. For instance, farmers could integrate QR code technology in their packaging to keep customers informed about where their food comes from and how it was grown. Digital marketing workshops should be set up to educate Thai farmers nationwide. For instance, farmers should be able to implement appropriate distribution channels, either offline, online, or even on new innovative channels, such as an omni-channel, so that they can earn more income from selling crops.

In the context of firms with CSR implementation, the work of Osburg & Schmidpeter (2013) offers useful recommendations for this study's context. Simply doing something positive for society is insufficient now unless a project is scaled and sustainable in the long run. The two case studies in this research serve as good models of CSR strategy implementation that try to create shared values between a firm and its stakeholders in a sustainable way. In other words, both case studies implemented their sustainability projects in order to enhance their brand positioning and harness technology expertise to also give something positive back to society.

Farmers are the backbone of economic growth in Thailand and they need to adapt, learn about, and cope with technology and innovation continuously. Otherwise, they will not be able to grow or cope with the rapid pace of business, technology, and market demand in the modern era. The insights from this study's findings are beneficial to entrepreneurs who would like to do something good for society via a corporate social responsibility or sustainability project and to the farmers who would reap the potential benefits of digital technology and innovation for sustainable farming and income generation.

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