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Using social practice theory to increase herd recording system engagement

Nalina Phisanbut, Kasidid Songsupakit, Poonsak Nuchsiri, Punpiti Piamsa-nga*

Department of Computer Engineering, Kasetsart University, Bangkok 10900, Thailand

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Abstract

In the age of ubiquitous and economically affordable computing, information and communication technology (ICT) is more accessible and increasingly being interwoven into people's daily practices. The rise of ICT has created a new realm of opportunities to improve the operational efficiency of farms by using digital technologies to transform everyday practices such as herd recording of smallholder dairy farmers in developing countries. However, greater appreciation is hindered by the willingness of farmers to participate and is unlikely to be realized without proper consideration of the social implications that shape herd recording practices. This paper used the concepts of field, habitus and capital from social practice theory (SPT) to guide understanding and designing a digital herd recording system for smallholder dairy farmers in Thailand. The success of the prototype system called "Cowlog" in substantially increasing the amount of collected data highlights the relevance of SPT in offering a perspective for addressing ICT system design challenges, which can be extrapolated to designing other everyday practice systems.

Introduction

The history of the Thai dairy industry is not long, beginning in the 1960s, after the establishment of the Dairy Farming Promotion Organization of Thailand (Dairy Farming Promotion Organization of Thailand (DPO), 2021). However, since then, it has developed to become one of the country's main livestock sectors, producing 1,284,177 t of raw milk in 2019 (Thailand Office of Agricultural Economics, 2019a and 2019b). Nonetheless, Thailand's milk yield of 11.53 kg per cow per day (Thailand Office of Agricultural Economics, 2019a and 2019b) is still relatively low compared to international productivity. The Thai government has been protecting the local dairy industry by imposing high tariff rates and limited import quotas for dairy products. However, following the 2005 Free Trade Agreements with Australia (Thailand-Australia Free Trade Agreement, TAFTA) (Thailand Department of Trade Negotiations, 2021a) and New Zealand (Thailand-New Zealand Closer Economic Partnership, THNZCEP) (Thailand Department of Trade Negotiations, 2021b), the tariff rates of dairy products from these two countries will reduce to zero in 2025. Therefore, local dairy farmers need to prepare themselves for the forthcoming economic challenge. To remain competitive with imported products, they need to

* Corresponding author.
E-mail address: pp@ku.ac.th (P. Piamsa-nga)

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strive to increase their farms' efficiency. Studies have shown that production loss can be reduced through simple but proper record keeping (Chagunda et al., 2006).

The Thai dairy industry comprises mainly smallholder farmers who are not financially strong and are incapable of investing in technology, specialized software, or employing skilled workers to manage their farms (Ballet, 2018). They usually have no systematic recording or fundamental procedure using written recording forms. While the pen-and-paper method is easy to set up, it may be difficult to link with other systems and to compare large or complex amounts of data. Consequently, farmers may have difficulty in carrying out any analysis to take full advantage of their farm data. However, in the digital era, with a fourth agricultural revolution currently underway, the agricultural practice is set to change as information and communication technology (ICT) will increasingly be used in agriculture, not only in developed countries but also in developing countries. For example, in Thailand, mobile phones are being adopted rapidly, reaching over 125 million mobile subscribers which theoretically equates to 180% uptake in Thailand and reflects a widespread acceptance of this technology or approximately 180% of the population in 2018 (International Telecommunication Union, 2021). This, together with the advanced technological software that they can host their own websites, with access to the internet being a potential game-changer, should enable smallholder farmers to access a tool not readily available previously. It could provide a novel way for smallholder farmers to improve their productivity and profitability. The notion of using ICT to provide benefits to farmers is not new. For example, Breen developed a decision support tool to maximize the return of investment in dairy farm infrastructure over the choice of technology, management practices and electricity tariff (Breen, 2019); Sengupta et al. introduced a farm equipment sharing app for financially constrained farmers in India (Sengupta et al., 2019.)

However, the success of an application does not rely on the technology and economic advantages alone but also hinges upon the acceptance of users and their willingness to share data. Full benefits are unlikely to be realized without adequately considering motivation and the role of users in the development and deployment of digital applications. Many sophisticated and seemingly beneficial digital applications have failed because they were unable to generate engagement. Although studies on the adoption of ICT by farmers exist (Marimuthu et al., 2017; Beza et al., 2018; Michels et al., 2019), it could be argued that the decision also entails a social dimension, emerging from the fact that the system is an intrinsically socio-technical system which involves interactions not only between users and technology but also among users and institutional and regulatory settings.

This paper addresses what arguably is an empirical gap in understanding the impacts of socio-technical factors on digital herd recording by smallholder dairy farmers. The approach taken stepped back from the benefits of what ICT can bring to the dairy farmers in terms of productivity and profitability to focus rather on the factors and processes that affect system engagement and data acquisition. Social Practice Theory (SPT) was used to provide a lens to the interrelations between agency, structure and herd recording with digital herd recording being defined not only as the use of technology to record herd data but also to encompass social relations, structured systems and social positions, as well as the meaning the practice has in an individual's life. This deeper understanding of the logics of practices should enable a better appreciation of digital herd recording possibilities.

The main goals of this paper are twofold. On one level, the paper aims to develop a conceptualization to uncover the often-hidden dynamics and logics of dairy farm practices related to herd recording and explore implications for facilitating digital herd recording engagement and data acquisition. On another level, the paper should provide additional insights into the challenge of designing ICT systems and the potential of SPT in offering a perspective for establishing system engagement which could be extrapolated to other applications involving everyday practices.

Materials and Methods

Research recognizes a gap between ICT innovation and ICT deployment in the dairy industry in Thailand. To bridge this gap, this paper established a set of design principles for increasing data acquisition of digital herd recording systems. These principles were applied in practice through a prototype digital herd recording system called "Cowlog." The current study adopted an action research methodology and an iterative design approach involving collaboration with stakeholders. The first version of Cowlog was developed based on the user interface/user experience (UI/UX) design principle (Songsupakit et al., 2019). Cowlog version 1 formed a preliminary exploratory into smallholder dairy farmers' herd recording practices. In particular, the lesson learned from the first version generated a shift of focus from the technical development to social aspects as an approach to design a herd recording system.

The overarching research question considered was: how can a digital herd recording system be purposefully designed to enable effective data acquisition?

The conceptual framework relied on social practice theory (SPT) to shine the light on the role of everyday farming practices in relation to digital herd recording. SPT has its foundation in the works of Bourdieu (1977) and Giddens (1989). While there is no universal definition of SPT, there is a common focus on understanding social systems through daily, routine practices, including how and when these practices are typically and habitually performed within the social space. Thus, in applying SPT, the focus is placed not on the individuals but the practices as the central unit of analysis.

The conceptual framework followed Bourdieu's concepts of field, habitus and capital (Bourdieu, 1977) to gain insights into individual and contextual factors that shape digital herd recording. According to Bourdieu, a field is a social space rather than a physical one. It is a network of structures and relations with its own logics of practices and accepted ways of behaving. For an individual, habitus refers to how people perceive the social world around them and react to it. It is a combination of perception, thinking, feeling, evaluating, speaking and acting. Habitus predetermines an individual's disposition toward ways of being, operating and perceiving without predetermining them. As habitus is shaped by an individual's experiences and circumstances, which are constantly changing, it also evolves continuously. The third concept is capital which acts as a social relation. Bourdieu's notion of capital departs from the conventional economic meaning to include social, cultural and symbolic forms designated as being values within a given field. Economic capital is financial resources, including monetary and material wealth, commodities and physical entities. Social capital refers to actual or potential resources from social networks such as farming networks. Bourdieu (1986) considered that cultural capital had three forms: embodied (knowledge, skills, experiences), objectified (materials such as equipment, accessories) and institutionalized (academic qualifications). Lastly, symbolic capital reflects power gain by an individual and is manifested in social position, rank, prestige or honor.

For Bourdieu, practices shape and are shaped by one's habitus and one's capital within a field. Formally, practices are the products of relations between field, habitus and capital as defined in Equation 1 (Bourdieu, 1984):

$$\text{Habitus} \times \text{Capital} + \text{Field} = \text{Practice} \quad (1)$$

Therefore, field, habitus and capital are intricately connected and do not act nor exist independently.

Thus, SPT provides a useful lens for understanding the culture of herd recording by smallholder farmers, including ways in which practices emerge, reproduce, resist and change and their relationship to structures of power and resources in the dairy industry. The current research developed this conceptualization through the analysis of a case study of dairy cooperatives in Thailand. Dairy cooperatives are particularly suitable for this research given their prominent role in the government's dairy promotion programs and their impact on smallholder dairy farmers. In addition, they provide services such as milk collection, milk processing, artificial insemination, veterinary health care, provision of feed supplies, credit, training and education.

The analysis studied farmers' practices over a period of 59 mth between 2019 and 2021 at the Khon Kaen Dairy Cooperative (KKDC). Situated in Khon Kaen province, Thailand, KKDC has 162 farm members and nearly 10,000 cows; it is one of the largest dairy cooperatives in Thailand.

Results and Discussion

In conceptualizing digital herd recording within the concepts of field, habitus and capital, our framework can be illustrated through an analogy of playing a game. An individual farmer can be seen as a player in a digital herd recording field defined by social relations, systems (such as rules and policies) and the positions (powers) of actors that shape digital herd recording practices. First, farmers are not the only players in the game. They do not act in isolation but depend on and relate to many other actors such as dairy cooperatives, experts (such as veterinarians and academics) and peer-farmers, who occupy different positions and whose presence and actions influence digital herd recording in dairy farms. Second, all games have rules that players are obliged to follow; for example, rules regulate how cows must be registered, how milk is sold and these, to some extent, can encourage or prevent digital herd recording practices. Third, like games, a herd recording field is competitive, with players constantly vying for better positions and more powers.

The analysis revealed pervasive themes that regulate practices and/or prevent opportunities for ICT innovation. These themes were not mutually exclusive but, in this paper, are discussed in turn to help unravel key implications for designing a sustainable digital herd recording system.

Service as a platform

Dairy cooperatives have been essential players in the field of herd recording. Their relations with farmers are instrumental in building farmers' economic capital. They operate milk collection centers. Through these centers, smallholder farmers become an integral part of the dairy value chain. The milk collection centers serve as a bridge in the supply chain between dairy farmers and milk processing factories that involves purchasing and collecting raw milk from dairy farms and transporting and selling collected milk to milk processing factories. Therefore, they have a strong influence on farmers' farming practices. As service providers, they have the power to structure the rules or tone of the technology used in herd recording. For example, the dairy cooperatives may use policy on loans as a control whereby farm data obtained through digital systems are used as objective data when reviewing loan requests. Farm members can still opt out if they wish, but their loan applications may not be approved. Promotion campaigns, such as insemination subsidies, can also be set by dairy cooperatives to encourage engagement from farmers. As advisers, they establish a special relationship with farmers in terms of trust, with farmers tending to be receptive to their advice.

Against this background, the digital herd recording system development should not focus solely on farmers. The inclusion of dairy cooperatives as system users will benefit all parties involved. It not only allows the dairy cooperatives to monitor farm/animal activities, reduces collecting data costs and errors and facilitates farmers receiving near real-time personalized technical advice but also enables the system to be integrated with other services within the dairy cooperatives. Furthermore, serving as a part of a more comprehensive service platform would permit policies to be imposed on farmers as part of persuasive strategies to encourage transformation.

Power (or powerless)

Dairy farmers operate in a highly controlled environment where rules are set by more powerful institutions that hold positions of authority. In the context of herd recording, dairy farmers are mandated by governmental regulation to keep a "cow identity document" for every cow in their herds. This paper document holds information on each cow, including: name, identification number, birth date and pedigree; parents' names, identification numbers and pedigrees; owner's name and address; and reproduction history of the cow. This requirement potentially creates farmers' behavioral lock-in. It prevents digital herd recording transformation as many farmers view digital recordings as an extra, unnecessary task because paper forms still serve as the official documents. As the less powerful actors, farmers cannot change this "rule of the game" imposed by the government. Therefore, the new digital herd recording system should be backward compatible with the current paper herd recording system. To avoid having farmers who are already under pressure with time to complete all daily tasks, doing duplicate recording, Cowlog version 2 was designed such that it can generate pdf reports in the same format and style as the paper forms which can be printed and serve as a paper document when required.

Playing the game

The habitus is the kind of practical sense akin to intuition for what is to be done in each situation (Bourdieu, 1998); for farmers with years in dairy farming, the "feel for the game" relies on an extensive body of knowledge. After a while, these practices eventually become part of their habitus, explaining why farmers do not document what they do. For example, cows are generally milked twice a day, but these activities are rarely documented. While most farmers practice automatic milking, they still rely on a manual weighing procedure. Since farmers are paid based on milk quantity at the destination (milk collection centers) and not on quantity at the origin (farms), nor on quality (the content of fat and protein), milk recording is not one of the farmers' main preoccupations in everyday farming. The milk collection centers instead document milk yields. Typically, raw milk is collected from farms twice daily (morning and afternoon) and delivered to milk collection centers run by dairy cooperatives. At the milk collection center, milk is weighed and recorded into the milk collection system. Then, farmers are issued with thermal printed paper receipts showing the received milk volume. As farmers and dairy cooperatives continue to play the game, they are disciplined into this "rule of the game", which becomes natural and unquestionable to them. Therefore, the new digital herd recording system should adhere to this rule of the game, which is laid out and the new system should not introduce significant intervention of a different field rule or a different habitus or both.

From this analysis, in Cowlog version 2, the dairy cooperatives were made the co-creators of milk recording data. While it was not feasible to have the digital herd recording system communicate directly with milk collection centers'

servers and databases via an application programming interface (API), this approach did guarantee the continuous flow of milk recording data into the system. However, it required additional players (API developers). Therefore, in Cowlog version 2, a less radical approach was adopted. The system was designed to directly import the milk records exported from their milk collection system through "one-click" file upload without any modification required or having to manually type the milk records through the system's milk recording function. Upon receiving the milk records, Cowlog immediately notified the farmers of the received milk volumes. Additional benefits were that it reduced the time and paper costs.

Persuasive strategies

While economic capital is, perhaps the most visible form of capital because it is directly associated with farms' revenues, it has been observed that many farmers' habitus are not economically motivated and instead, farmers often adopt specific practices based on what they consider more convenient and efficient to ensure that they complete all tasks for the day (Songsupakit et al., 2019). As a result, their habitus may not necessarily correlate with what is regarded as "best practices" by experts.

Daily, farmers are required to perform multiple, repetitive on-farm tasks such as milking, heat detection, insemination, pregnancy examination and calving. These tasks differ from animal to animal. Therefore, each animal needs to be approached as an individual, which can be difficult for farmers to keep track of, especially when herd sizes are large. Among many on-field activities, heat detection and insemination are two of the time-sensitive management factors relating to reproductive performance, contributing to the overall efficiency of a dairy's production and profitability. Artificial insemination (AI) is an essential reproductive technology in the dairy industry. Standing heat is an indicator to determine when a cow should be inseminated. For an estrus cycle of 21 d, there is a brief window of only 7–12 hr to fertilize the ovum (Hall et al., 1959). Failure to detect oestrus (heat) leads to improper timing of insemination and results in a low conception rate, extended calving interval (time between the birth of a calf and birth of a subsequent calf), extended day open (time between calving and next conception) and semen expense. For a cow with a 12 mth calving interval, a 21 d delay in calving means an approximately 6% loss in potential milk production alone.

Cow status notification is one of the main features of Cowlog. It provides the status of entire cows within the herd to reduce short-term (heat examination, insemination time), intermediate (today-list farm activities) and long-term (cow characteristics) memory load for the farmers. The mathematical algorithm which drives the notification is based on the 21-estrus cycle model (Koonawootrittriron, 2017). It uses previous heat detection, insemination, pregnancy checking, confirmed pregnancy and calving dates to compute "today" status, informing farmers of any essential activities, especially time-sensitive ones, such as the onset of estrus, insemination time window and expected calving date. Since the notification function relies on previous herd data, farmers will have to record these data to receive return benefits.

Some key reproduction management user interfaces of Cowlog are shown in Fig. 1. Fig. 1A shows a list of on-farm activities of a farm on a particular day. Cows are listed along with brief descriptions of their status and activities needing attention are flagged in red. Fig. 1B demonstrates a screen flow of a cow with user interaction.

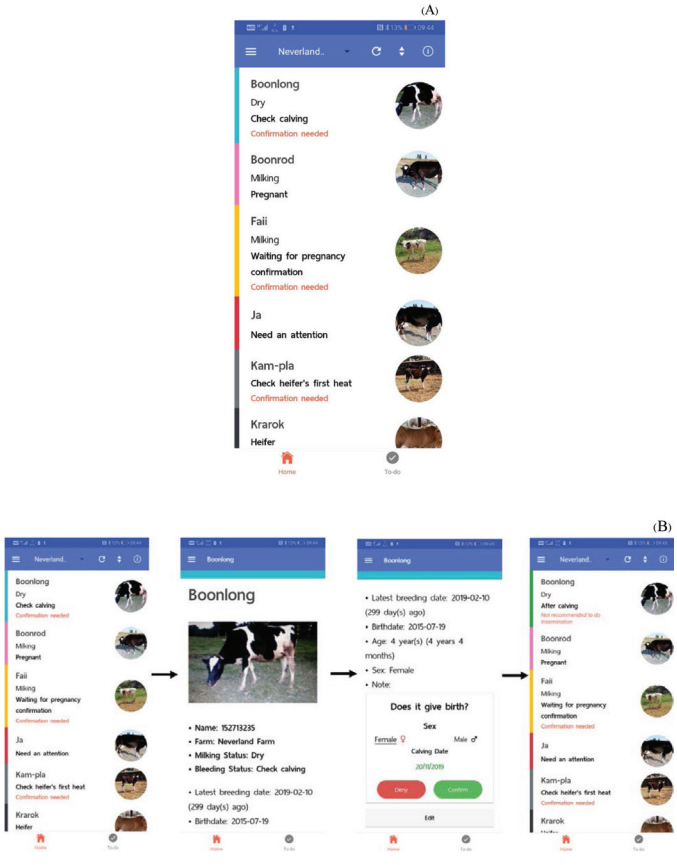

Fig. 1 Reproductive management user interfaces: (A) notification of daily events to user, where each row shows a cow with its recent status and red text indicates action is required; (B) example of screen flow of user interaction

Digitalization of farm data with Cowlog also allowed farmers to immediately gain insightful information to support their farm decision-making. Fig. 2 shows some charts and infographics from Cowlog, which are automatically generated from collected data, giving real-time information of various farm parameters. Fig. 2A shows the ratio of cow status in the herd and indicates the proportion of activities for the day. Fig. 2B provides an overview of the production ratio in the herd, where dry cows and heifers are currently not in production. Fig. 2C provides a summary of the status of a cow. Fig. 2D depicts the daily milk production of a farm. Fig. 2E is a scoreboard showing daily activities, which is computed from the status of all cows of a farm and from herd data that provides an overall summary of current farm status.

Social influence

Small family farms, more so than any other agriculture sectors, are businesses rooted deeply in tradition, where younger generations tend to follow the practices adopted by their elder family members. Thus, farmers' herd recording habitus is shaped by cultural capital associated with what are regarded as "good farming practices" within family traditions (cultural and symbolic capital). Experts such as veterinarians and academics who have farmers' trust based on their professional status (symbolic capital) also seem to exert influence in shaping what farmers constitute as good herd recording practices. Farmers' receptiveness to expert advice suggests that there is an opportunity for knowledge transfer from experts to farmers, which could further build farmers' cultural capital and shape farmers' herd recording habitus. For example, it has been observed that farmers often only record sires' names and not other detailed information such as pedigree, because it is not obvious to most farmers that this detailed information would complement the breeding program. Therefore, they see no benefit in keeping such records. Educating farmers on the benefit of these data could encourage more recordings.

Building their social capital through communications with peer-farmers and online communications (such as agricultural forums) could build farmers' cultural capital and consequently shape their herd recording practice. Therefore, Cowlog version 2 also features in-apps knowledge, news and Internet content sharing which provide curated content, ranging from agricultural news, valuable blog posts and expert advice to market prices (Fig. 3).

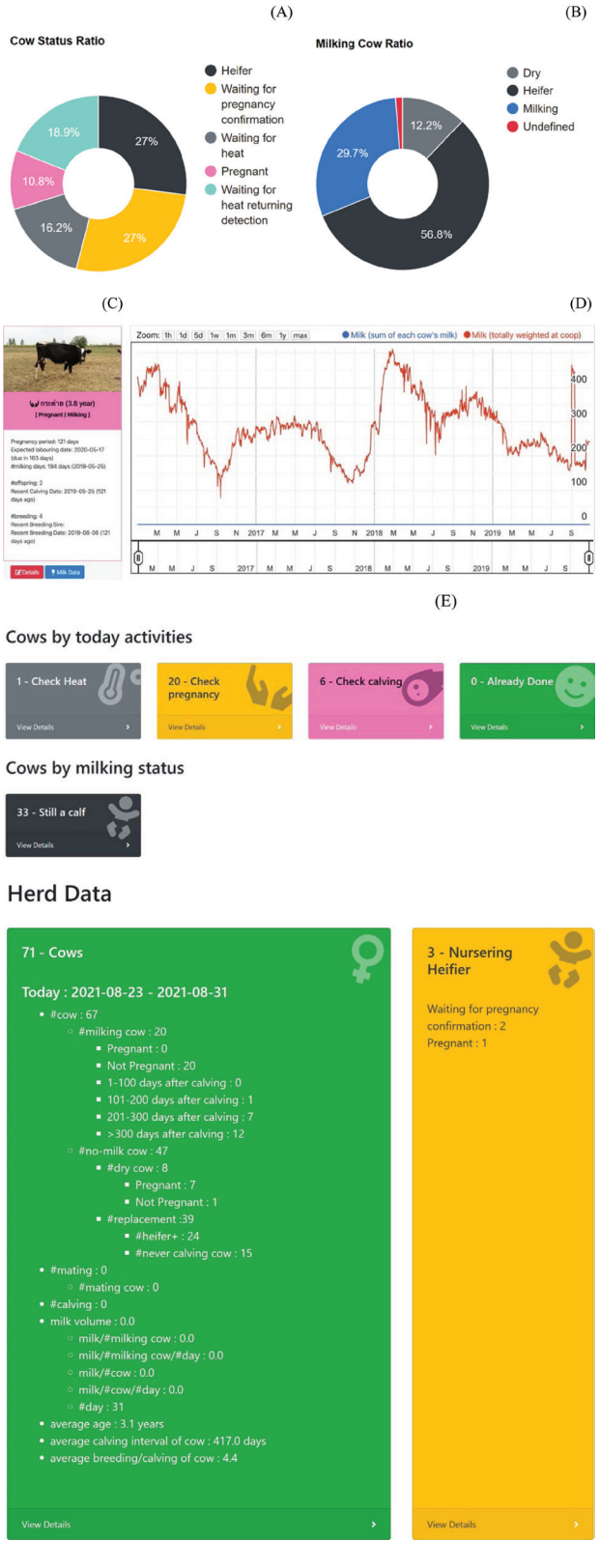

Fig. 2 Some infographics automatically generated from collected data: (A) cow status ratio; (B) milking cow ratio; (C) cow card; (D) daily milk production; (E) scoreboard

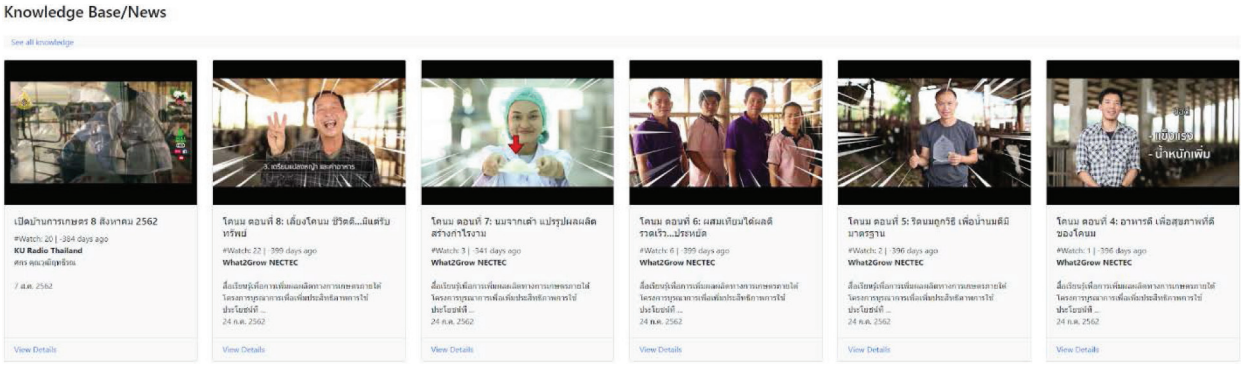

Fig. 3 Indicative on-screen information style for knowledge and news sharing from Cowlog version 2, where text is in Thai for local farmer audience

Digital literacy

Within the digital herd recording field, the use of ICT could be seen as a "new rule of the game." However, some farmers may not have sufficient cultural capital to internalize this new rule of the game. Computer literacy and fear of technology, especially among the older generation farmers, have been identified as one of the main constraints to engagement, particularly during the start-up process. The level of support is a critical attribute in addressing digital literacy and building farmers' cultural capital. Support services such as training could ease users into using the application. Further, Cowlog is designed to be easy to use, even for people who are computer illiterate. It requires minimum user inputs and in many cases, when necessary, it only requires a one-click "Confirm" or "Deny" response.

Based on Cowlog version 1 is was apparent that in Thailand, farmers breed their cows all year round using artificial insemination, with semen from the livestock semen production centers of the Bureau of Biotechnology in Livestock Production (Thailand Department of Livestock Development, 2021) and private organizations and companies. Therefore, to avoid users having to type in the sire's information which may be time-consuming and lead to incomplete or inaccurate information or both, Cowlog version 2 has incorporated the Bureau of Biotechnology in Livestock Production, (Thailand Department of Livestock Development, 2021) dairy sire semen records and private organizations and companies dairy sire semen records to create an artificial insemination (AI) sire database to our system. Creating the AI sire database allows users to select a sire from the drop-down list and improve the quality and completeness of sires' information in the system.

User diversity

While almost all farmers own mobile phones, tablets or personal computers or a combination, such items are only considered as objectified cultural capital within the herd recording field if they are used for herd recording. Therefore, to cater to users with diverse backgrounds, ages, lifestyles and revenues (economic capital), Cowlog version 2 is a bilingual (Thai and English) system and has Android OS and iOS smartphone application components and a website component. However, multiple UI/UX system designs and developments to accommodate all user groups are more costly. Therefore, cross-platform development tools have been used in implementing Cowlog version 2 to minimize development costs.

Deployment

The overall conceptual framework from applying the social practice theory to acquiring the conceptual design of the herd recording system is integrated and depicted in Fig. 4. SPT is applied to analyze and generate the design issues, providing more comprehensive analysis from the data collection system, so that system engagement should be effectively improved.

Fig. 5 shows milk recording data entries and breeding data in the Cowlog version 2 system over 59 wk during the study period. At 14 wk, KKDC was introduced as co-creators of milk recording data, resulting in a major increase in the number of milk recording data entries in the system. The interdependence between farmer engagement and the provision of support services is evident from the number of breeding data entries. It was found that sufficient personal one-to-one training to participating farmers was useful in helping to encourage farmer engagement. The training gave farmers more exposure to the benefits of using the Cowlog system and provided the

means for them to become familiar with all functionalities of Cowlog. With support from the cooperative, it was possible to schedule training during regular cooperative training sessions. From these sessions, it was observed that the participants had no difficulty understanding the logic and functions of Cowlog, but felt more comfortable after training, resulting in a steady increase in the number of breeding records.

This study explored the challenge of designing a digital herd recording system to facilitate more system engagement and data acquisition and suggested a way to maneuver around these challenges. System design should not be limited to technical aspects, nor should the emphasis be placed only on an individual as an agent in charge. In contrast, the discourse should be on the broader social relations, structured systems and social powers. Drawing on SPT, the analytical focus was shifted toward how practices emerge, reproduce, persist and change within the broader context of social space.

The analysis of the logics of practices through the lens of SPT shed light on the dynamic interplay between everyday farming practices, systems and powers that mutually influence

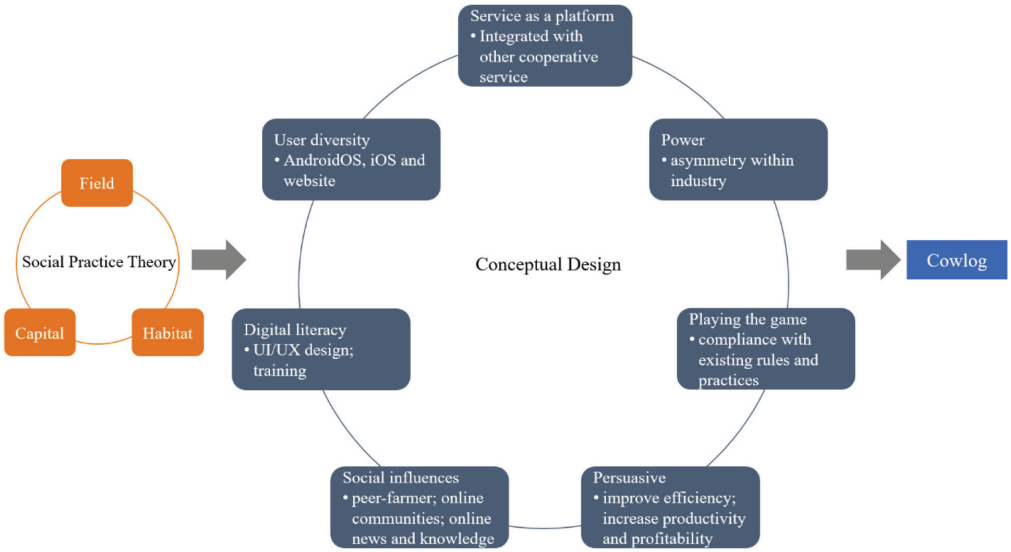

Fig. 4 Conceptual framework

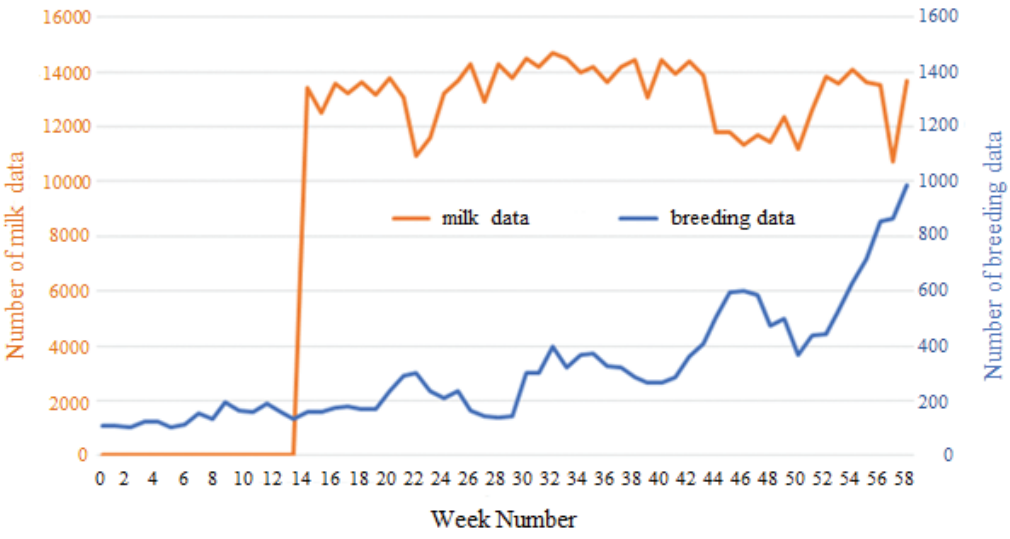

Fig. 5 Collected data record entries before and after applying social practice theory at week 14

herd recording practices. The case study of smallholder dairy farmers in Thailand revealed that the influence of players occupying higher positions of power can be fundamental in digital herd recording transformation. The benefits of designing the system as a platform were clear. The collaboration with dairy cooperative created a foundation for: 1) building trust and developing understanding of the value of the application with the farmers; 2) establishing a data-sharing pipeline to allow a continuous data flow of milk records into the system; 3) facilitating persuasive strategies to encourage farmer engagement; and 4) serving as an intermediary between the system developer and farmers. The procession, accumulation and generation of various forms of capital played a prominent role in impacting the farmers' habitus within the field of herd recording, increasing opportunities for farmers to become more powerful in their business operations, to build their knowledge and the necessary computer skills and to utilize supporting social networks that can facilitate digital herd recording transformation.

Beyond recognizing the relevance of SPT in designing digital herd recording systems, this shift of theoretical perspective to conceptualize practices as the central unit of analysis has the potential to guide future research with an approach for understanding the logics of practices of everyday life. Although SPT does not offer explicit strategies for prescribing practice transformation, it provides concepts for analyzing dynamics of practices and guiding us in generating empirical research strategies for constituting change.

Conflict of Interest

The authors declare that there are no conflicts of interest.

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