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Research Paper

Utilizing Technology Management for Effective Cattle Management

Sai Seng Harn[1]*
[1] Payap University, Thailand

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Abstract

This research explores the opportunities presented by integrating sensors, big data, and machine learning technology within the global cattle farming industry. The primary objective of this study is to assess the efficacy of technology management in advancing cattle management practices on a global scale. Data was collected from 554 ranchers, with 386 respondents having a minimum of five years of cattle management experience. Rigorous analysis was conducted to examine the impact of technology management, particularly focusing on sensors, big data, and machine learning, on various aspects of effective cattle management. The findings demonstrate the significant importance of technology management and Machine Learning in cattle farming. The study reveals strong correlations between technology management practices and all sub-factors of effective cattle management, including productivity, cost, and health. The research results suggest a substantial positive influence of technology management on enhancing effective cattle management, supported by a 95% confidence level. Furthermore, the study recommends Thailand as an attractive destination for foreign investment in the beef industry, highlighting the pivotal role of artificial intelligence technology in realizing this potential.

Keywords *Technology, Effective Management, Cattle Farm*

INTRODUCTION

The majority of people who work in cattle farms in developing are unaware of how technology management can help ease their lives and help them work efficiently and effectively, such as most of the Western World. Contrary to what most people think, predicting the expenses of the food and supplies for cows can be extremely challenging as consumption varies depending on the gender, age, and weight of cows, and this research will mention how AI can come into action in terms of software that would identify the budget and investment required at the beginning of each year for food and supplies expenses.

This research offers valuable insights for ranchers and workers in developing countries, facilitating their comprehension of technology management adoption in cattle farming. By addressing significant gaps in the current literature regarding Technology Management's role in developing country cattle farms, this study aims to bridge the knowledge divide. Most existing research on this topic originates from non-developing country contexts. In the pursuit of understanding the applicability of technology management, particularly in Thailand with its vast cattle population, an extensive survey involving 8,000 workers and ranchers has been conducted.

This research will illustrate how the software program can predict the capital required and will be shown to the workers in cattle farms. Then, there will be another program to recognize whether people are satisfied with the technology management program or not.

LITERATURE REVIEW

Theory

A technology-driven approach enhances cattle ranching by facilitating real-time interactions with veterinarians via GPS connectivity. This application, available on IOS and Android platforms,

Corresponding author's email: sengharnbrave@gmail.com

overcomes language barriers through translation, enabling seamless communication. As a comprehensive resource hub, it provides insights into cattle health, feeding practices, and disease detection individually. Notably, this innovation extends its benefits to remote areas with an offline option via a USSD code.

Simplifying cattle management, the application integrates record-keeping features, enabling ranchers to meticulously track finances. Beyond bolstering day-to-day operations, this technology addresses emerging diseases, minimizing veterinary expenses and ensuring the overall health of the cattle. Wancharoen (2020) emphasizes the relevance of this approach in disease-prone regions, exemplified in Thailand, curbing unnecessary expenditures on healthcare. Automated record-keeping significantly slashes costs, optimizing resource allocation (White et al., 2018). This reallocation, coupled with data-driven insights, translates to an approximate 50% reduction in expenses, encompassing feed and supplements. The application also imparts valuable guidance on reproduction, vaccination, and nutrition, a pivotal asset in regions such as Thailand, where reliance on imported beef often overshadows local produce.

Extending the technological arsenal, advanced cameras and thermal sensing equipment transform large-scale cattle management. Integrated via cloud-based systems, drones monitor individual cow health by gauging body temperatures. Notably, the efficiency of this approach trumps conventional methods, with drones accomplishing in minutes what once took an entire day (Price, 2019). Employing AI and facial recognition, smart cameras individualize livestock tracking. Real-time updates, coded in red for illness and green for health, empower ranchers with swift decisions. Amid Thailand's regulatory framework for drone operation, the technology holds significant promise. Capitalizing on the nation's commitment to robust internet access, the government aligns with technological advancements, bolstering 5G implementation for seamless execution of these innovations.

Conceptual Framework

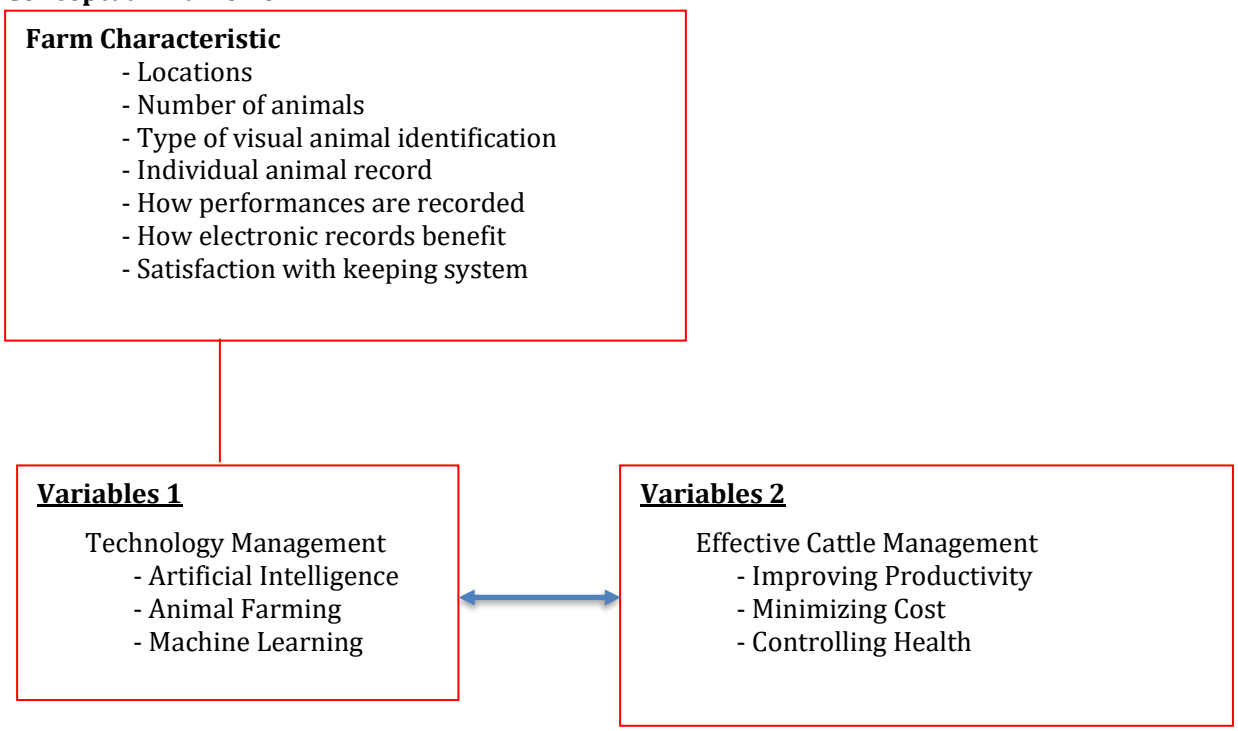

Figure 1. Conceptual Framework

Artificial Intelligence

Artificial Intelligence (AI) has catalyzed transformative technological applications by simulating general cognition through algorithmic execution of tasks across various technologies, software, and computers. This development encompasses predictive analytics, deep learning, and machine learning, collectively called data science. AI-based algorithms, known as algorithms, facilitate data collection in cattle farms, enhancing decision-making and operational efficiency. Modern livestock farms incorporate devices that monitor individual animal well-being, simplifying ranchers' lives and facilitating informed decision-making across global cattle farming practices.

Animal Farming

Mechanistic models offer insights into complex systems by explaining mechanisms underpinning patterns, particularly relevant for multifaceted issues. These models assist in addressing challenges such as identifying limiting factors, optimizing animal feed composition, and predicting outcomes across various scenarios. Big data's role in modern technology integration and sophisticated AI and machine learning algorithms supports comprehensive solutions in animal farming, enhancing monitoring and disease prediction. The convergence of cameras, big data, AI, and machine learning revolutionizes livestock management practices (Neethirajan, 2020).

Machine Learning

Automated systems, driven by machine learning and big data, rapidly process and analyze extensive data sets, enabling data-driven decision-making in livestock management. Sensors and machine learning algorithms detect subtle changes in animal behavior, assisting in identifying diseases and anomalies. For instance, drones provide insights into isolated areas, while cameras and thermal sensing equipment detect health issues and predict disease outbreaks. These technologies enhance livestock welfare, reduce costs, and foster efficient disease management (Nasirahmadi, 2019).

Effective Cattle Management

Effective cattle management encompasses various facets, including reproduction, nutrition, animal health, and market demand considerations. Livestock managers oversee multiple responsibilities, ranging from animal welfare to financial records. Swine operations, cattle ranches, and other livestock farms benefit from efficient management practices, optimizing animal care and responding to market dynamics. Machine learning technology facilitates streamlined management through activity tracking, treatments, and budgeting. These advancements enhance ranchers' capabilities and promote industry best practices (Ehrhart & Hansen, 1997).

Planning (Improving Productivity)

Ranchers employ efficient livestock management practices by integrating machine learning technology software, which aids in monitoring treatments, breeding, feeding, and more. These tools offer scheduling and budgeting capabilities, ensuring accurate and accessible data for stakeholders. Streamlined data tracking, facilitated by technologies like ear tagging and management software, supports comprehensive livestock care and informed decision-making across the industry.

Implementing (Minimizing Cost)

Specialized machine learning software empowers livestock managers to efficiently monitor and manage various activities, contributing to optimized operations. These technologies enhance precision and accuracy in record-keeping, enabling informed decision-making and efficient

resource allocation.

Controlling (Controlling Health)

Effective cattle management encompasses multiple factors, including animal health, nutrition, and reproduction. The application of technologies like drones, advanced cameras, thermal sensing equipment, and big data enhances disease detection and prevention. These technologies predict health issues, aid decision-making, and minimize disease spread, ultimately enhancing livestock well-being (Mathivanan & Jayagopal, 2018).

RESEARCH METHOD

Population and Sample

The research was conducted within the positivist paradigm utilizing a quantitative approach. The target population for this study consisted of cow-calf producers across various countries, including the Netherlands, Wales, Canada, Philippines, USA, Brazil, Kenya, England, Nigeria, and India. An online survey was the primary data collection method, distributed among ranchers from diverse regions through a network of 8,000 members. Prior to participation, respondents were presented with comprehensive guidelines elucidating the application of Technology Management with Artificial Intelligence (AI) in cattle farming. The survey focused on individuals with a minimum of 5 years of experience in cattle management and who actively engage in monitoring and tracking cows on their respective farms.

Survey Procedures

To ensure respondents' familiarity with machine learning technology, information about the successful implementation of Technology Management with AI in cattle farms from various countries was provided alongside the online survey. The survey was administered using Google Forms to facilitate efficient data collection and organization.

Sample Size Determination

The sample size was determined using the formula introduced by Cochran (1977) to estimate proportions with a desired level of accuracy. The minimum required sample size was calculated considering a standard normal deviation at a 95% confidence level (1.96), an estimated proportion of respondents selecting a specific response (50% = 0.5), and a confidence interval (0.05 = ±5). The study collected a total of 554 online survey responses, criteria of a minimum 5 years of cattle management experience, 168 responses were excluded, resulting in 386 valid and usable responses.

Research Instrument

The research instrument consisted of a structured questionnaire encompassing three distinct parts.

Part 1: Farm Characteristics

This section comprised 8 multiple-choice questions on farm characteristics. The questions encompassed topics such as geographical location, number of different locations, animal count, methods of visual animal identification, animal record-keeping practices, perceived benefits of record-keeping systems, and overall satisfaction with these systems.

Part 2: Technology Management

This part has 14 questions, 13 questions in Likert scale following 5 = strongly important, 4 =

important, 3 = neither nor important, 2 = unimportant, and 1 = strongly unimportant, that concern with artificial intelligence, animal farming and machine learning such as table below and 1 question of which technology management is most important.

Part 3: Effective Cattle Management

This part has 22 questions, 21 questions on the Likert scale following 5 = strongly effective, 4 = effective, 3 = neither nor effective, 2 = not effective, and 1 = strongly not effective, that concern with the application of drones, application of advanced cameras, application of thermal sensing equipment, and application of big data such as table below and 1 question of how to satisfy with Effective Cattle Management.

FINDINGS AND DISCUSSION

Result

The table below depicts whether or not ranchers in cattle farms keep an individual animal record. From the survey results, it has been found that the majority of the respondents, or 87.56%, collect and store individual animal records in their cattle farms, and 12.44% said no.

Table 1. Individual Animal Record Keeping by Respondents

The Individual Animal's Record Kept	Number of Responses	Responses in Percentage
Yes	338	87.56%
No	48	12.44%
Total Responses	**386**	**100%**

Regarding the benefits for ranchers storing individual animal records, the majority of them, up to 45.08%, are to reduce costs. Besides, 15.03% use it to reduce human labor, 14.51% to save time, 11.40% said storing should specific date of an operation with 8.81% pointed out it requires and some responses, as 5.18% have other reasons they do not have to be around it and let the machines do the work.

Table 2. Benefits for Storing Individual Animal Records

Reasons for storing	Number of Responses	Responses in Percentage
Reduce Costs	174	45.08%
Save Time	56	14.51%
Specific date of an Operation	44	11.40%
Reduce human labor	58	15.03%
It Requires	34	8.81%
Others (Safety)	20	5.18%
Total Responses	**386**	**100%**

Statistic

This part will describe the statistic in mean and standard deviation from the Likert scale and interpret as below:

Table 3. Likert-scale interpretation

Interpreting	Range
Strongly important	4.21-5.00
Important	3.41-4.20
Neither nor important	2.61-3.40
Unimportant	1.81-2.60
Strongly unimportant	1.00-1.80

This part collected data and described the mean, standard deviation, and interpretation from the 13 questions on the Likert scales, in particular artificial intelligence, animal farming, and machine learning.

Artificial Intelligence

With 4.487 mean of artificial intelligence shows AI technology is highest important factors in Technology Management according to 386 ranchers. Utilizing AI to simplify complicated data, analyzing individual well-being, and monitoring data period by time is the highest mean of this category. It shows AI is the key player in organizing big data for Technology Management.

Animal Farming

The 4.198 mean of animal farming is still considered high even though it is the least important out of 3 categories. The dilemma problem with the highest importance of animal farming categories shows that ranchers still need to decide over technology according to experience rather than letting technology do all the work. The least important is the study of vast amounts of data related to Technology Management, with the highest important mainly AI to study and simpler big data or helping humans to analyze big data for easier management.

Machine Learning

The 4.405 mean of machine learning is almost as important as AI, the highest important mean. Conducting the treatment of individual has the highest important of the category, with the second highest Machine Learning which will help humans work smarter in big data Technology Management. Machine Learning shows that it helps ranchers do difficult work, and humans still do the work but smarter.

Table 4. Dominant of Technology Management

Technology Management		**Mean**	**Standard Deviation**	**Interpretation**
Artificial Intelligence	Prior to purchasing software	4.466	0.926	Strongly Important

	Given free preview periods to validated farm.	4.513	0.860	Strongly Important
	Modern industrial farms adopt devices.	4.083	0.905	Important
	Monitor the individual well-being of each animal	4.702	0.797	Strongly Important
	Simpler by the utilization of Artificial Intelligence software.	4.671	0.708	Strongly Important
	Total	**4.487**	**0.839**	**Strongly Important**
Animal Farming	Useful for solving complex problems with multiple variables.	4.316	0.723	Strongly Important
	The dilemma cannot be overcome only by experiments	4.456	0.996	Strongly Important
	Necessitates the rigorous compilation	4.085	0.620	Important
	Study of vast amounts of data	3.933	1.240	Important
	Total	**4.198**	**0.895**	**Important**
Machine Learning	Help humans make smarter decision.	4.492	0.943	Strongly Important
	Assist ranchers in tracking animal activities in real-time	4.244	1.226	Strongly Important
	Be able conduct decides treatment on time.	4.609	0.822	Strongly Important
	Effectively detect the occurrence of many diseases	4.275	0.854	Strongly Important
	Total	**4.405**	**0.961**	**Strongly Important**

To understand what the ranchers think of technology management, almost all of them, 95.34%, believe that utilizing sensors, big data, and machine learning technology will benefit their cattle farm to effectively and efficiently track individual animal records, i.e., health, weight, disease, etc.

Table 5. Perspective of satisfies the record-keeping system

Perspective of satisfying the record keeping system	Number of Responses	Responses in Percentage
Help cattle management effectively	368	95.34 %
Prefer Utilizing	350	90.67 %
Help Better Livestock Quality.	386	100.0

1. Effectiveness of Cattle Management

The beef industry grapples with multifaceted challenges stemming from low yielding, inadequate animal care, infections, and high mortality rates. These obstacles often lead to suboptimal beef processing efficiency, compromised meat quality, and mechanistic models' efficacy in enhancing management practices and cost-efficiency. These models streamline operations while minimizing human labor and time consumption.

The study of Machine Learning algorithms, big data, and sensors in disease detection and overall cattle management. These technologies assess cattle health, nutrition, water access, disease prevention, and veterinary care, enhancing the well-being of livestock. Moreover, assessing economic effectiveness, encompassing metrics like feed conversion rates, weight gain, disease control expenses, and overall profitability, contributes to comprehensive cattle management evaluation.

2. Utilizing Technology Management in Global Cattle Farms

The integration of technology management holds significant promise for the livestock industry. Streamlining cattle management through software applications facilitates financial tracking, disease control, and record-keeping. Highlights AI's ability to forecast individual cattle body weight, leading to cost savings and improved cattle health. This technology empowers ranchers with data-driven insights into farm management, encompassing reproduction, vaccination, and nutrition.

Technology serves as an optimal approach for addressing myriad challenges in animal farming. Automation and Data Management technologies streamline processes in large farms through sensor systems, monitoring devices, and data analytics. The real-time tracking and analysis of parameters such as feeding, health, weight, and behavior enable informed decision-making. Remote monitoring, technology adoption, and comprehensive data management enable efficient cattle management with international business standards, fostering positive impacts on the industry.

3. Analyzing the Influence of Technology Management on Effective Cattle Management

Survey responses from ranchers underscore the time constraints in tracking and recording individual animal data. Advanced cameras and thermal sensing equipment emerge as valuable aids, efficiently monitoring individual cow health in minutes. These technologies align with ranchers' interests in adopting sensors, big data, and machine learning, enhancing animal

identification, infection control, and overall management.

The satisfaction among ranchers and cattle farm workers regarding technology management's efficacy is evident. The shift from manual labor to AI-driven efficiency significantly eases their workload and reduces capital expenditures.

The AI-based intelligence indicates a 50% reduction in antibiotic usage, showcasing the impact of technology on health monitoring. Disease management also benefits from remote sensing and diagnostic tools. Furthermore, data-driven decision-making thrives, as AI-powered analytics lead to substantial productivity improvements while minimizing intervention and antibiotic usage. As technology advances, the future holds promise for the cattle industry. Emerging technologies like artificial intelligence, blockchain, and precision feeding systems are poised to enhance effective cattle management, address limitations, and steer the industry toward a more optimized and sustainable future.

CONCLUSIONS

This study employed an online survey distributed via social media platforms, engaging a diverse group of ranchers and workers across cattle farms from more than ten countries, including the Americas, Canada, Europe, and Asia. A carefully selected sample of 554 ranchers, meeting the criterion of five years' experience in cattle farming, participated in the survey.

Farm Characteristic: The respondents, primarily aged 41-50 with extensive ranching experience, represented various operations. Around 33% managed multiple cattle operations across different locations, reflecting the complexities of modern livestock production. While computerized record-keeping methods were favored by over 87.56%, only a small percentage (12.44%) did not maintain individual animal records. Over 90.67% of respondents preferred Technology Management, citing its potential to streamline operations and enhance livestock management.

Technology Management: Technology Management, encompassing Artificial Intelligence, Animal Farming, and Machine Learning, demonstrated high importance ratings. Artificial Intelligence and Machine Learning were strongly important, while Animal Farming was considered important.

Effective Cattle Management: Effective cattle management was evaluated through three dimensions: Planning (Productivity), Implementing (Cost), and Controlling (Health). The respondents rated Each dimension as strongly effective, with scores of 4.509, 4.236, and 4.362, respectively.

Hypothesis and Conclusion: With a 95% confidence level and analysis based on 386 respondents, the study established a significant correlation between technology management and effective cattle management on a global scale.

Recommendation

1. **Implementing AI knowledge in Cattle Management**:

AI technology offers a promising opportunity to enhance cattle management efficiency. Recognizing its success in various industries, integrating AI into cattle management can reduce costs, time savings, and decrease physical labor. Particularly in Thailand's cow-calf sector, characterized by small-scale, consumption-driven ranching practices, introducing AI-driven solutions like sensors, big data, and machine learning can revolutionize operations. Highlighted in Table 3 by a mean score of 4.702 (highest in its category), individual animal well-being monitoring proves vital. Ranchers exhibit a keen interest in utilizing sensor-driven, data-centric technologies (4.6.9 mean) to enhance livestock quality and timely treatment decisions, effectively saving lives while mitigating financial risks. As Thailand's beef demand continues to

surge, bridging the technology gap is essential to compete with imported beef offerings.

2. **Advancing Effective Cattle Management**

Elevating existing cattle management practices necessitates the integration of AI technology. With a focus on optimizing workflows and ensuring cattle health, AI offers invaluable assistance. Highlighted by significant cost reduction and remote farm monitoring through big data emerge as key advantages of modern management. While AI's benefits are well-established, many farms, including those in Thailand, continue to operate traditionally. Thailand's potential as a thriving hub for beef cattle is evident, given its attractiveness for foreign investment and the growing regional and global demand for Thai beef.

3. **Challenging stakeholders in the Cattle Industry**

Traditional cattle farms are urged to embrace the potential of AI technology for long-term business sustainability and growth. Despite an initial investment cost, the benefits of Technology Management have been validated by the survey's AI technology users and experienced respondents. While the upfront expenses might exceed those of conventional farms, AI's substantial role guarantees long-term profitability and enhanced livestock quality control, as demonstrated in this survey. The advantages of AI extend beyond ranchers and investors. By reducing manual labor, AI technology eases the workload of workers and facilitates the affordability of high-quality beef products. Therefore, adopting AI not only secures profits for the cattle industry stakeholders but also fosters accessibility to premium beef for a broader audience.

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