APPLICATION OF THE TRACKING AND INSPECTION SYSTEM FOR PIG TRANSPORTATION IN NAKHON PATHOM PROVINCE

Tanawat Wisedsin[*], Phutthiwat Waiyawuththanapoom[**], Phitphisut Thitart[***], Piyamas Klakhaeng[****]

College of Logistics and Supply Chain Suan Sunandha Rajabhat University

E-mail: [*]Tanawat.wi@ssru.ac.th, [***]Phutthiwat.wa@ssru.ac.th, [***]Phitphisut.th@ssru.ac.th, [****]Piyamas.kl@ssru.ac.th

ABSTRACT

The purpose of this research is to study the appropriate information technology format for monitoring and tracking pig transportation and to design a device for reducing pig temperature during the transportation process by writing a timing program and using sensors to measure temperature. The results of the simulated weather experiment during the pig transportation period were from 4: 00 a. m. to 12: 00 p. m. with a temperature range of 25–40 degrees Celsius. Using a timed system for the operation of the fog pump every 30 minutes, during the low- temperature period, the pump system will not be instructed to operate. However, during the high-temperature period, the timing system will instruct the water pump to operate for the specified time of 5, 7, and 10 minutes. The fog was sprayed to reduce the temperature for 10 minutes. In order for the operation to be suitable for the transportation period, a design has been made to spray water according to the transportation time from start to destination. Starting with the no spray system and spraying for 5, 7, and 10 minutes at intervals, the temperature inside the pen decreased, with a minimum value of 24.38 ℃ and a maximum temperature of 31. 41 ℃. The average temperature of the entire transportation system is 26.14 ℃.

Keywords: Pig Transportation, Tracking, Fogging, Temperature Reduction

INTRODUCTION

Currently, the transportation of pigs across provinces takes an average of 4-6 hours, but in some cases, it can take up to 12 hours, including breaks for pig rest, disease inspection, and reporting the origin of animal movement at the animal quarantine checkpoints in each province. In most cases, pig transportation occurs during the night to avoid heat during daytime transport. There are two transportation methods for pigs: group transportation and single-crate transportation. These methods differ in the density of pigs in the crates. In group transportation, pigs are tightly packed into layers in the truck, causing them to compete for space and air, while single- crate transportation helps eliminate fighting among pigs, resulting in better skin quality without injuries from transport- related struggles. Regardless of the transportation method, whether group or single- crate, pigs may exhibit signs of stress and heat- related distress, particularly if there is a lack of water. In such cases, transporters need to stop the vehicle and provide water to the pigs using water pumps connected to water sources or by using water available at animal quarantine checkpoints. This helps reduce the temperature and stress levels of the pigs. If transporters neglect this aspect, there is a risk of pigs dying from high temperatures and stress during transport, impacting the quality and price of pork.

To address these transportation issues, researchers have proposed solutions, starting with studying information technology models suitable for pig transportation. This includes developing prototype devices to reduce pig temperatures and stress during transport. Sensors measuring temperature and sound levels above what pigs can tolerate are processed by

microcontrollers to assess the heat and needs of the pigs. When high temperatures and loud pig noises are detected, the microcontrollers collect data for analysis of sound and temperature in the crates.

To mitigate temperature during transport, the research team has designed a misting system that commands misting pumps or misting frames to spray water onto the pigs, reducing their temperature and stress caused by heat and compression in the crates during transport. The testing process involves spraying at intervals of 30 minutes, with varying misting durations of 5, 7, and 10 minutes each.

OBJECTIVES OF THE RESEARCH

1. To study the problems of pig transportation
2. To create a prototype device for tracking and monitoring temperature control during pig transportation

RELATED RESEARCH

2.1 Research in Pig Transportation field

The research findings indicate that the transportation of pigs without proper cleanliness and temperature control results in pork becoming a breeding ground for bacteria. Amnart Wanangkarn (2020) emphasized that pig transportation is a crucial factor that significantly influences customer preferences for pork products, and the lack of proper care during transportation affects the quality of pork. Furthermore, the cost of transportation is a key aspect that influences pig farming operations. Combining pig transportation with other processes helps reduce the overall transportation costs. Sarawut Jeongwatthanaphong and Sumethi Wongsa (2013) highlighted the importance of cost-effective pig transportation in the overall pig farming industry. During pig transportation, behavioral issues and stress are commonly encountered due to cramped conditions, high density, and heat. Pongchan Nampang (2010) pointed out that these factors lead to aggressive behavior among pigs, as they compete fiercely for space.

2.2 Researcher in the Heat Control Technology

In this research group, studies have been conducted on temperature reduction through an automated system that allows control through online channels. The development of temperature and humidity control systems involves the integration of a microcontroller board and DHT22 temperature and humidity sensors. These components command misting pumps to spray mist when the greenhouse temperature exceeds 40 degrees Celsius, effectively reducing the temperature. (Chalermchatri Saowaruj, 2017) Another study involves the creation of a web application combined with an Arduino UNO R3 device for temperature and water level measurements. This system allows for the automatic adjustment of temperature and dissolved substances. (Phonkid Ankhaow, 2018) In a different approach, a system has been developed to send alerts through dashboard checks. When temperature and humidity exceed predefined values, the system sends notifications via email, Line, and microsoft Teams to the system administrator. (Jettanun Juejantorn, 2019) As a result, user satisfaction with the system was measured at an average of 4.40/5.00. The system enables automatic watering based on changing weather conditions with precision. (Sittichok Parkpitak, 2021)

THEORIES AND TECHNOLOGIES RELEVANT TO THE STUDY

3.1 Tracking System

A Tracking System is a system designed to monitor and inspect work processes to reduce issues related to inquiries. It streamlines the steps for tracking tasks, minimizing complexities associated with the tracking process. It provides real-time display of the status of products or services, and the results presented on the screen can serve as reference data. The information obtained from the system can be utilized for proactive analysis of the situation.

3.2 Internet of Things (IOT)

Current Trends in logistics Improvement through IoT and Arduino Technology. The present scenario, where efforts are being made to enhance logistics operations at a lower cost, allows for the integration of IoT (Internet of Things) systems. This involves the application of knowledge in logistics combined with remote control via the Internet. The widely used device for this purpose is the Arduino board, known as the Arduino Aduno. Arduino is a microcontroller board developed as an open- source platform, disclosing both hardware and software information. The Arduino board is designed for user- friendly operation, and users can easily expand and develop the board or programs. The simplicity of the Arduino board allows users to connect external electronic circuit devices by interfacing them with the I/ O pins of the board. Additional components such as infrared sensors, light sensors, magnetic sensors, or boards that aid in controlling various operations can be easily added. This results in the capability to receive signals from sensors and utilize them for various functions.

3.3 Temperature Sensor Operation System

A temperature sensor measures temperature levels by utilizing the principle of resistance change in a wire. Generally, the internal structure consists of a small wire wound around a central axis made of ceramic glass. For the wire winding of RTDs (Resistance Temperature Detectors) , it is typically made of pure metals, commonly platinum, silver, or nickel. These metals exhibit electrical resistance values that are precisely related to the temperature. Due to this property, the sensor can accurately detect temperature changes. These sensors are produced in affordable formats, such as the DHT11 sensor, which is proficient in measuring both temperature and humidity with precise accuracy in operation.

3.4 Diaphragm Pump

Diaphragm pump operates on the principle of suction and compression, working as a positive displacement pump. Inside, there is a rubber diaphragm for liquid suction, assisted by the use of compressed air. The air pressure controls the flow volume. This type of pump is commonly used for handling viscous liquids, those with high pressure, and situations where minimal water usage is preferred compared to regular water pumps. Consequently, the diaphragm pump can be effectively utilized in research applications, aiding in efficiently reducing the temperature of pigs during transportation

3.5 Transmitting Data through Google Sheets System

The method of saving Arduino NodeMCU data to Google Sheets in real- time, using Arduino ESP8266 IFTTT Google Sheets, allows the creation of a link to send desired data values directly to Google Sheets by invoking a URL or using the GET Method, without the need to set up a server. This approach ensures high stability and functionality, making it adaptable for diverse applications of sending and receiving data or recording information. The system is suitable for transmitting data with a consistent format and has the capability to present real- time information effectively, offering versatility and ease of use.

RESEARCH METHODOLOGY

4.1 Study of Pig Transportation Process Issues:

In this initial phase, the researcher will delve into the challenges of the pig transportation process**.** Excessive temperatures in pig transport vehicles may induce stress and have health implications**.** Suitable transportation temperatures range between **15- 25** degrees Celsius**.** Interviews with experts in pig farming and transportation will be conducted to gather data on challenges in the pig transportation process**.**

4.2 Design of Equipment Set for Temperature Reduction in Pig Transportation

This stage involves designing equipment based on relevant research and insights obtained from interviews. Statistical data on internal temperatures during pig transportation will be utilized. Arduino microcontroller boards will be employed to link and transmit internal temperature data, controlling water pumps in the framework to release mist and reduce transport temperatures.

4.3 Testing of Prototype Equipment for Temperature Reduction in Pig Transportation

The testing phase will include delivering water by spraying mist into the pig pen and measuring internal temperatures**.** Tests will involve spraying intervals every **30** minutes, and mist durations of 5 , 7 , and 10 minutes**.** The goal is to evaluate the impact on temperature reduction during transportation**.**

4.4 Analysis of Mist Spraying Time Results for Temperature Reduction in Pig Pens

This step involves analyzing results obtained from mist spraying tests, focusing on a **30 -** minute interval and mist durations of **5** , **7** , and **10** minutes**.** The analysis aims to determine optimal misting parameters for effective temperature reduction during transportation**.**

4.5 Summary of Research Operation Results

In the final phase, the researcher will summarize experimental results, identifying suitable misting intervals and durations for pig transportation. Conclusions and recommendations based on the research findings will be presented.

STUDY RESULTS

5.1 Issues in Pig Transportation

The problem of transporting pigs can be summarized as limited transport space, resulting in aggressive behaviors such as space competition, injuries, climbing, turning, slipping, standing, sitting, lying down, and fighting**.** These behaviors are interrelated with temperature, affecting the pigs' aggressive tendencies, as found in the research of Pongchan in lampang **(** 2010**) .** Therefore, the researchers sought solutions to create a set of equipment to reduce temperature during pig transportation, focusing on research in the heat control technology group**.** This aligns with studies indicating that innovation management has a positive impact on agricultural machinery businesses in Thailand, as observed by Sudarat Pimolrattanakarn **(**2022**).** If innovative inventions can be developed, they could significantly enhance the efficiency of pig transportation**.**

5.2 Design of Pig Transportation Monitoring System with Heat Dissipation

The preliminary design involves the integration of key components such as microcontrollers, temperature sensors, misting pumps, solar panels, a charging control system, batteries, water tanks, and Google Sheets**.** The entire system is powered by solar energy stored in batteries**.** The temperature sensor sends data to the ESP**8266** microcontroller, which, in turn,

controls misting pumps to spray water and reduce temperature stress during transportation**.** Real**-** time temperature data is transmitted to Google Sheets throughout the journey in Figure 1**.**

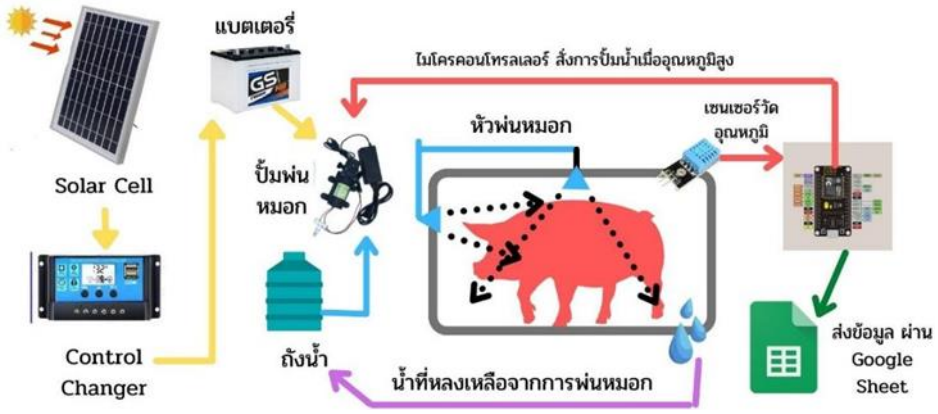

Figure 1: Design of the Temperature Reduction and Stress Alleviation Equipment for Pig Transportation.

Figure 1 illustrates the design, showcasing the integration of solar energy- driven components and misting system to maintain optimal temperatures and reduce stress during transportation. The temperature sensor, microcontroller, and misting pumps are powered by solar energy, ensuring the system's sustainability. The proposed system aims to address the challenges identified during the study and improve the well-being of pigs during transportation. Further research will involve testing the effectiveness of this system in real- world pig transportation scenarios.

5.3 Results of the Prototype Cooling System for Pig Transportation

From studying the distances in the transportation of pigs, both short and long distances, which have total travel times ranging from 1 hour per round to up to 4 hours per round, coupled with the weather conditions, it was found that during midday, the maximum temperature is between 33-36 degrees Celsius, and during the night, the minimum temperature is between 24 - 25 degrees Celsius. Based on this information, the researchers designed experiments with simulated weather conditions by setting up equipment in an open area and using devices to introduce heat into the simulated pens. The experiments were conducted at temperatures ranging from 24 to 41 degrees Celsius, which represent the local temperatures in Thailand. The researchers set intervals for fogging to reduce the temperature every 30 minutes and sprayed mist for 5 , 7 , and 10 minutes, respectively. Additionally, temperature inside the pens was measured during the experiments, and the results are as follows:

Table 1 : Experimental Results of Pig Pen Temperature at Different Temperature Ranges and Spraying Durations (5, 7, and 10 minutes)

Temp (C)	**Average Collect each 30 min about 2 Hr.**					
	Spay 5 Min	**Reduce (C)**	**Spay 7 Min**	**Reduce (C)**	**Spay 10 Min**	**Reduce (C)**
24	23.27	0.73	21.83	2.17	21.14	2.86
25	23.57	1.43	23.97	1.03	21.76	3.24

Temp (C)	Average Collect each 30 min about 2 Hr.					
	Spay 5 Min	Reduce (C)	Spay 7 Min	Reduce (C)	Spay 10 Min	Reduce (C)
26	24.90	1.10	24.10	1.90	22.02	3.98
27	25.27	1.73	25.04	1.96	23.10	3.90
28	26.18	1.82	26.10	1.90	24.20	3.80
29	28.68	0.32	27.69	1.31	25.78	3.22
30	29.39	0.61	28.23	1.77	27.98	2.02
31	29.58	1.42	28.14	2.86	28.50	2.50
32	30.37	1.63	30.06	1.94	28.83	3.17
33	32.31	0.69	31.05	1.95	29.92	3.08
34	32.62	1.38	31.14	2.86	31.89	2.11
35	34.74	0.26	32.90	2.10	33.87	1.13
36	35.71	0.29	33.91	2.09	34.58	1.42
37	35.90	1.10	35.25	1.75	35.07	1.93
38	36.46	1.54	36.85	1.15	36.22	1.78
39	37.73	1.27	37.41	1.59	37.17	1.83
40	39.67	0.33	38.71	1.29	37.14	2.86
41	40.37	0.63	38.06	2.94	38.80	2.20
Average	31.48	1.02	30.58	1.92	29.89	2.61

The test results revealed that a misting duration of 10 minutes had the most significant impact on temperature reduction. However, it is essential to note that a substantial amount of water is required for this duration. Therefore, adjustments in the misting system's operation need to be made to achieve optimal efficiency for each time interval, as shown in Table 2.

Table 2 : Summary of Experimental Results for the Prototype Cooling System During Pig Transportation

Time Interval	Transportation Time	Initial Temperature Inside the Pen	Misting System Activation Duration	Temperature Inside the Pen After Misting
1	4:00	24.38	Not in operation	24.38
2	4:30	24.40	Not in operation	24.40
3	5:00	25.14	Not in operation	25.14
4	5:30	25.70	Not in operation	25.70
5	6:00	25.01	Operated for 5 minutes	23.22
6	6:30	26.72	Operated for 5 minutes	24.90
7	7:00	26.85	Operated for 5 minutes	24.94

Time Interval	Transportation Time	Initial Temperature Inside the Pen	Misting System Activation Duration	Temperature Inside the Pen After Misting
8	7:30	27.03	Operated for 5 minutes	25.26
9	8:00	27.21	Operated for 5 minutes	25.55
10	8:30	27.57	Operated for 7 minutes	25.53
11	9:00	28.61	Operated for 7 minutes	25.81
12	9:30	29.27	Operated for 7 minutes	26.88
13	10:00	30.49	Operated for 10 minutes	26.79
14	10:30	31.62	Operated for 10 minutes	28.28
15	11:00	32.92	Operated for 10 minutes	30.10
16	11:30	33.72	Operated for 10 minutes	31.40
16	12:00	33.94	Operated for 10 minutes	31.41
			Average temperature after the misting system operation	26.14

RESULT

In the research project, the design of the equipment utilized temperature and humidity sensors, specifically the DHT22, in accordance with the work of Chalermchat Saoawarot (2020) and Phokit Ankhaw (2021). These sensors were interfaced with the ESP8266 microcontroller board, allowing real- time reporting of the temperature conditions inside the pigpen through Google Sheets. Following the experiments, it was found that spraying water on pigs during transportation helped in providing care, resulting in lower temperatures in the transport pen. This aligns with the research of Amnarut Wanangkarn (2023), who emphasized the importance of maintaining suitable temperatures during pig transportation. However, it was noted that the spraying process, occurring every 30 minutes, and the appropriate duration of spraying helped eliminate problems related to aggressive behavior and stress during pig transportation, addressing the issue of space competition and aggression caused by heat, as identified by Pongchan in lampang (2010).

Research Recommendations

The addition of a web application system to monitor pig transportation includes features such as temperature alerts within the pigpen, monitoring pig vocalizations, and installing cameras to capture aggressive behavior. This aims to address transportation issues and develop a tracking system for pig management. The web application provides real- time notifications, sound alerts, and visual surveillance to track and mitigate aggressive behavior during transportation. Additionally, GPS technology is integrated to track the current location of the transportation, facilitating efficient and well- planned routes for pig transportation, thus enhancing the overall speed and effectiveness of the process.

REFERENCES

Pongchan, N. L. (2010). The impact of pig transportation methods in Thailand on carcass performance and quality. Department of Animal Production Technology, School of Agricultural Technology, Suranaree University of Technology.

Sruwuthipong, J., & Sumetee, W. (2013). A study of cost and efficiency of transportation systems in the swine industry in Nakhon Pathom Province. Proceedings of the 5th NPRU National Academic Conference, 140.

Wacharaphon, D. (2016). Logistics management affecting the efficiency of operations on pig farms in the upper northern region of Thailand. Master's thesis, College of Logistics and Supply Chain, National Institute of Development Administration.

Chalermchatri, S. (2017). Automatic climate control in hydroponic greenhouses with misting systems. Master's thesis, Department of Mechanical Engineering, Faculty of Engineering, Suranaree University of Technology.

Chalermchon, V., & Rajanada, K. (2018). Application of PLC control and IoT systems for sound, temperature, and humidity control in laying hen businesses. UTCC Academic Day 2019, 1956–1972.

Phongkit, A. (2019). Automatic nutrient solution control system for hydroponic vegetable cultivation using the Internet of Things (IoT). Journal of Research, Rajamangala University of Technology Srivijaya, 11(1), 145–157.

Jetnunt, J. (2019). Research project on monitoring the temperature and humidity status of server rooms using IoT. Research project, Budget Type for Research Promotion and Development Fiscal Year 2022, Computer Center, Burapha University.

Amrattana, W. (2020). Evaluation of bacterial contamination sources in pig meat during transportation and distribution in Phitsanulok Province. Agricultural Science Journal, 17(1), 77–86.

Sokorn, B. (2019). Development of a prototype system with tracking equipment for real- time parcel transportation using RFID technology. Sai Tech Journal, 3(2), 202.

Sitthichok, P. (2023). Development of an automatic water control system through wireless sensor networks to increase sugarcane yields. Journal of Information Technology Application, 7(2), July–December 2024.

Nittikorn, N. (2022). Design of a small-scale air-conditioned room with IoT control for salad greens. Proceedings of the 15th National and International Research Presentation Conference, March 21, 2022.

Pimonratanakan, S. (2022) . The Causal Factors That Influence the Organization Performance of The Agricultural Machinery Industry. AgBioForum, 24(1) , 72- 82. https://doi.org/10.5247/24-1-4