Statistical Quality Control Application in a Poultry Farm

by

Mr. Panjapon Chariyatharasit

A Final Report of the Six-Credit Course
CE 6998 - CE 6999 Project

Submitted in Partial Fulfillment
of the Requirements for the Degree of
Master of Science
in Computer and Engineering Management
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Academic Year	November 2004

The Graduate School of Assumption University has approved this final report of the six-credit course, CE 6998 — CE 6999 PROJECT, submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer and Engineering Management.

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ABSTRACT

This project concentrates on using SPC and control chart to monitor before and after bird flu to help management system in the farm and how to protect and prevent bird flu in the A.B.P. Farm. In this project, we find steps for protection and prevention of bird flu and the effects of bird flu.

Statistical Process Control or SPC is a method for achieving quality control in manufacturing processes. It was pioneered by Walter A. Shewhart and taken up by W. Edwards Deming with significant effects by the Americans during the World War II to improve aircraft production. Deming was also instrumental in introducing SPC techniques into Japanese industry after that war.

A.B.P. Farm, the core business of Chariyatharasit Family, is a farm that conducts business for producing food, especially chicken, for consumers in Ratchaburi Province since 1981; more than 20 years ago. There were approximately 100,000 chickens contained in opened-houses farm for a period of every 45 days.

We find how to protect and prevent Avian Influenza Viruses in the farm. The steps of process is destroying and preventing bird flu. The method of rebuilding structures of house is in EVAP system, and monitoring and controlling the management system in the farm. We use SPC method and control chart to help the management system in the farm.

ACKNOWLEDGEMENTS

Several people have made contributions to this project. I would like to acknowledge their efforts and thank them for their contributions.

First of all, I would like to thank Dr. Chamnong Jungthirapanich, Dean of School of Computer and Engineering Management, my advisor who has always showed his support, assistance, guidance, and who has given me the needed directions to accomplish this project.

I would like to express my sincere thanks to every one of my classmates for the good time we had together, and who encouraged me in many ways.

Finally, I appreciate having such a lovely family who always encourages me throughout this project.

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I. INTRODUCTION.

1.1 General Background of the Project

A.B.P. Farm, the core business of Chariyatharasit Family, is a farm that conducts business for producing food, especially chicken, for consumers in Ratchaburi Province since 1981; more than 20 years ago. There were approximately 100,000 chickens contained in opened-houses farm for a period of every 45 days.

Over these years, the Farm had never faced any problem regarding severe disease until the beginning of the year 2004: Bird Flu or Avian Influenza Virus occurred. We had to kill all chickens in our farm immediately when a veterinarian could prove that the Bird Flu had infected the chickens in the Farm. However, causes of this disease could not be clarified. Consequently, the Bird Flu still expands and can not be protected although the governmental sector strongly helps to solve the problem. From the effect of the Flu, the Chariyatharasit Family has obtained the biggest loss from destroying the birds. Other business operators have losses also.

The preliminary way for solving this problem as mentioned above, the Family agreed to change the farming system by building new houses, the closed-houses farm, for chickens with EVAP system which are the best houses to protect and prevent them from any infection.

The purpose of this report is to analyze issues regarding causes of the Avian Influenza Virus, including obstacles to solve the problems and find the best solution for protecting and preventing from this virus which is an ongoing process at present.

The report will focus on the solutions of the Bird Flu problems by dividing into three phases i.e. introduction to bird flu situation and solution, destroying chickens, cleaning houses, and rebuilding houses to EVAP system.

First, it is the introduction to bird flu situation. This process will substantially concern cause of bird flu. What is the bird flu? What are the causes of bird flu? The introduction of bird flu situation is in the world.

The second phase, it consists of ways to destroy chickens. This process will substantially concern the safe ways to kill them. How to kill them safely by protecting the virus from extending to other farms during the destroying period? How to destroy them as quickly as possible? After that, it is the cleaning-houses process. The cleaning-houses process is one of the most important phases to solve the Flu problem. The purpose of this process is to absolutely destroy the Viruses in whole houses even their floors and roofs.

The last phase, the rebuilding of houses; former houses have to be changed to closed houses which can protect and prevent all viruses infecting chickens that is more effective than the open houses system. In addition, the close houses system makes the quality of chicken growth better, the death rate and the numbers of employee are reduced, and monitoring and implementing by using SPC.

1.2 OBJECTIVES of the project:

The objectives of this project are as follows:

(1) Use the Statistical Quality Control (SQC) to monitor the farm

(2) To understand the causes of Bird Flu.

(3) To protect and destroy Bird Flu.

(4) To improve the chicken-farming system.

1.3 SCOPE of the Project:

(1) Within the operating and maintenance scope.

(2) Within the area of faun.

(3) The method protects and destroys bird flu.

IL LITERATURE REVIEW

2.1 Need for QC

The product of a testing process is a numerical result. Unlike a physical product that can be inspected to assess whether it looks good or bad, you can't look at a test result and tell whether it's valid. 247 - what do you think? If this is a patient sample, do you think the test result is of good quality (meaning the correct value)?

If the value of 247 is measured on a sample that has been analyzed before and has the values shown in the accompanying histogram, do you think the test result is of good quality? Because values between 240 and 260 have often been observed in the past measurements, it is expected that this new value should also fall in that range if everything is working okay; therefore, the patient test results included in this run of measurements are also most likely to be correct.

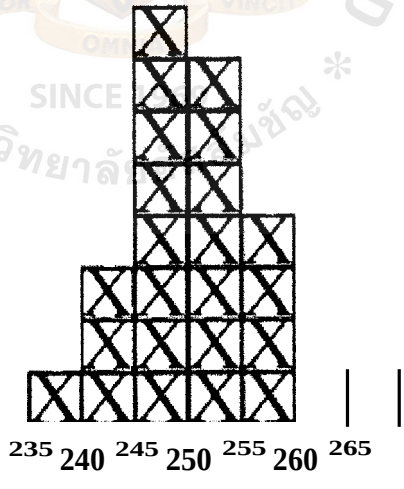

Figure 2.1. Histogram.

A simple graphical tool - the QC chart

In the laboratory, control charts are used to make it simple to compare today's observed value with what is expected based on past history. As shown in the second figure, by turning the histogram sideways and spreading the results out according to the time they were collected, it is easy to see how each observation compares to the expected distribution of past observations, which are shown by the central line and certain limits calculated from the mean and standard deviation (SD) of the of the past control data. In this figure, the limit lines correspond to the mean plus/minus 1 SD, 2 SD, and 3 SD. Assuming a gaussian or normal distribution, it would be expected that about 68% of the points fall within 1 SD of the mean, 95% within 2 SD of the mean and 99.7% within 3 SD of the mean. Therefore, it would be very unexpected (0.3% chance) to observe a control value greater than 3 SD from the mean and such an observation usually indicates there is a problem with the method. It is somewhat unexpected to observe a control value greater than 2 SD from the mean, but this will happen at least 5% of the time when analyzing 1 control per run, so it may indicate a real problem or it may be a false alarm. It is very common (32% chance) to see individual values beyond 1 SD from the mean, therefore this control limit is of no value for making a judgment about method performance based on a single control value.

That's the idea behind statistical quality control. See if you can get the right answer for a known sample. The right answer is actually a range of values that are calculated from the mean and standard deviation of past results. That mean and control limits can be shown on a control chart to make it simple to plot new control measurements and see how they compare with the expected range of values.

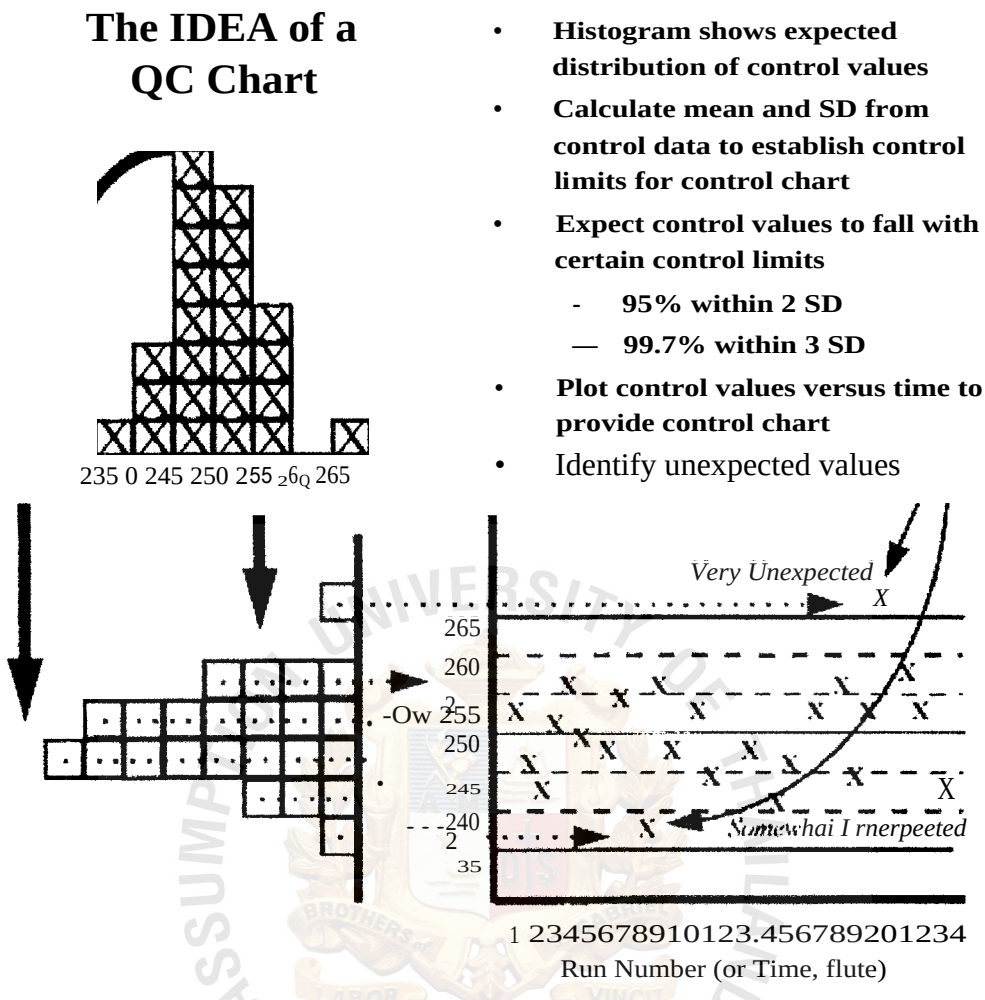

Figure 2.2. The idea of a QC chart.

In the beginning, there was Shewhart

Walter A. Shewhart was a statistician at Bell Telephone Laboratories who developed the scientific basis for statistical process control. Shewhart stated that "the object of industry is to set up economic ways of satisfying human wants and in so doing to reduce everything possible to routines requiring a minimum amount of human effort. Through the use of the scientific method, extended to take account of modern statistical concepts, it has been found possible to set up limits within which the results of routine efforts must lie if they are to be economical. Deviations in the results of a routine

process outside such limits indicate that the routine has broken down and will no longer be economical until the cause of trouble is removed." Shewhart made this statement in the preface to his book on the "Economic Control of Quality of Manafactured Product" that was published in 1931.

Statistical process control, from the beginning, has been concerned with achieving the desired quality (satisfying human wants) at minimum cost (economic control). Shewhart identified critical elements such as the expected variation of a routine process, a way to set limits that will identify when the routine has broken down, and the need to eliminate causes of trouble when the process was observed to exceed those limits.

Almost twenty years passed before Levey and Jennings introduced statistical control methods in clinical laboratories in 1950. Shewhart's original recommendations called for making a group of measurements, calculating the average and range (maximum difference), then plotting the average and the range on two different control charts. Levey and Jennings proposed making duplicate measurements on a patient specimen. Because the actual level of the measured constitutent varied from specimen to specimen, this was a more difficult application. Henry and Segalove developed an alternative procedure in which a stable reference sample was analyzed repeatedly and individual measurements were plotted directly on a control chart. This reference sample type of QC in which individual values or single values are plotted directly is commonly known today as a Levey-Jennings chart.

Since that time, industry has developed stable control products that mimic patient samples, thus today there are safe QC materials readily available for most established tests. A better understanding of the performance characteristics of QC procedures has been developed, which has led to refinements such as the multirule

procedure for evaluating and interpreting control data. Strategies for cost-effective operation have been further refined. Computer programs have been developed to implement statistical control procedures by performing the necessary calculations, preparing graphical displays, applying the desired control rules, and alerting analysts to problem situations. Today, support for handling control results is provided by most automated analyzers, information systems, and even point-of-care devices.

Learning the QC lingo

Statistical process control is the general term used to describe those aspects of a control system in which statistics are applied to determine whether observed performance is within the expected variation of the process, in contrast to other components of a total control system such as preventive maintainence, instrument function checks, operator training, etc., that are included in CLIA's broad definition of quality control.

Statistical control procedure is used here to refer to a specific protocol for analyzing a specific number of control materials and interpreting a specific number of test results. In Healthcare Laboratories, a control procedure is usually implemented by collecting test results on stable control materials, then plotting those control observations on a control chart that has specified control limits or by evaluating those control results by data calculations employing specified decision criteria or control rules.

Control chart is a graphical method for displaying control results and evaluating whether a measurement procedure is in-control or out-of-control. Control results are plotted versus time or sequential run number; lines are generally drawn from point to point to accent any trends, systematic shifts, and random excursions.

Control limits are lines drawn on a control chart to provide graphical criteria for assessing whether a measurement procedure is in-control or out-of-control. These

control limits are usually calculated from the mean and standard deviation (SD, or s) determined for a given control material. Typically the interpretation is based on a specified number of results or points exceeding a certain control limit when in-control patient test results are reported. When out-of-control, the run is rejected and no test results can be reported.

Control rule means a decision criterion for judging whether an analytical run is in-control or out-of-control. It is commonly defined by a symbol of the form AL, where A is an abbreviation for a statistic or represents a number of control measurements, and L identifies the control limits, often specified as the mean plus or minus a multiple of the standard deviation (s) or sometimes by a specified probability for false rejection (Pfr). Some examples follow:

1_{3s} refers to a control rule that is commonly used with a Levey-Jennings chart when the control limits are set as the mean plus 3s and the mean minus 3s. A run is rejected when a single control measurement exceeds the mean plus 3s or the mean minus 3s control limit.

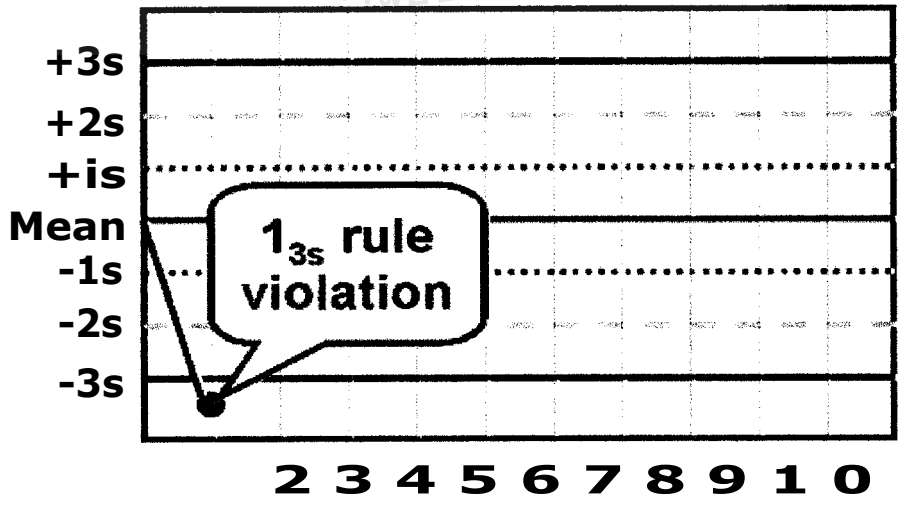

Figure 2.3. 1_{3s} refers to a control rule.

1_{2s} refers to the control rule that is commonly used with a Levey-Jennings chart when the control limits are set as the mean plus/minus 2s. In the original Westgard multirule QC procedure, this rule is used as a warning rule to trigger careful inspection of the control data by the following rejection rules.

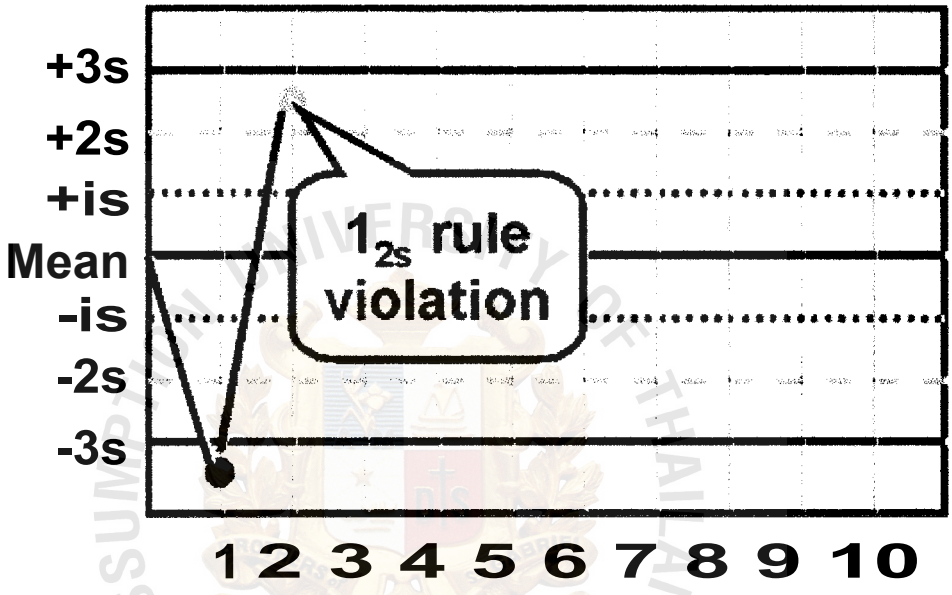

Figure 2.4. 12_s refers to the control rule.

2_{2s} - reject when 2 consecutive control measurements exceed the same mean plus 2s or the same mean minus 2s control limit.

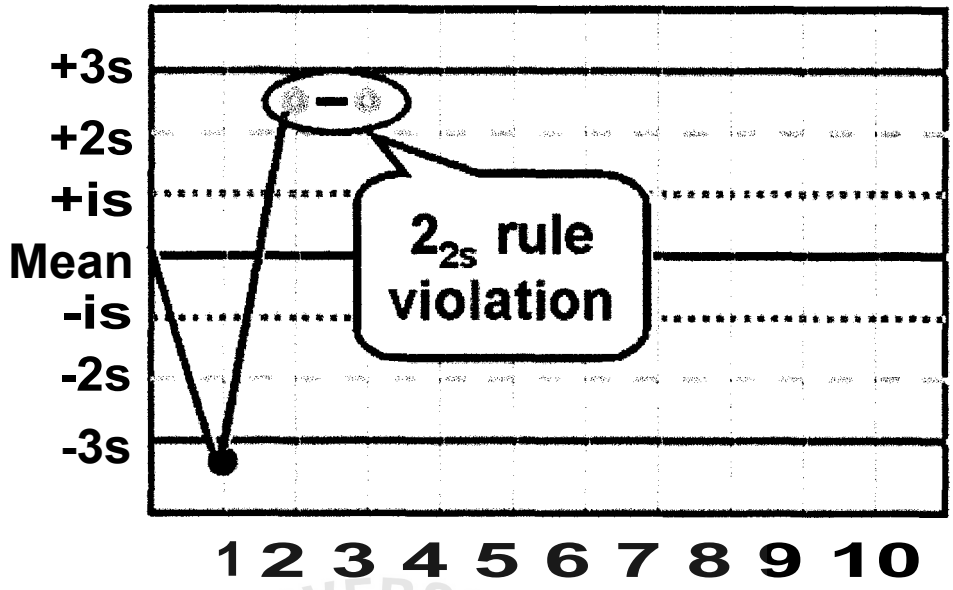

Figure 2.5. 22_s - reject when 2 consecutive control.

$R4_s$ — reject when 1 control measurement in a group exceeds the mean plus 2s and another exceeds the mean minus 2s.

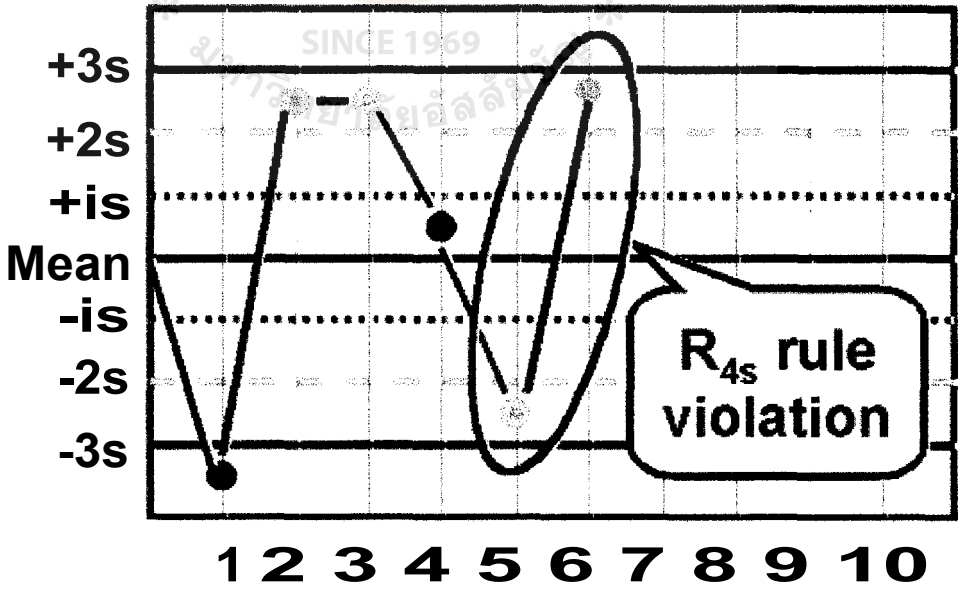

Figure 2.6. R4s — reject when 1 control measurement.

Run, analytical run, or run length refer to the interval, which could be a period of time or group of samples, for which a decision on control status is to be made. CLIA defines a maximum run length of 24 hours for chemistry analytes and 8 hours for hematology tests. Many laboratories define a shorter period based on changes that may affect the performance of the testing process, such as changing operators, changing reagents, recalibration, or other factors that may make the process susceptible to problems. Run length varies from system to system and laboratory to laboratory. For random access automated systems, a run is usually defined as the time interval at which controls are reanalyzed. For manual systems and batch instruments, a run is often defined as a group (or batch) of samples that are all analyzed at the same time.

Doing the deed

The idea is simple, but the application can be complicated.

First, you need to obtain control materials that are appropriate for the tests of interest and the methods in use. See QC - the Materials for a discussion of important factors, such as matrix effects, stability, vial to vial variation, assayed versus unassayed materials, analyte levels, and pre-treatment problems.

Then you must assay the selected control materials under routine operating conditions to characterize the expected measurement variation and establish the expected distribution of values. This usually involves obtaining at least 20 values and calculating the mean and standard deviation. There are a number of pitfalls from using bottle values or other estimates of the means, standard deviations, and control limits, so you need to be careful with this step. See QC - the Calculations for more information about data calculations.

Next you need to define appropriate control rules, numbers of control measurements (N), and the analytical run length. See QC - the Regulations for the legal

requirements for laboratory QC. See QC - the Planning Process for a brief description of QC planning and links to other materials on this website.

You must also define how you will implement these rules and Ns - manual plotting, or computer assessment by the analyzer, a PC workstation, or a laboratory information system. For manual implementation, see QC - the Levey-Jennings Control Chart for directions on how to prepare the control chart, plot control results, and interpret control data.

Finally, you should prepare written guidelines to define the QC procedure in detail. This written document is important for teaching laboratory analysts the QC procedure and establishing a uniform practice. It is also necessary for meeting US regulatory requirements.

2.2 STATISTICAL QUALITY CONTROL

Statistical Quality Control is defined in this work as: "with the help of numbers, or data (Statistical), to study the characteristics of our process (Quality) in order to make it behave the way we want it to behave (Control)." The main issue is quality evaluation, because quality is vital to the organization survival and growth. Therefore one needs to systematically study a process variability to assure its quality. The only way of doing it is by using statistical methods.

There are three major components of Statistical Quality Control: Statistical Process Control (SPC), Acceptance Sampling and Design of Experiments.

Statistical Process Control includes Control Charts, which monitor a process performance, and Process Capability Studies, which measure the process' ability of producing items according to specifications. SPC also includes some "opportunity tools," like the Ishikawa diagram and the fluxogram, and statistical tools, like Pareto

diagram and the histogram (those tools are used to find the causes of a process misbehaving, perhaps an opportunity for improving its quality).

Acceptance Sampling can be defined as the group of statistical techniques used to accept or reject lots of finished goods or raw material received from suppliers. Some authors [31 emphasize that Acceptance Sampling does not estimate lot quality, it just recommends a course of action: to accept or reject the lot based on a random sample from it.

Design of Experiments is a broad statistical issue. Properly designed statistical experiments can discover what variables are causing a process to misbehave and also the magnitude of the effect.

2.3 Statistical Process Control

Statistical Process Control or SPC is a method for achieving quality control in manufacturing processes. It was pioneered by Walter A. Shewhart and taken up by W. Edwards Deming with significant effect by the Americans during the World War II to improve aircraft production. Deming was also instrumental in introducing SPC techniques into Japanese industry after that war.

The technique hinges on the observation that any manufacturing process is subject to seemingly random variations, which are said to have *common causes,* and non-random variations, which are said to have *special causes.* A common cause might be air movement in the manufacturing environment, which causes variations that are outside the control of manufacturing operatives. A special cause might be the fact that the operative has a hang-over. Management can usually determine special causes for manufacturing defects by consulting the workforce, but dealing with common causes is a management responsibility.

SPC relies on measuring variation in manufacturing output and setting *control limits* based on observations of variations arising solely from common causes. A process that is "in control" is expected to generate output that is within the control limits. If the process produces an "out of control" point, one would not necessarily assume the process had moved to an "out of control" state but would try to locate the special cause(s) for this condition. Only if special causes could not be found would an assumption be made that there might be new common causes to be identified. One aspect of process quality improvement is achieved as these common causes are found and corrected - special causes have no bearing on the overall quality improvement process.

The main quality improvement process consists of the intentional varying the production process to achieve a smaller range of control limits (See, for example, design of experiments). It has been shown that manufacturing processes can achieve control limits which are a tenth of the specified manufacturing tolerance. Such a process can achieve zero defects - because even articles that are outside the control limits due special causes are still within the specified tolerances. The reduction in waste and inspection resources can make processes subject to SPC far more efficient, and the predictablility implied by processes that are in control allows further savings to be made by adopting just in time inventory control.

Processes may have outputs that can be measured as *variables* or as *attributes.* Variables are characteristics of a product that can be measured on a continuous scale. An example of a variable would be the length or width of a product or part. An attribute is an aspect or characteristic of a product that cannot be put on a linear scale. For example, a light bulb will either light or fail to light. "Good/bad" is an attribute, as is the *number* of defects.

There are several types of commonly used process control charts. Among them are X-Bar, R Chart; P Chart; NP Chart; C Chart; and U Chart. Each chart has a specific area of application.

2.4 Influenza Viruses

Types, Subtypes and Strains

There are three types of influenza viruses: A, B, and C.

Influenza Type A

Influenza type A viruses can infect people, birds, pigs, horses, seals, whales, and other animals, but wild birds are the natural hosts for these viruses. Influenza type A viruses are divided into subtypes based on two proteins on the surface of the virus. These proteins are called hemagglutinin (HA) and neuraminidase (NA). There are 15 different HA subtypes and 9 different NA subtypes. Many different combinations of HA and NA proteins are possible. Only some influenza A subtypes (i.e., H1N1, H1N2, and H3N2) are currently in general circulation among people. Other subtypes are found most commonly in other animal species. For example, H7N7 and H3N8 viruses cause illness in horses.

Subtypes of influenza A virus are named according to their HA and NA surface proteins. For example, an "H7N2 virus" designates an influenza A subtype that has an HA 7 protein and an NA 2 protein. Similarly an "H5N1" virus has an HA 5 protein and an NA 1 protein.

Influenza Type B

Influenza B viruses are normally found only in humans. Unlike influenza A viruses, these viruses are not classified according to subtype. Although influenza type B viruses can cause human epidemics, they have not caused pandemics.

Influenza Type C

Influenza type C viruses cause mild illness in humans and do not cause epidemics or pandemics. These viruses are not classified according to subtype.

Strains

Influenza B viruses and subtypes of influenza A virus are further characterized into strains. There are many different strains of influenza B viruses and of influenza A subtypes. New strains of influenza viruses appear and replace older strains. This process occurs through a type of change is called "drift.". When a new strain of human influenza virus emerges, antibody protection that may have developed after infection or vaccination with an older strain may not provide protection against the new strain. Thus, the influenza vaccine is updated on a yearly basis to keep up with the changes in influenza viruses.

2.5 How Influenza Viruses Change: Drift and Shift

Influenza viruses can change in two different ways.

One type is called "antigenic drift," which occurs through small changes in the virus that happen continually over time. Antigenic drift produces new virus strains that may not be recognized by antibodies to earlier influenza strains. This process works as follows: a person infected with a particular flu virus strain develops antibodies against that virus. As newer virus strains appear, the antibodies against the older strains no longer recognize the "newer" virus, and infection with a new strain can occur. This is one of the main reasons why people can get the flu more than one time. In most years, one or two of the three virus strains in the influenza vaccine are updated to keep up with the changes in the circulating flu viruses. For this reason, people who want to be immunized against influenza need to receive a flu vaccination every year.

The other type of change is called "antigenic shift." Antigenic shift is an abrupt, major change in the influenza A viruses, resulting in a new influenza virus that can infect humans and has a hemagglutinin protein or hemagglutinin and neuraminidase protein combination that has not been seen in humans for many years. Antigenic shift results in a new influenza A subtype. If a new subtype of influenza A virus is introduced into the human population, if most people have little or no protection against the new virus, and if the virus can spread easily from person to person, a pandemic (worldwide spread) may occur.

Influenza viruses are changing by antigenic drift all the time, but antigenic shift happens only occasionally. Influenza type A viruses undergo both kinds of changes; influenza type B viruses change only by the more gradual process of antigenic drift.

2.6 Avian Influenza Viruses

Influenza viruses that infect birds are called "avian influenza viruses." Only influenza A viruses infect birds. All known subtypes of influenza A virus can infect birds. However, there are substantial genetic differences between the subtypes that typically infect both people and birds. Within subtypes of avian influenza viruses there also are different strains.

Avian influenza H5 and 1-17 viruses can be distinguished as "low pathogenic" and "high pathogenic" forms on the basis of genetic features of the virus and the severity of the illness they cause in poultry; influenza H9 virus has been identified only in a "low pathogenicity" form. Each of these three avian influenza viruses (H5, 117, and H9) can theoretically be partnered with any one of nine neuraminidase surface proteins; thus, there are potentially nine different forms of each subtype (e.g., H5N1, H5N2, H5N3, H5N9).

Spread of Avian Influenza Viruses among Birds

Avian influenza viruses circulate among birds worldwide. Certain birds, particularly water birds, act as hosts for influenza viruses by carrying the virus in their intestines and shedding it. Infected birds shed virus in saliva, nasal secretions, and feces. Susceptible birds can become infected with avian influenza virus when they have contact with contaminated nasal, respiratory, or fecal material from infected birds. Fecal-to-oral transmission is the most common mode of spread between birds.

Most often, the wild birds that are host to the virus do not get sick, but they can spread influenza to other birds. Infection with certain avian influenza A viruses (for example, some H5 and H7 strains) can cause widespread disease and death among some species of domesticated birds.

2.7 Overview of 2003-04 Avian Influenza Outbreaks

Since January 2004, outbreaks of avian influenza (bird flu) among poultry have been reported in several parts of the world. In Vietnam and Thailand, avian influenza H5N1 outbreaks among poultry have been associated with illness and death in humans.

This section provides background information about recent avian influenza outbreaks and the risk to human health.

Outbreaks in Asia

H5N1 in Asia

An outbreak of avian influenza, more commonly known as bird flu, is affecting bird populations in countries throughout Asia. The outbreak is caused by the H5N1 subtype of influenza A. Human cases also have been reported.

(1) **In birds:** Outbreaks of avian influenza A (H5N1) have been confirmed among poultry in Cambodia, China, Hong Kong (in a single peregrine falcon), Indonesia, Japan, Laos, South Korea, Thailand, and Vietnam.

Information on Influenza A (H5N1)

(1) **Background:** Influenza A (H5N1) is a subtype of the Type A influenza virus. Wild birds are the natural hosts of the virus, hence the name avian influenza or bird flu. The virus was first isolated from birds (terns) in South Africa in 1961. The virus circulates among birds worldwide. It is very contagious among birds and can be deadly to birds, particularly domesticated birds like chickens.

Spread: Infected birds shed virus in saliva, nasal secretions and feces. Avian influenza viruses spread among susceptible birds when they have contact with contaminated excretions. It is believed that most cases of H5N1 infection in humans have resulted from contact with infected poultry or contaminated surfaces.

2.8 Epidemiology

The immediate source of infection for domestic poultry can seldom be ascertained, but most outbreaks probably start with direct or indirect contact of domestic poultry with waterbirds. Many of the strains that circulate in wild birds are either non-pathogenic or midly pathogenic for poultry. However, a virulent strain may emerge either by genetic mutation or by reassortment of less virulent strains.

Once AI is established in domestic poultry, it is a highly contagious disease and wild birds are no longer an essential ingredient for spread. Infected birds excrete virus in high concentration in their faeces and also in nasal and ocular discharges. Once introduced into a flock, the virus is spread from flock to flock by the usual methods involving the movement of infected birds, contaminated equipment, egg

flats, feed trucks, and service crews, to mention a few. The disease generally spreads rapidly in a flock by direct contact, but on occasions spread is erratic.

Airborne transmission may occur if birds are in close proximity and with appropriate air movement. Birds are readily infected via instillation of virus into the conjunctival sac, nares, or the trachea. Preliminary field and laboratory evidence indicates that virus can be recovered from the yolk and albumen of eggs laid by hens at the height of the disease. The possibility of vertical transmission is unresolved; however, it is unlikely infected embryos could survive and hatch. Attempts to hatch eggs in disease isolation cabinets from a broiler breeder flock at the height of disease failed to result in any AI-infected chickens. This does not mean that broken contaminated eggs could not be the source of virus to infect chicks after they hatch in the same incubator. The hatching of eggs from a diseased flock would likely be associated with considerable risk.

Incubation Period

The incubation period is usually 3 to 7 days, depending upon the isolate, the dose of inoculum, the species, and age of the bird.

Clinical signs

The clinical signs are very variable and are influenced by factors such as the virulence of the infecting virus, species affected, age, sex, concurrent diseases and environment.

In virulent (or highly pathogenic) AI of the type traditionally associated with fowl plague, the disease appears suddenly in a flock and many birds die either without premonitory signs or with minimal signs of depression, inappetence, ruffled feathers and fever. Other birds show weakness and a staggering gait. Hens may at

first lay soft-shelled eggs, but soon stop laying. Sick birds often sit or stand in a semi-comatose state with their heads touching the ground. Combs and wattles are cyanotic and oedematous, and may have petechial or ecchymotic haemorrhages at their tips. Profuse watery diarrhoea is frequently present and birds are excessively thirsty. Respiration may be laboured. Haemorrhages may occur on =feathered areas of skin. The mortality rate varies from 50 to 100%.

In broilers, the signs of disease are frequently less obvious with severe depression, inappetence, and a marked increase in mortality being the first abnormalities observed. Oedema of the face and neck and neurological signs such as torticollis and ataxia may also be seen. The disease in turkeys is similar to that seen in layers, but it lasts 2 or 3 days longer and is occasionally accompanied by swollen sinuses. In domestic ducks and geese the signs of depression, inappetence, and diarrhea are similar to those in layers, though frequently with swollen sinuses. Younger birds may exhibit neurological signs.

Vaccination

Inactivated quality assured oil-emulsion vaccines have been demonstrated to be effective in reducing mortality, preventing disease, or both, in chickens and turkeys (7). These vaccines, however, may not prevent infection in some individual birds, and if infected could shed virulent virus. Nevertheles, the amount of virus shed is considerable less than that of non-vaccinated and infected birds.

It is imperative that the circulating antigenic avian influenza virus be known and the vaccine represent this antigenic strain, since there is no crossprotection among the 15 known HA subtypes. A recombinant fowl pox virus vaccine containing the gene that codes for the production of the H5 antigen has recently been

licensed in some countries but is not widely used currently.

Pathology

Birds that die of peracute disease may show minimal gross lesions, consisting of dehydration and congestion of viscera and muscles.

In birds that die after a prolonged clinical course, petechial and ecchymotic haemorrhages occur throughout the body, particularly in the larynx, trachea, proventriculus and epicardial fat, and on serosal surfaces adjacent to the sternum. There is extensive subcutaneous oedema, particularly around the head and hocks. The carcase may be dehydrated. Yellow or grey necrotic foci may be present in the spleen, liver, kidneys and lungs. The air sac may contain an exudate. The spleen may be enlarged and haemorrhagic.

AI is characterised histologically by vascular disturbances leading to oedema, haemorrhages and perivascular cuffing, especially in the myocardium, spleen, lungs, brain and wattles.Necrotic foci are present in the lungs, liver and kidneys. Gliosis, vascular proliferaion and neuronal degeneration may be present in the brain.

2.9 CONCEPT OF EVAPORATIVE COOLING

To offset periods of extreme temperature that affect the in-house environments and therefore production, Coolair evaporative cooling systems are used with outstanding success. The benefits of evaporative pad cooling are obtained by moving large quantities of air through water-saturated pads. The resulting evaporation of water will lower the air temperature 10 to 25 degrees. This method of cooling can provide dependable relief from heat stresses in periods of hot weather. Suited for all geographic

locations, a Coolair Evap-Pad System delivers the greatest economic benefits in areas where higher temperatures during longer periods of time are normal.

RECOMMENDED TOOLS

The following is a list of tools required for the installation of your Coolair Evap-Pad System.

Tape Measure
Chalk Line
Level
Drill with 5/32" Drill Bit
3/8" and 5/16" Sockets and Drive
Hack Saw
Caulk Gun
Screwdriver
Tin Snips

PARTS LIST

(A) Your Coolair Evap-Pad System consists of:

(1) A water distribution and return system complete with the correct number of the following parts :(Number of some parts is dependent upon size of system)

11/2" PVC Distribution Pipe
PVC Female Adapter
PVC End Plugs
11/2" PVC Distribution Pipe Tee
PVC Pipe Cement
Troughs
Trough Hangers
Trough Connectors
Trough End Caps
Pad Retainers (for all 7 and 8' systems and 4" thick 5' and 6' systems only)
Pipe Cover Back Plates
Pipe Covers
Pipe Supports
Pipe Cover End Caps
Various Fasteners
Drip Pans (for 4" pad systems only)
Pad Spacers (for 4" pad systems only)

(2) A Plumbing Kit

(3) Evaporative Cooling Pads

(4) Sump Pump

(B) Parts required for the Evap-Pad System, but that are not supplied by Coolair consist of:

(I) Framing Materials

(2) Sump Tank, Sump Drain and Sump Cover

(3) Return Pipe from Trough Drain to Sump

(4) Water Supply to Float Valve

PAD LOCATION IN BUILDING

For greenhouse applications, the pads' midpoint should be centered on the crops to be cooled. The pads should be located on one end of the building and the fans on the other end, except in wide greenhouses where the pads should be on one side and the fans on the opposite side.

For poultry or livestock applications, the top of the pads should be at the highest level at which cooling is desired. The pads should be located on one end or side of the building, with the fans on the opposite end or side. The air should be drawn the length of the building except in cases where the resulting air velocity exceeds the comfort level for the animals being housed. In these cases, the pads should be on both sides at both ends of the house, with the fans on both sides in the middle.

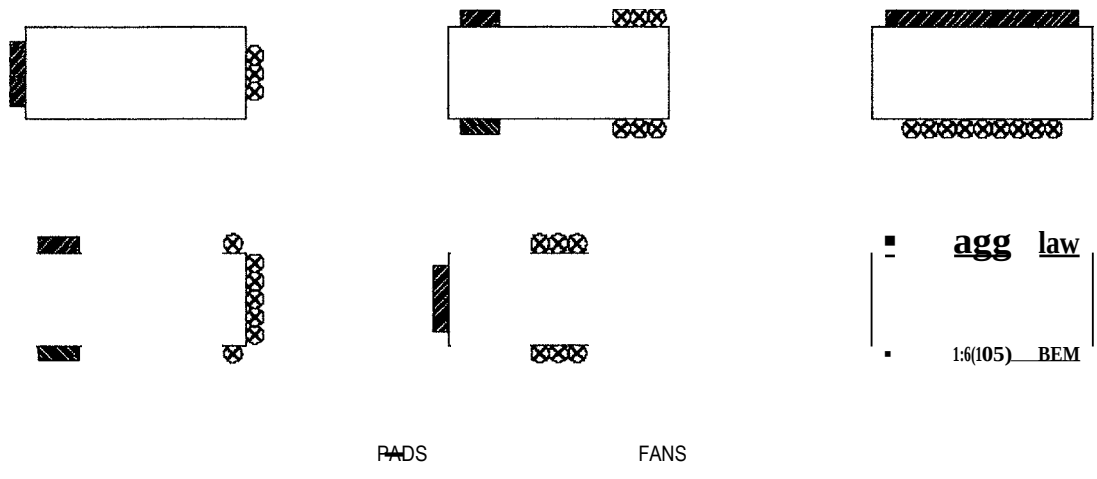

Figure 2.7. Contact your Coolair representative for recommendations.

Many other designs are acceptable. Contact your Coolair representative for recommendations.

INSTALLATION PROCEDURES

(A) Installation of Upper and Lower Stringers - 5 to 25 Foot Systems

(B) Installation of Upper and Lower Stringers - 30 to 110 Foot Systems

(C) Installation of the Middle Stringer

(D) Installation of the Trough Hanger

(E) Assembly of the Downspout and End Cap Sections

(F) Installation of the Trough

(G) Installation of the Pipe Cover Back Plate and Pipe Support

(H) Installation of the Distribution Pipe

(I) Pad Installation for 4" Cooling Pads

(J) Pad Installation

(K) Pipe Cover Installations

(L) Installing the Sump, Pump and Piping

START UP PROCEDURE

Remove the end plugs in the distribution pipe. Prime the pump per the instructions included with the pump. Next, fully open the volume control valve. Turn the pump on and let it run for a few minutes to flush out any debris that has accumulated in the system. Turn the pump off and replace the end plugs. Turn the pump on and remove the last pipe cover. The water should be squirting up 3-4 inches. Adjust the volume control valve until the proper flow is achieved. Check the complete length of the distribution pipe to be sure that none of the holes are plugged. Use a piece of wire to unplug any holes that need it.

To ensure that you are getting the best performance from your system, check to be sure that the entire pad is getting wet. Also, make sure that the pads fit tightly, not allowing any air to leak around them.

When first starting the system, it sometimes takes several hours of operation for the pads to become completely wet. After the initial wetting, the pads should wet in a few minutes. Complete pad wetting may also be a problem due to dust accumulating after the pads have been dry for several months.

The initial wetting can be aided by spraying water on the pad with a garden hose and also flooding the pads with excess water for the first hour. After the pads become wet the first time, turn the water down by the use of the volume control valve until the water comes down the pad in a soaking action and not a stream flooding down the pad.

OPERATING INSTRUCTIONS

(1) The pads are very durable and will last 5 or 6 years if properly maintained. When the water is circulated and evaporated, the mineral content of the remaining water gets higher. To keep the mineral content within workable levels, 5% to

10% of the circulated water must be bled off through the hose bibb. When mineral deposits are observed on the pad, increase the amount of bleed off

(2) The pH of the recirculated water must be maintained between 6 and 9.A pH of 7 is neutral water. A pH above 9 or below 6 will drastically reduce the life of the pad.

(3) Algae growth and water bacteria in the pads must be controlled. The pads are treated with a fungus resistant additive but this does not completely prevent algae growth. Treat the water with any of the chlorine algaecides (Calcium Hypochlorinates) used for swimming pools, HTH or Pace. Tablet forms of these algaecides are the most economical and best to use in the sump for slow release. Maintain the sump water for recirculation at 1 ppm (part per million) chlorine. If a chlorine smell is present, too much has been added. If any algae grows, tablets need to be added. Water pH and chlorine levels should be checked weekly. Kits for testing pH and chlorine may be purchased at any swimming pool supply store. The life of your pad depends on its proper maintenance. Do not use copper sulfate in the system as it will corrode the pump and other metal parts of the system.

(4) Clean the filter at least once a week, more often if foreign materials are present in the water system.

(5) Flush pipe distribution system at least once a month. This is done by opening both ball valves while the pump is running and allowing water to flow through and out of the system.

(6) Regulate your ventilation system so that the pad system is turned off while all the fans are still running. This will pull air through the pads after the water is turned off, allowing them to dry properly and killing the algae spores. Do not keep the pads wet around the clock as this will also make the pads soft.

(7) When the evaporative pad system is operating, check the pads for dry spots. When dry spots are observed, remove the pipe cover and check the holes in the pipe. Clean any stopped up holes with a wire until adequate water flows from each hole.

(8) DO NOT FLOW EXCESSIVE WATER ON THE PAD. The pads are more efficient if they just have enough water to keep them wet, but not a stream of water cascading down the pad.

(9) Drain and clean the sump as necessary to remove any dirt or trash that it may have accumulated.

(10) At the end of the evaporative cooling season, drain the pump, sump and pipe system to avoid freezing damage in cold weather. If the pump cannot be completely drained, put anti-freeze in it.

III. PROJECT METHODOLOGY

3.1 Project Criteria

The project will focus on the solutions of the Bird Flu Virus problems by dividing into three phases.

First, it is the introduction to the Bird Flu Virus situations in Thailand and A.B.P. Farm. This process will substantially concern causes of the Bird Flu. What is the Bird Flu? What are causes of the Bird Flu? The introduction of bird flu situation is around the world.

The second phase consists of ways to destroy chickens. This process will substantially concern safe ways to kill them. How to kill them safely by protecting the Virus not to extend to other farms during the destroying period? How to destroy them as quickly as possible? After that, it is a cleaning-houses process. The cleaning-houses process is one of the most important phases to solve the Flu problems. The purpose of this process is to absolutely destroy the Virus in whole houses even their floors and roofs.

The last phase, the rebuilding of houses, former houses have to be changed to closed houses which can protect and prevent all viruses infecting chickens and more effective than the open houses system. In addition, the close houses system makes the quality of chicken growth better, the death rate and the numbers of employees are reduced.

3.2 Project Problem Statements

There are three purposes of having the problem statements;

(1) To focus on the solutions of the Bird Flu problems.

(2) To rebuild houses to EVAP system.

(3) Monitoring quality control after changing system.

3.3 Defined Phase

Problem Statements

Influenza A (H5N1) is a subtype of the Type A influenza virus. Wild birds are the natural hosts of the virus, hence this virus is named the "Avian Influenza or Bird Flu." The virus was first isolated from birds (terns) in South Africa in 1961. At present, the Bird Flu Virus circulates among birds worldwide. It is extremely contagious among birds, and then makes birds dead, particularly domesticated birds like chickens. It also occurred in the A.B.P. Farm. Seriously, it is necessary to cull the chickens infected by the Viruses from the Farm, destroy such chickens and do any process to prevent and protect all birds from Bird Flu Viruses in the A.B.P. Farm. We change the system from the opened-house system to EVAP system. We are monitoring and improving by using SPC and control chart. Comparison between the old system and new system is in control or out control.

Objectives and Targets

The objectives are monitoring quality control in the farm after changing system to protect and prevent from the Avian Influenza Viruses in the A.B.P. Farm by rebuilding all houses in the Farm to EVAP system. We can control quality of chickens in the farm. And we can increase quality and profit in the farm. We reduce some costs which are not necessary.

Process to be Taken

The first phase: Studying and understanding the nature of Bird Flu

Type A influenza viruses can infect several animal species, including birds, pigs, horses, seals and whales. Influenza viruses that infect birds are called "Avian Influenza

Viruses." Birds are an especially important species because all known subtypes of influenza A viruses can circulate among wild birds, which are considered the natural hosts for influenza A viruses. Avian influenza viruses do not usually directly infect humans or circulate among humans.

Influenza A viruses can be divided into subtypes on the basis of their surface proteins — hemagglutinin (HA) and neuraminidase (NA). There are 15 known H subtypes. While all subtypes can be found in birds, only 3 subtypes of HA (H1, H2 and H3) and two subtypes of NA (N1 and N2) are known to have circulated widely in humans. Avian influenza viruses occurring in Thailand and in my farm is Influenza A viruses H5N1.

The second phase: Preventing and destroying disease

The method of destroying disease and chickens:

(1) During this phase, we destroyed carcasses of chickens infected by the Bird Flu Virus by burning or burying. In case of burning carcasses, we buried them by digging a hole more deeper than 1 meter, and then put chickens carcasses in the hole. Subsequently, the chickens were disinfected by lime or chlorine solution scattered around this hole, and the hole was covered up.

(2) While taking carcasses, people who are involved in the outbreak control and eradication activities (e.g., euthanasia, carcass disposal, and cleaning and disinfecting of premises affected by avian influenza) should use masks and wear gloves for protection when they were in poultry farms or living birds markets which were risky for exposing to the Avian Influenza Viruses. After that eradication activity, they should wash hands and clean bodies. Such

people are easily infected by the Bird Flu Virus because they are often directly contacted with infected birds and/or contaminated surfaces of relating equipments.

(3) In addition, we should clean the used equipment with disinfectant powder and destroy used masks by burning or burying.

(4) Disinfecting by using disinfectant solution in and around the houses every morning and evening.

The method of cleaning and disinfecting the houses:

(1) Taking all equipments out of the houses to disinfect:

(a) Cleaning with mixed powdered detergent and water to rub or polish slough or dust and then wash with water.

(b) Drying equipments by exposing to the sun.

(c) Disinfecting equipments by using disinfectant powder.

(2) Eradicating the remaining dust and chicken dung in all chicken coops by using disinfectant powder, and then burning or burying them.

(3) Eradicating animals carrying disease germs (such as rats, ants and termites) with the chemical solution such as poison.

(4) Cleaning houses with mixing powdered detergent and water to rub or polish slough or dust and then wash with water again.

(5) Disinfecting by using disinfectant power for the whole houses.

(6) In addition to the mentioned clause, disinfecting in the inner and surrounding places of the houses every morning and evening.

(7) After cleaning process, we should not use the chicken coop for at least 90 days.

The third phase: rebuilding houses in the farm to EVAP system.

After cleaning process, we demolished the old houses in my farm and rebuild houses in the EVAP system.

The fourth phase: monitoring by SPC

We are monitoring both systems by using SPC. We use the death rate of chickens, the average chicken weight, and the Food Conversion Ratios (FCR) to plot control chart for see difference between the old system and the new system.

3.4 Measurement Phase

The methodology of measurement phase is to analyze the death rate of chickens, the average chicken weight, and the Food Conversion Ratios (FCR).

The death rate

The death rate is the ratio of total deaths to total population in a specific community or area over a definite period.

The death rate (%) = (Number of dead chickens / Total chickens) x 100

The average chicken weight

The average chicken weight is the random weight of chicken to the total number of chickens.

The average chicken weight (kg./chicken) = (the random weight of chickens/ total chickens)

Food Conversion Ratios (FCR)

Food Conversion Ratios (FCR): To work out the amount of feed you will need, you need to have an idea of the Food Conversion Ratio (FCR) that has been achieved for that species. The FCR is the ratio in dry weight of food fed to the weight gain of the

animals. It measures the efficiency of an animal in converting artificial food to weight gain.

The FCR can be calculated easily at the end of the growout season after a pond has been harvested. At this stage you should know accuracy weights of chickens produced and the amount of feed used.

Food Conversion Ratio = total feed divided by total biomass.

The Food Conversion Ratios (FCR) = total feed/ weight of chickens.

In general, the standard of domestication of chickens for different ages is as shown in the Table 3.1:

Table 3.1. the standard of domestication of chickens.

Age (Days)	Feed/Chicken		The Number of Food Bag/I 00 Chicken	Average Weight (g/Chicken)	Increased Weight (g/Day)	Average Increased Weight (g/Chicken/ Day)	FCR (per day)	FCR (cumulative)	Cumulative Death Rate (%)
	g/Day	Cumulative							
1	12	12		40	0		0.300	0.300	
2	15	27		50	10		1.500	0.540	
3	18	45		70	20		0.900	0.643	
4	21	66		90	20		1.050	0.733	
5	23	89		110	20		1.150	0.809	
6	26	115		130	20		1.300	0.885	
7	29	144	0.5	155	25	16.40	1.160	0.929	1.00
8	32	176		180	25		1.280	0.978	
9	36	212		205	25		1.440	1.034	

Table 3.1. the standard of domestication of chickens (continued).

Age (Days)	Feed/Chicken		The Number of Food Bag/100 Chicken	Average Weight (g/Chicken)	Increased Weight (g/Day)	Average Increased Weight (g/Chicken/ Day)	FCR (per day)	FCR cumulative	Cumulative Death Rate (%)
	g/Day	Cumulative							
10	39	251		235	30		1.300	1.068	
11	42	293		265	30		1.400	1.106	
12	45	338		295	30		1.500	1.148	
13	48	386		325	30		1.600	1.188	
14	52	438	1.5	360	35	29.28	1.486	1.217	2.00
15	55	493		395	35		1.571	1.248	
16	58	551		435	40		1.450	1.267	
17	61	612		475	40		1.525	1.288	
18	64	676		515	40		1.600	1.313	
19	68	744		555	40		1.700	1.341	
20	71	815		595	40		1.775	1.370	
21	75	890	3.0	640	45	40.00	1.600	1.391	3.50
22	79	969		685	45		1.758	1.415	
23	83	1,052		730	45		1.844	1.441	
24	87	1,139		775	45		1.933	1.470	
25	90	1,229		825	50		1.800	1.490	
26	93	1,322		875	50		1.860	1.511	
27	97	1,419		925	50		1.940	1.534	
28	100	1,519	5.1	975	50	47.80	2.000	1.558	4.25

Table 3.1. the standard of domestication of chickens (continued).

Age (Days)	Feed/Chicken		The Number of Food Bag/I 00 Chicken	Average Weight (g/Chicken)	Increased Weight (g/Day)	Average Increased Weight (g/Chicken/ Day)	FCR (per day)	FCR cumulative	Cumulative Death Rate (%)
	g/Day	Cumulative							
29	103	1,622		1,025	50		2.060	1.582	
30	106	1,728		1,075	50		2.120	1.607	
31	109	1,837		1,130	55		1.982	1.626	
32	112	1,949		1,185	55		2.036	1.645	
33	115	2,064		1,240	55		2.091	1.665	
34	118	2,182		1,295	55		2.145	1.685	
35	121	2,303	7.7	1,350	55	53.50	2.200	1.706	5.50
36	123	2,426		1,405	55		2.236	1.727	
37	126	2,552		1,460	55		2.291	1.748	
38	129	2,681	8.9	1,515	55		2.345	1.770	
39	132	2,813		1,575	60		2.200	1.786	
40	134	2,947		1,635	60		2.233	1.802	
41	136	3,083		1,695	60		2.267	1.819	
42	139	3,222	10.7	1,755	60	57.80	2.317	1.836	6.50
43	141	3,363	11.2	1,810	55		2.564	1.858	
44	143	3,506	11.7	1,865	55		2.600	1.880	
45	**145**	**3,651**	**12.2**	**1,920**	**55**		**2.636**	**1.902**	
46	147	3,798	12.7	1,975	55		2.673	1.923	
47	149	3,947	13.2	2,035	60		2.483	1.940	

Table 3.1. the standard of domestication of chickens (continued).

Age (Days)	Feed/Chicken		The Number of Food Bag/100 Chicken	Average Weight (g/Chicken)	Increased Weight (g/Day)	Average Increased Weight (g/Chicken/ Day)	FCR (per day)	FCR cumulative	Cumulative Death Rate (%)
	g/Day	Cumulative							
48	152	4,099	13.7	2,095	60		2.533	1.957	
49	154	4,253	14.2	2,150	55	56.40	2.800	1.978	7.50

3.5 **Analysis Phase**

We choose the SPC for monitoring and measuring values before and after and during occurrence of bird flu. Before and after changing the system, we bring the data of chicken farm to calculate values and plot the control chart.

Statistical process control (SPC) involves the application of statistical techniques in monitoring and controlling the process to prevent excessive defects or nonconformance products.

Control Chats

(a) Graphs showing if sample results are within statistical control limits.

(b) Control limits are the upper and lower boundaries of a control chart.

(c) The control charts are employed to establish the control limits for a process and then to monitor the process to indicate when it is out of control.

(d) A process is " **in control "** if

(1) No sample point lies outside the control limits.

(2) Most points fall near the process average. Few of them are close to the control limits

(3) Approximately equal numbers of points occur above and below the process average.

(4) The points are randomly distributed around the process average.

We choose x-chart to plot control of death rate, average weight and FCR. We calculate values in using plot control chart of death rate, average weight and FCR. We calculate values of x-chart by using the formula below:

Control Charts for Variables

A mean (x -chart) utilizes the process average of a sample.

A Mean or x -chart

Based on the normal distribution

The upper control limit (UCL) and the lower control limit (LCL) of a mean chart can be computed as follows:

UCL = + za

LCL = μ - za

where

z = the number of standard deviations from the process average

= the process average = x = + XZ + + k

K = the number of samples

= the standard deviation of the sample

$$\sqrt{\frac{\sum\left(\overline{x}_i-\overline{\overline{x}}\right)^2}{k-1}}$$

We use x-chart to analyze quality control before and after changing the system in the farm. We see the entire farm to be one system. In the system, we have many chicken coops in the farm.

In this project phase, we compared the death rate of chickens, the average weight of chickens, the Food Conversion Ratio (FCR) between the old house system (opened-house) and the new house system (EVAP system) from domesticated chickens at the same period. Use Statistical Process Control

IV. RESULTS AND DISCUSSIONS

4.1 Measurement Phase

The results on measurement phase reflect the death rate of chickens, the average chicken weight, and the Food Conversion Ratios (FCR). The result is shown in below table.

Table 4.1. Data 1 old system.

Data 1	in	out	death	death rate	Total Feeds	net weight	average weight	FCR
1	10000	9689	311	0.03	1195	17548	1.81	2.04
2	10000	9632	368	0.04	1223	18546	1.93	1.98
3	10000	9616	384	0.04	1186	16513	1.72	2.15
4	10000	9724	276	0.03	1163	16745	1.72	2.08
5	10000	9690	310	0.03	1025	15681	1.62	1.96
6	10000	9568	432	0.04	1253	17586	1.84	2.14
7	10000	9644	356	0.04	1186	18452	1.91	1.93
8	10000	9733	267	0.03	1175	16778	1.72	2.10
9	10000	9353	647	0.06	1184	16847	1.80	2.11
10	10000	9735	265	0.03	1165	17865	1.84	1.96
Total	100000	96384	3616	0.04	11755	172561	1.79	2.04

Table 4.2. Data 2 old system.

Data 2	in	out	death	death rate	Total Feeds	net weight	average weight	FCR
1	10000	9562	438	0.04	1172	18056	1.89	1.95
2	10000	9486	514	0.05	1163	17268	1.82	2.02
3	10000	9451	549	0.05	1214	18214	1.93	2.00
4	10000	9665	335	0.03	1230	19406	2.01	1.90
5	10000	9551	449	0.04	1222	18536	1.94	1.98
6	10000	9345	655	0.07	1153	16697	1.79	2.07
7	10000	9469	531	0.05	1142	16970	1.79	2.02
8	10000	9601	399	0.04	1197	18119	1.89	1.98
9	10000	9030	970	0.10	1121	15967	1.77	2.11
10	10000	9606	394	0.04	1156	17030	1.77	2.04
Total	100000	94766	5234	0.05	11770	176263	1.86	2.00

Table 4.3. Data 3 old system.

Data 3	in	out	death	death rate	Total Feeds	net weight	average weight	FCR
1	10000	9560	440	0.04	1170	17548	1.84	2.00
2	10000	9488	512	0.05	1185	18647	1.97	1.91
3	10000	9449	551	0.06	1145	15823	1.67	2.17
4	10000	9670	330	0.03	1233	16854	1.74	2.19
5	10000	9556	444	0.04	1245	17586	1.84	2.12
6	10000	9342	658	0.07	1199	18251	1.95	1.97
7	10000	9473	527	0.05	1145	17885	1.89	1.92
8	10000	9610	390	0.04	1189	16854	1.75	2.12
9	10000	9562	438	0.04	1195	18654	1.95	1.92
10	10000	9656	344	0.03	1185	17586	1.82	2.02
Total	100000	95366	4634	0.05	11891	175688	1.84	2.03

Table 4.4. Data 4 old system.

Data 4	in	out	death	death rate	Total Feeds	net weight	average weight	FCR
1	10000	9587	413	0.04	1241	17952	1.87	2.07
2	10000	9518	482	0.05	1220	17552	1.84	2.09
3	10000	9244	756	0.08	1198	17586	1.90	2.04
4	10000	9484	516	0.05	1165	17552	1.85	1.99
5	10000	9379	621	0.06	1145	17203	1.83	2.00
6	10000	9574	426	0.04	1142	16253	1.70	2.11
7	10000	9427	573	0.06	1253	16754	1.78	2.24
8	10000	9249	751	0.08	1158	17586	1.90	1.98
9	10000	9417	583	0.06	1253	17486	1.86	2.15
10	10000	9144	856	0.09	1158	17953	1.96	1.94
Total	100000	94023	5977	0.06	11933	173877	1.85	2.06

Table 4.5. Data 5 old system.

Data 5	in	out	death	death rate	Total Feeds	net weight	average weight	FCR
1	10000	9542	458	0.05	1105	17885	1.87	1.85
2	10000	9482	518	0.05	1210	17662	1.86	2.06
3	10000	9212	788	0.08	1175	16995	1.84	2.07
4	10000	9358	642	0.06	1178	18112	1.94	1.95
5	10000	9316	684	0.07	1149	17245	1.85	2.00
6	10000	9438	562	0.06	1143	16948	1.80	2.02
7	10000	9575	425	0.04	1259	17035	1.78	2.22
8	10000	9247	753	0.08	1152	17351	1.88	1.99
9	10000	9416	584	0.06	1111	17542	1.86	1.90
10	10000	9174	826	0.08	1178	18523	2.02	1.91
Total	100000	93760	6240	0.06	11660	175298	1.87	2.00

Table 4.6. Data 1 new system.

Data1	in	out	death	death rate	Total Feeds	net weight	average weight	FCR
1	20000	19378	622	0.03	2284	36286	1.87	1.89
2	20000	19264	736	0.04	2345	37512	1.95	1.88
3	20000	19232	768	0.04	2210	35124	1.83	1.89
4	20000	19448	552	0.03	2315	36856	1.90	1.88
5	20000	19380	620	0.03	2291	36511	1.88	1.88
6	20000	19136	864	0.04	2265	35896	1.88	1.89
7	20000	19288	712	0.04	2412	38456	1.99	1.88
8	20000	19466	534	0.03	2352	37158	1.91	1.90
9	20000	18706	1294	0.06	2291	36251	1.94	1.90
10	20000	19470	530	0.03	2330	36884	1.89	1.90
total	200000	192768	7232	0.04	23095	366934	1.90	1.89

Table 4.7. Data 2 new system.

Data 2	in	out	death	death rate	Total Feeds	net weight	average weight	FCR
1	20000	19414	586	0.03	2344	37412	1.93	1.88
2	20000	19146	854	0.04	2326	37114	1.94	1.88
3	20000	19048	952	0.05	2351	37812	1.99	1.87
4	20000	19316	684	0.03	2358	37485	1.94	1.89
5	20000	19246	754	0.04	2374	37895	1.97	1.88
6	20000	19252	748	0.04	2314	36845	1.91	1.88
7	20000	19342	658	0.03	2351	37185	1.92	1.90
8	20000	19043	957	0.05	2394	37845	1.99	1.90
9	20000	19038	962	0.05	2359	36251	1.90	1.95
10	20000	19124	876	0.04	2351	36517	1.91	1.93
total	200000	191969	8031	0.04	23522	372361	1.94	1.90

Table 4.8. Data 3 new system.

Data 3	in	out	death	death rate	Total Feeds	net weight	average weight	FCR
1	20000	19149	851	0.04	2340	37185	1.94	1.89
2	20000	19251	749	0.04	2370	37294	1.94	1.91
3	20000	19342	658	0.03	2320	36851	1.91	1.89
4	20000	19371	629	0.03	2348	37548	1.94	1.88
5	20000	19002	998	0.05	2381	37412	1.97	1.91
6	20000	19416	584	0.03	2398	37182	1.92	1.93
7	20000	19379	621	0.03	2303	36818	1.90	1.88
8	20000	19259	741	0.04	2378	37221	1.93	1.92
9	20000	19148	852	0.04	2380	37895	1.98	1.88
10	20000	19053	947	0.05	2320	36284	1.90	1.92
total	200000	192370	7630	0.04	23538	371690	1.93	1.90

Table 4.9. Data 4 new system.

Data 4	in	out	death	death rate	Total Feeds	net weight	average weight	FCR
1	20000	19048	952	0.05	2362	37485	1.97	1.89
2	20000	19149	851	0.04	2351	36849	1.92	1.91
3	20000	19344	656	0.03	2362	37496	1.94	1.89
4	20000	19255	745	0.04	2302	36251	1.88	1.91
5	20000	19007	993	0.05	2290	36125	1.90	1.90
6	20000	18942	1058	0.05	2284	35912	1.90	1.91
7	20000	18755	1245	0.06	2256	35814	1.91	1.89
8	20000	19049	951	0.05	2316	36512	1.92	1.90
9	20000	19247	753	0.04	2320	36581	1.90	1.90
10	20000	19144	856	0.04	2316	36511	1.91	1.90
total	200000	190940	9060	0.05	23159	365536	1.91	1.90

Table 4.10. Data 5 new system.

Data 5	in	out	death	death rate	Total Feeds	net weight	average weight	FCR
1	20000	19081	919	0.05	2389	37486	1.96	1.91
2	20000	18964	1036	0.05	2340	36859	1.94	1.90
3	20000	19155	845	0.04	2312	36253	1.89	1.91
4	20000	19046	954	0.05	2320	36224	1.90	1.92
5	20000	19168	832	0.04	2298	36154	1.89	1.91
6	20000	19247	753	0.04	2286	36215	1.88	1.89
7	20000	19315	685	0.03	2313	36581	1.89	1.90
8	20000	18914	1086	0.05	2304	35816	1.89	1.93
9	20000	19247	753	0.04	2225	35183	1.83	1.90
10	20000	19036	964	0.05	2356	37046	1.95	1.91
total	200000	191173	8827	0.04	23143	363817	1.90	1.91

The new system (EVAP system) is shown in the above table.

4.2 Analysis Phase

We are monitoring and calculating by using SPC method. We have result to using calculate values in SPC in x chart. We plot control chart (x chart). We have results in the below table. The old system is shown in table 4.11 and 4.12

Table 4.11. The values of x chart old system.

X	1	2	3	4	5	6	7	8	9	10
in	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000
out	9588	9521.2	9394.4	9580.2	9498.4	9453.4	9517.6	9488	9355.6	9463
death	412	478.8	605.6	419.8	501.6	546.6	482.4	512	644.4	537
death rate	0.04	0.05	0.06	0.04	0.05	0.05	0.05	0.05	0.06	0.05
Feeds	1176.6	1200.2	1183.6	1193.8	1157.2	1178	1197	1176	1172.8	1168.4
net weight	17797.8	17935	17026.2	17733.8	17250.2	17147	17419.2	17337.6	17299.2	17791.4
average weight	1.86	1.88	1.81	1.85	1.82	1.81	1.83	1.83	1.85	1.88
FCR	1.98	2.01	2.09	2.02	2.01	2.06	2.07	2.03	2.04	1.97

Table 4.12. The values of x chart old system.

	in	out	death	death rate	Feeds	net weight	average weight	FCR
II	10000	9485.98	514.02	0.05	1180.36	17473.74	1.84	2.03
STD deviation				0.0074			0.0263	0.0368
UCL				0.0735			1.9215	2.1391
LCL				0.0293			1.7635	1.9184

The new system is shown in table 4.13 and 4.14

Table 4.13. The values of x chart new system.

X	1	2	3	4	5	6	7	8	9	10
in	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
out	19214	19154.8	19224,2	19287.2	19160.6	19198.6	19215.8	19146.2	19077.2	19165.4
death	786	845.2	775.8	712.8	839.4	801.4	784.2	853.8	922.8	834.6
death rate	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.04
Feeds	2343.8	2346.4	2311	2328.6	2326.8	2309.4	2327	2336.6	2315	2334.6
net weight	37171	37125.6	36707.2	36872.8	36819.4	36410	36970.8	36910.4	36432.2	36648.4
average weight	1.93	1.94	1.91	1.91	1.92	1.90	1.92	1.93	1.91	1.91
FOR	1.89	1.90	1.89	1.89	1.90	1.90	1.89	1.91	1.91	1.91

Table 4.14. The values of x chart new system.

	In	out	death	death rate	Feeds	net weight	average weight	FCR
Pt	20000	19184.4	815.6	0.04	2327.92	36806.76	1.92	1.90
STD deviation				0.0028			0.0129	0.0083
UCL				0.0493			1.9574	1.9235
LCL				0.0323			1.8799	1.8735

After that, we bring the results to plot graph control. The old system has shown below figure.

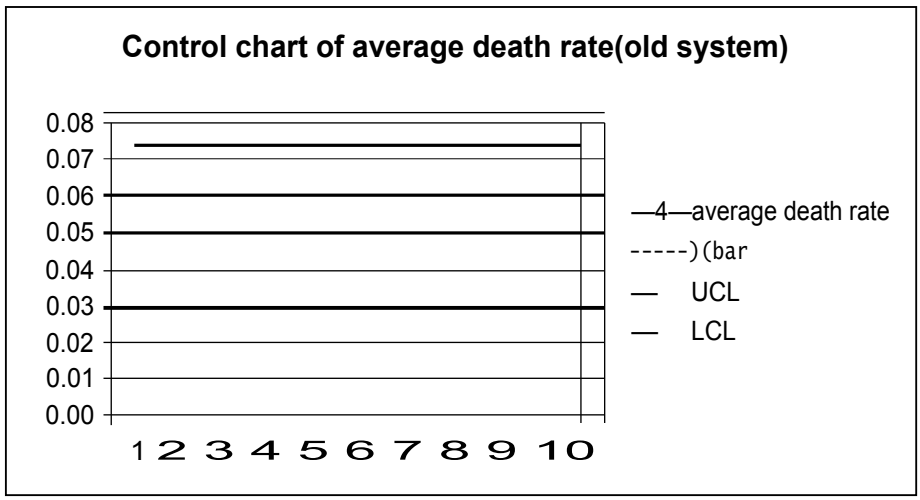

Figure 4.1. Control chart of average death rate (old system).

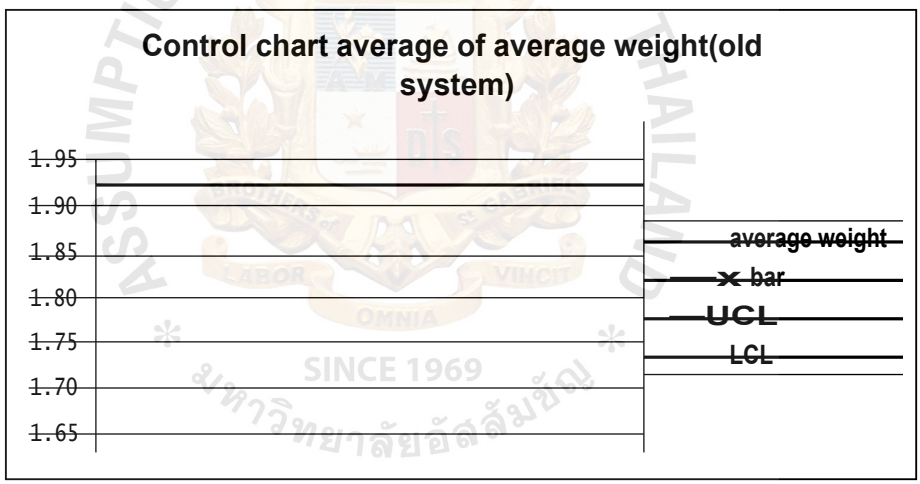

Figure 4.2. Control chart of average of average weight (old system).

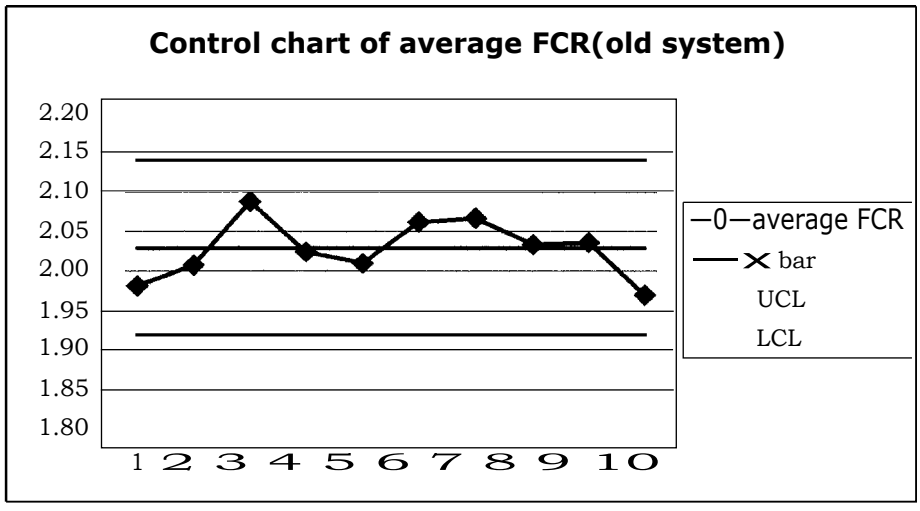

Figure 4.3. Control chart of average FCR (old system).

The new system is shown below figure.

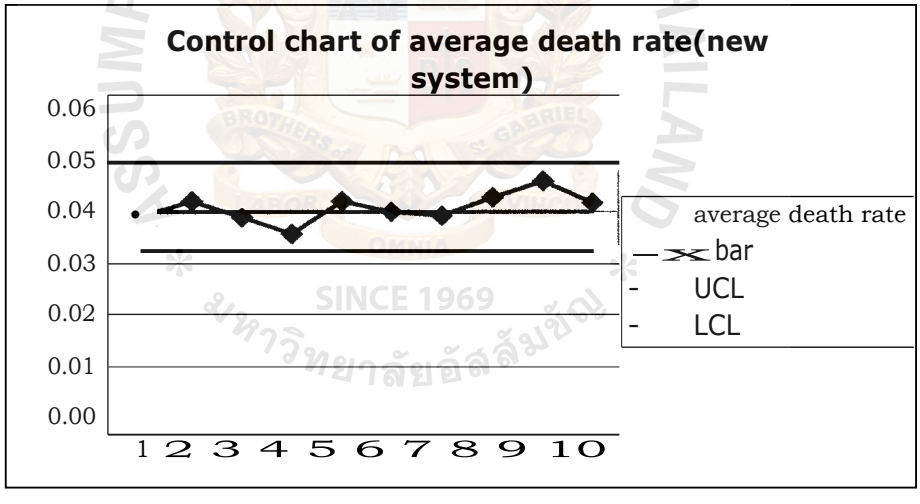

Figure 4.4 Control chart of average death rate (new system).

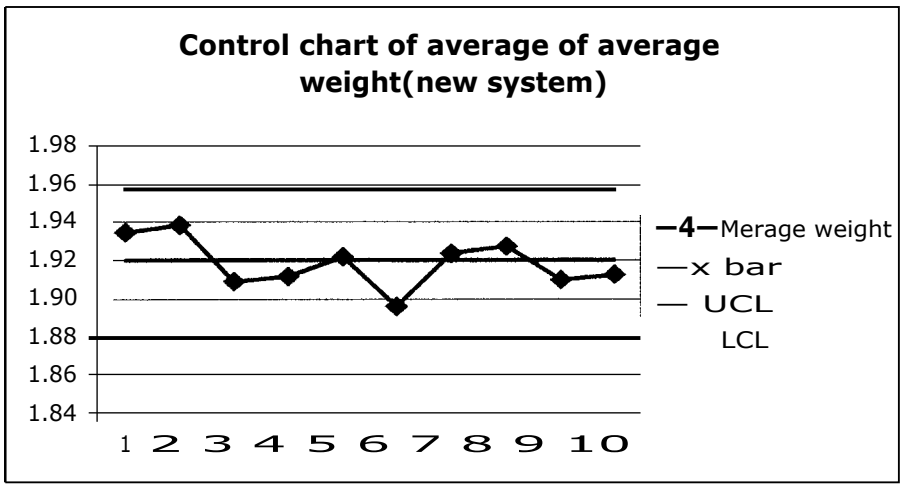

Figure 4.5. Control chart of average of average weight (new system).

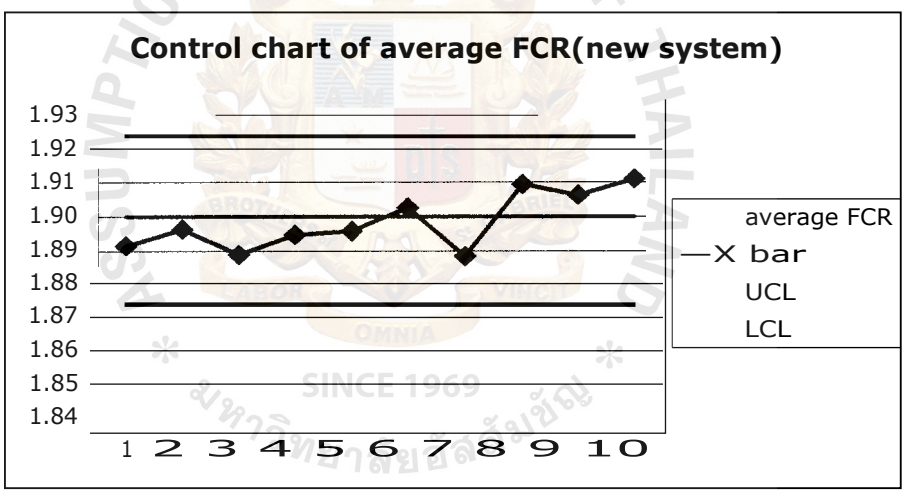

Figure 4.6. Control chart of average FCR (new system).

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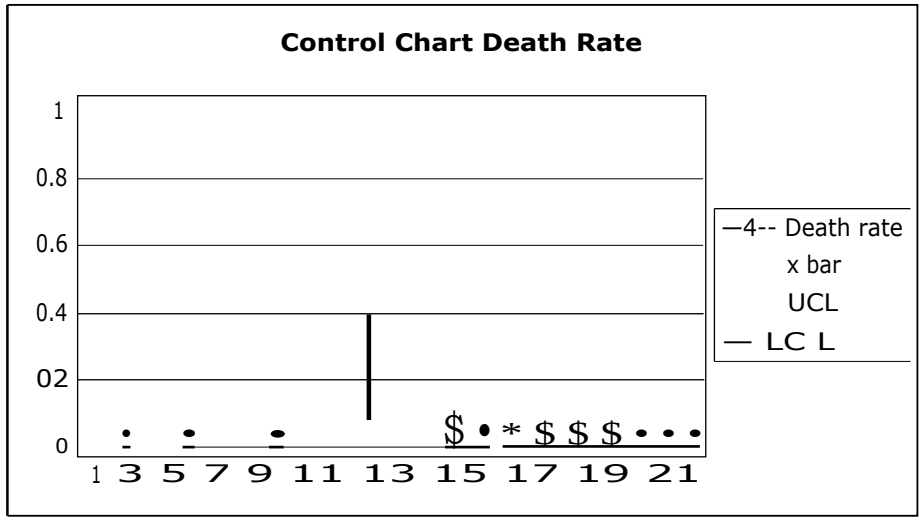

Figure 4.7. Control chart of average death rate.

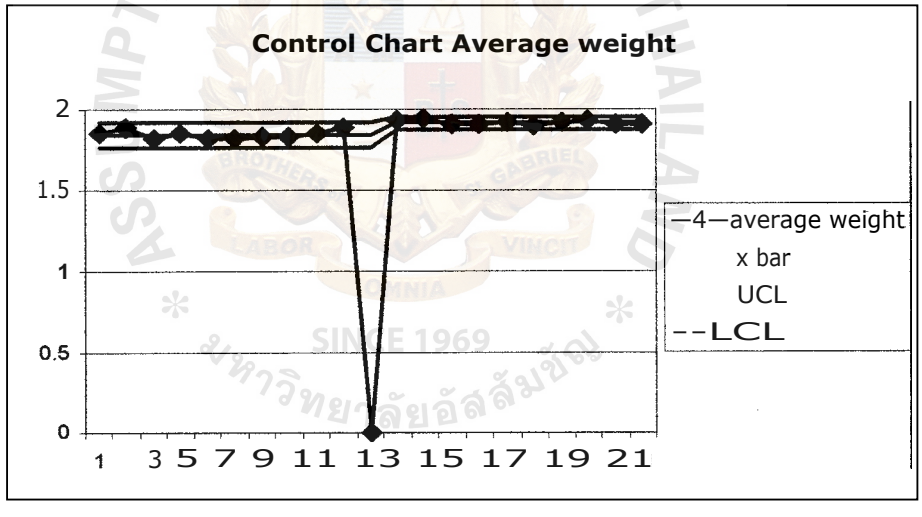

Figure 4.8. Control chart of average weight.

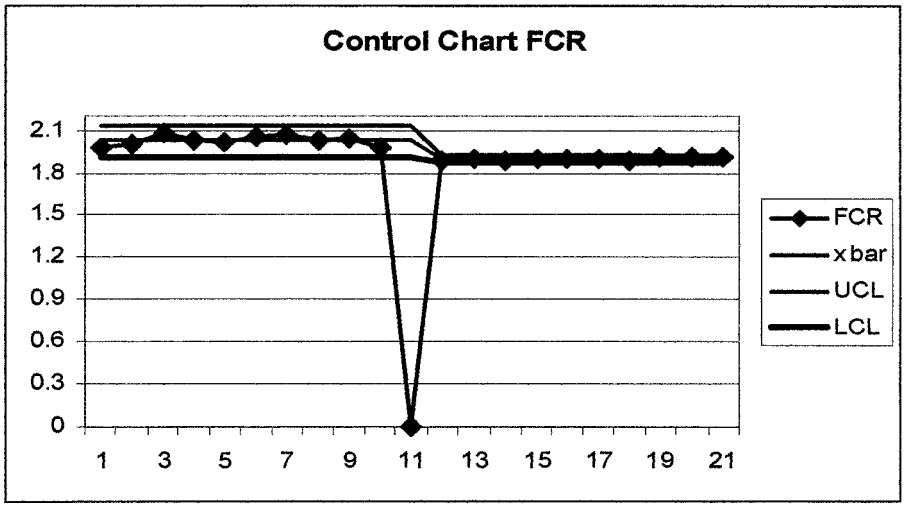

Figure 4.9. Control chart of average FCR.

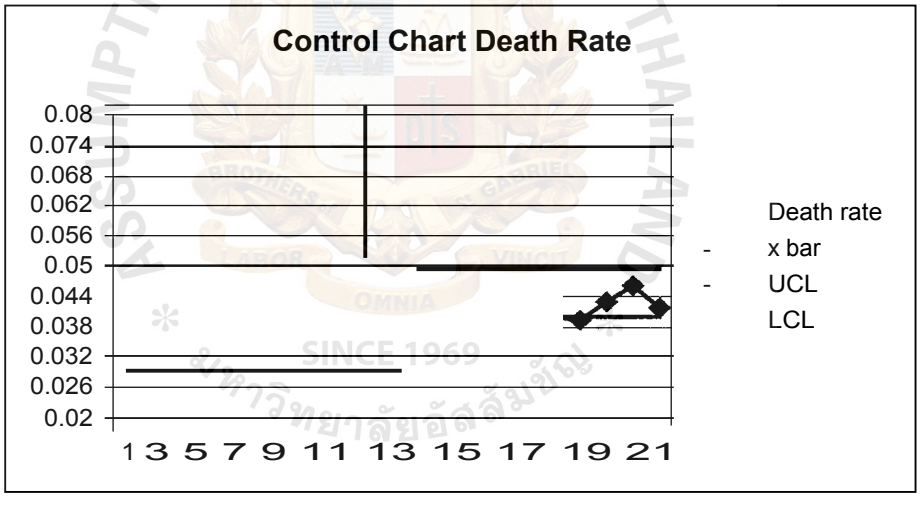

Figure 4.10 Control chart of average death rate.

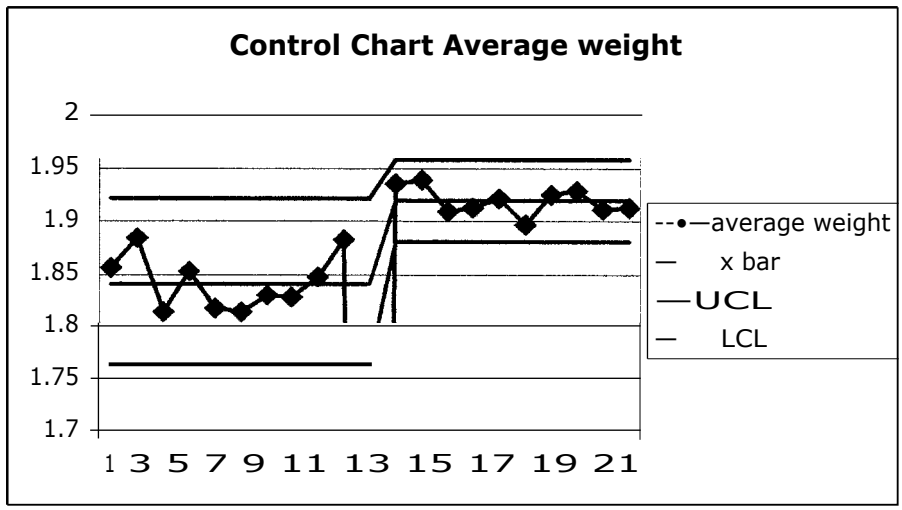

Figure 4.11. Control chart of average weight.

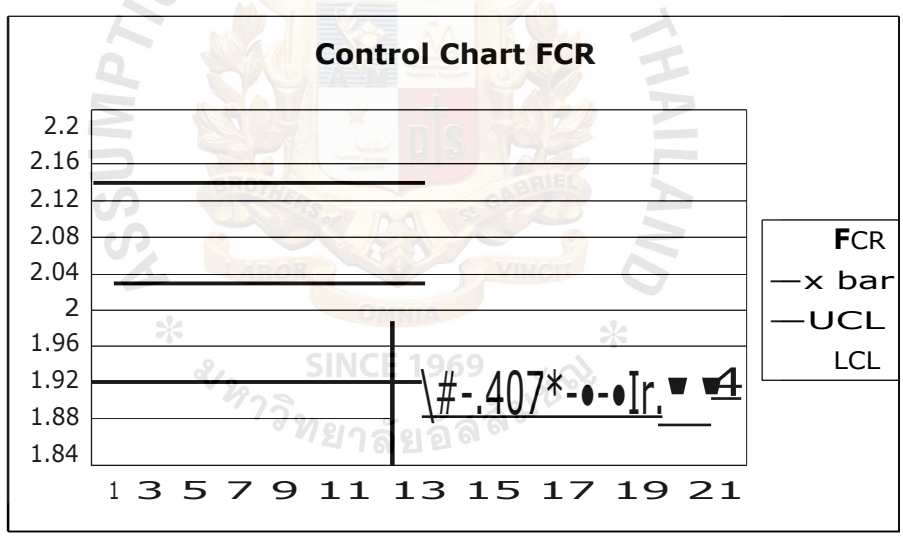

Figure 4.12. Control chart of average FCR.

In comparison with the control chart of average death rate between the old system (as shown in the Figure 4.1) and the standard of the domestication rate, the rate of the old system is more than the standard of domestication rate, and thus the number of products of livestock chickens is still not appropriate. More seriously, during the

infection of the Bird Flu, the death rate could not be controlled because all chickens are killed by completely destroying all chickens as the result shown in the Figure 4.7. However, after destroying the chickens, and then using the new system, the average death rate (4%) could be controlled and is not only better than the old system, but also the standard rate (between 6.5-7.5 %). Consequently, the better increase of product, the more profit.

For the average weight rate, the weight of chickens domesticated in the old system (about 1.90 kilograms) is almost equivalent to the standard rate (1.92 kilograms). Like the average death rate, during the infection of the Bird Flu, the average of the average weight rate was out of control due to the destroying of all chickens, whether they are infected or not. After that we used the EVAP system, as a result, the best average weight of chickens (1.94 kilograms) is more than the standard rate.

About the average of FCR, chickens domesticated in the old system weighed close to the standard because they consumed a lot of food, so there was a lot of expenses occurred and the old FCR rate (2.10) is higher than the standard (1.902). In other words, the FCR rate still could not be controlled during the Bird Flu infection because it was necessary to destroy all chickens. However, we could control the FCR after destroying chickens and using the EVAP system. Possibly, the best new FCR resulting from the new system (1.91) is quite close to the standard rate.

According to the table mentioned above, it is indicated that the EVAP system is more advantageous than the old system: the death rate and the FCR are reduced. In comparison to the table of the standard rate of domesticated chickens in the opened-houses, it is obvious that the death rate of the EVAP system is not only absolutely better than the death rate of the old system, but also the standard rate. In the same way, the FCR of the EVAP system is also better than the old system and the standard rate.

Additionally, the average of weight of the chickens domesticated by the EVAP system is increased equal to the standard rate.

From the case study, there are advantages and disadvantages of both the opened-house system and the EVAP system as follows:

Advantages for the EVAP system:

(1) The EVAP system can get more amounts of chickens in the same size area.

(2) It helps to decrease the death rate. The product, the number of chickens, is increased. As a result, the Farm could make more profit from conducting business although the cost and expenditure increased.

(3) The average weight increased. Consequently, we have more bargaining power than other merchandises to sell chickens at a higher price.

(4) The EVAP system can protect all viruses better than the opened-house.

(5) The chickens are healthier.

(6) The cost of employment decreased.

(7) The structure of the houses in the EVAP system is more strong and stable.

(8) The EVAP system can control temperature in the house better than the old one.

Disadvantages for the EVAP system:

(1) There are more expenses than the opened-house system.

(2) It uses more electricity than the old system.

Advantages for the old system (opened-house):

(1) The cost of housing structure is lower than EVAP system.

(2) It uses less electricity than the EVAP system.

Disadvantages for the old system:

(1) The growth of chicken depends on the environment. It could not be controlled.

(2) It is difficult to mitigate the high risk rate from the death of chickens.

(3) It cannot control and protect from Viruses as well as the EVAP system.

Summary table 4.15 of the advantages and the disadvantages between the opened-house system and the EVAP system

Table 4.15. The advantages and the disadvantages.

Title	EVAP System	Opened-house System (Old System)
Death Rate	Average 0.04	Average 0.05
Average weight of chicken	Average 1.92	Average 1.84
FCR	Average 1.90	Average 2.03
The number of chickens in the same size area	20000 chickens/ coop	10000 chickens/ coop
Protecting of viruses	More effective than the old system	
Healthy of chickens	Healthier than the old system	
Cost of employment	Cheaper than the old system	
Strength of the Structure of House	More stronger than the old system	
Expenses		Cheaper than the EVAP system
Electricity used		Less than the EVAP system

V. CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

Statistical Quality Control is defined in this work as: "with the help of numbers, or data (Statistical), to study the characteristics of our process (Quality) in order to make it behave the way we want it to behave (Control)." The main issue is quality evaluation, because quality is vital to the organization survival and growth.

Avian influenza, or "Bird Flu," is a contagious disease of animals caused from viruses that normally infect only birds and, less commonly, pigs. While all bird species are thought to be susceptible to infection, domestic poultry flocks are especially vulnerable to infection and the Viruses can rapidly reach epidemic proportions.

A.B.P. Farm, the core business of Chariyatharasit Family, is a farm that conducts business for producing food, especially chicken, for consumers in Ratchaburi Province since 1981; more than 20 years ago. There were approximately 100,000 chickens contained in opened-houses farm for the period of every 45 days.

We use protection and cleaning process for destroying all Bird Flu infected in the Farm.

After cleaning process, we demolished the old houses in the Farm and rebuilt houses in EVAP system. Chickens domesticated by the new system have never infected the Bird Flu because the closed-house system can absolutely protect and prevent the viruses. In addition, besides the good quality of protecting and preventing from the Bird Flu, the results from domesticating chickens by the EVAP system obviously indicates that there are more advantages than the opened-house system, the old system. The EVAP system makes the death rate reduced and the chicken weight increased. Therefore, the income of business increased from the increasing livestock chicken

products and the higher weight of chickens. Furthermore, the new system also makes the FCR reduced. This shows that the chickens can have higher weights by not consuming a lot of food. As a result, the expenses of domesticated chickens are reduced, and thus we can make a huge profit.

For the best quality of product and the highest profit, we decide to radically rebuild the old houses in the EVAP system and also expand the new houses for the long term of best quality of domestication of chickens.

As an advantages of the EVAP system mentioned above, we recommend that all farmers should change opened houses to the EVAP system without reservation.

5.2 RECOMMENDATIONS

For this project, we see many difference points between old system (opened-house) and new system (EVAP system). The SPC method helps to see the different points between death rate, average weights and FCR of the chicken farm. After we monitor control charts. We make control feed and growth of chicken in a better than old system. If we can reduce cost of structure coop and reduce electric cost, we can have more profit from this business. We should find structure coop which uses cheaper material but quality of control is the same. It helps reduce asset of production.

For this project, we use SPC method and control chart. We choose a Mean or x - chart in the measurement. We should choose to use other SQC methods. SQC consists of statistical process control and acceptance sampling.

Statistical process control (SPC) involves the application of statistical techniques in monitoring and controlling the process to prevent excessive defects or nonconformance products.

Acceptance sampling is concerned with random sampling to determine if a lot is acceptable.

Statistical process control (SPC) and control chart have many charts in the measurement. Control chart is a graphical method for displaying control results and evaluating whether a measurement procedure is in-control or out-of-control. Control results are plotted versus time or sequential run number; lines are generally drawn from point to point to accent any trends, systematic shifts, and random excursions. Control charts have control chart for attributes and variables. Control chart for attributes has p-chart and c-chart. And control chart for variables has x -chart and R-chart. There are several types of commonly used process control charts. Among them are X-Bar, R Chart; P Chart; NP Chart; C Chart; and U Chart. Each chart has a specific area of application.

We have several types of control charts. We should choose to use other control charts for increasing correction of Data and management in the farm. If we use other methods in the measurement and analysis, it makes sure of the management in which we make to correct direction, and decreasing fixed costs and increasing quality and profit of production.

We should record data and make development all the time because the technology always develops new technologies.

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