FSIS Work Measurements Final Report

Brandon Fallon
Sara Hoffmann
Arun Pillai

SEOR Capstone Course

Dr. Kathryn Laskey

Table of Contents

Executive Summary

Background

The Food Safety and Inspection Service (FSIS) is a public health agency in the United States Department of Agriculture (USDA). Their responsibility is to ensure the commercial supply of meat, poultry and egg products is safe, wholesome, and correctly labeled and packaged. In order to accomplish this, FSIS employs about 7,800 in plant inspection program personnel who inspect more than 6,200 federally inspected establishments across the United States.[1]

FSIS launched the Public Health Information System (PHIS) to help manage, collect and analyze data including scheduling the tasks deemed necessary to fulfill their public safety missions. PHIS is designed so it allocates an appropriate number of tasks so that inspectors are assigned a workload of 100% (targeting 75 - 125%) based on a 40 hour work week. This measurement is used to determine the necessary number of inspectors required by the agency and is subsequently used in annual budget requests to the US Congress.

When scheduling an individual task, FSIS considers four main time groupings:

- Direct time (i.e., cutting and bagging meat for lab testing)
- Indirect time (e.g., data entry, research, and task preparation)
- Internal travel time (i.e., inside the plant)
- External travel time (i.e., outside of the plant)

To simplify the time model and use a common measurement for all establishments, FSIS utilizes an indirect multiplier which bases the amount of indirect time off the direct time.

Problem Statement

FSIS has tasked GMU to conduct a time study based on the experience and lessons learned of a previous GMU project team. The time study focuses on the N60 sampling method[2] that uses a current indirect multiplier of 0.8. The project goal for this semester is to validate the results of the Fall 2013 GMU project team and determine whether or not the indirect multiplier being utilized by FSIS is a valid approach to time estimation per task.

Project Plan

In order to validate the indirect multiplier, the project team has decided to conduct a time study that utilizes a data collection plan built upon the previous GMU project team. The previous team developed a Data Collection Sheet (DCS), which decomposed the tasks necessary to perform the N60 sampling. It was

---

[1] http://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/production-and-inspection/slaughter-inspection-101/slaughter-inspection-101

[2] The N60 sampling method involves collection of a composite sample comprising 60 pieces of meat. See: http://www.fsis.usda.gov/wps/wcm/connect/50c9fb74-c0db-48cd-a682-b399ed6b70c0/29_IM_Raw_Beef_Prod_Sampling.pdf?MOD=AJPERES

determined by FSIS that a time study that utilized a similar DCS could be sent out to multiple plants with the understanding that either the bargaining unit employees or FSIS management would fill out the data sheets and send them back to GMU for data compilation and analysis. The Spring 2014 project team also built upon several lessons learned from the previous team including (1) Further decomposition of the DCS, (2) Training on the DCS prior to having it filled out, and (3) Teaming up with the Bargaining Unit employees for data collection. In addition, several online webinars were provided to the time study participants in order for them to get a better understanding of the task and prevent them from making general assumptions while conducting the time study. The updated DCS and instructions were sent out by FSIS and once the data was returned, it was compiled, reviewed for data entry accuracy, cleaned based on inconsistent time measurement methods, and documented in Excel for analysis.

Data Collection

Data collection was performed by CSI (Consumer Safety Inspectors), which are members of the bargaining unit, or FSIS supervisors, including FLS (Front Line Supervisors), PHV (Public Health Veterinarians), or SCSI (Supervisory Consumer Safety Inspectors). We received 84 DCS, of which 79 DCS were useable in the analysis. Of those 79 DCS that could be used in the data analysis, 22 were from bargaining unit employees while the rest were non-bargaining unit employees.

Statistical Analysis

The collected data was entered into Excel and broken out by either indirect or direct time. The analysis was done in two parts; first combined with the Fall 2013 Project data and second analysis on only the Spring 2014 Project data. Linear regression was used to determine the validity of the indirect multiplier on both data sets. Furthermore, the DCS collected several different parameters that were tested with ANOVA and Median One-Way Analysis to determine if the average and median time within those parameters were statistically different.

Results

The results on the combined Fall 2013 Project and Spring 2014 Project data showed consistent results from the Fall 2013 Project study, seen in Figure 1. The average indirect and direct times were a minute or two different and the Confidence Intervals around the mean times were roughly the same. However, one new observation is the increased standard deviation across the combined data set, indicating the Spring 2014 Project data included more variability in the data.

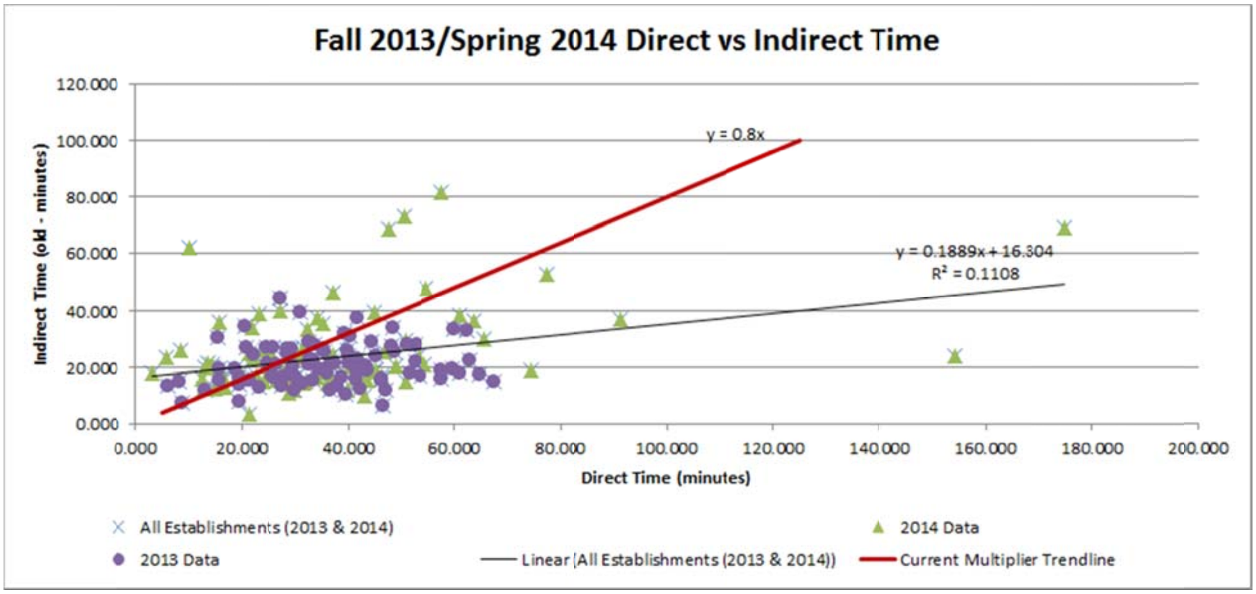


Figure 1: Fall 2013/Spring 2014 Projects Scatter Plot Indirect Time vs Direct Time

Figure 2 shows the results of the Spring 2014 Project by itself, with the inclusion of the further decomposed line items on the DCS, shows a weak linear relationship between indirect and direct times for the N60 sampling method. However, there is evidence that average indirect times differ across several parameters. The inclusion of these parameters into the methodology could better reflect the total indirect time it takes to perform the N60 sampling.

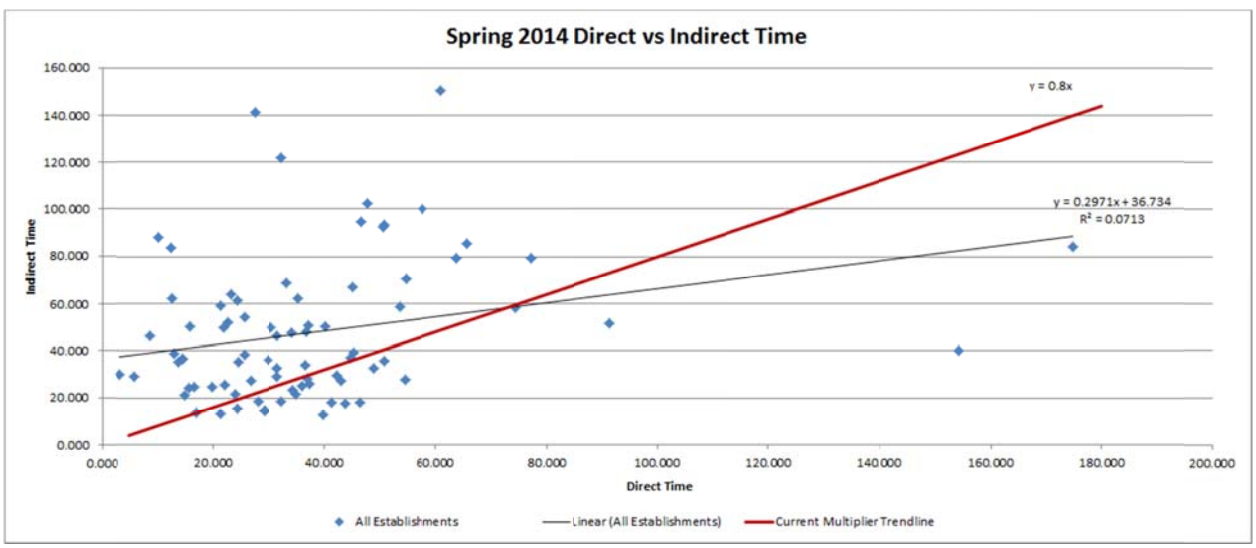


Figure 2: Spring 2014 Project Scatter Plot Direct Time vs Indirect Time

Recommendations

Due to the lack of a strong relationship between indirect and direct time, the GMU team recommends replacing the indirect time multiplier with a fixed indirect time, which+ could better represent the amount of time it takes to perform certain sampling tasks. Furthermore, analysis of several parameters, most notably the HACCP (Hazard Analysis and Critical Control Points) establishment size breakout, indicate the average indirect time is different and should be taken into account when determining a fixed indirect time.

Further recommendations involve the scheduling of sampling tasks. Smaller establishments don't have a set product schedule to know when the appropriate product will be available for sampling, which leaves inspectors unable to schedule the N60 sampling immediately when the task is assigned (typically at the beginning of each month). Inspection program personnel often have to contact the establishment repeatedly and re-schedule the sampling task multiple times before the sample can be collected. Due to limited lab availability, if the sampling isn't scheduled early in the process, there may not be available laboratory capacity to analyze the sample once the product schedule is determined. Hence, it would be beneficial to modify the sample scheduling process for these smaller establishments.

1 Introduction

The Food Safety and Inspection Service (FSIS) is a public health agency in the United States Department of Agriculture (USDA). Their responsibility is to ensure the commercial supply of meat, poultry and egg products is safe, wholesome, and correctly labeled and packaged. To better accommodate the work required for the inspectors, FSIS launched the Public Health Information System (PHIS) to help manage, collect and analyze data. This system also assists in scheduling the tasks deemed necessary to fulfill their public safety missions. PHIS is designed so it allocates an appropriate number of tasks so that inspectors are assigned a workload of 100% (targeting 75 - 125%) based on a 40 hour work week. This measurement is used to compute the annual number of hours needed to perform tasks which then determines how many inspectors need to be employed. This is used in the agency's budget numbers which are in turn approved by Congress.

1.1 FSIS Work Measurements Background

In 1930's, manufacturing industries began using work measurement and time studies to determine average time for a worker to complete tasks. Time studies and work sampling were widely used for establishing time standards. FSIS first began using work measurements in the 1960's. Standard times were developed for slaughter and processed product tasks. In 1987, work measurement estimates for the Inspection System Work Plan (ISWP) were developed. The data for these estimates were collected during a pilot study in Long Beach, California. On June 9, 1988, the revised ISWP were completed. On August 31, 1988, industrial engineers verified the ISWP time standards. The ISWP work measurement standards were incorporated into the Performance Based Inspection System (PBIS). FSIS Front Line Supervisors (FLS) and the FSIS district office developed assignment workloads based upon the ISWP time standards which were maintained in the PBIS. The PHIS replaced PBIS. In cases where the PBIS and the PHIS tasks were exactly the same, the PHIS time was used for the work measurement. For new PHIS tasks, FSIS calculated new work measurement data. A group of supervisory Consumer Safety Inspectors, Import Surveillance Liaison Officers, and Regional Import Field Supervisors were trained in work measurement time gathering techniques. From June 2009 through November 2009 this group collected work measurement data for PHIS tasks, Sanitary Dressing Verification task, Hazard Analysis Verification tasks, Export Activities, and Sampling. The data from this study were incorporated into PHIS and used for assignment workloads.

FSIS categorizes work measurements into four areas: direct time, indirect time, internal travel, and external travel. Direct time is the amount of time to perform the actual task, such as cutting off samples of meat which will later be shipped to a lab. Indirect time is the time to perform support tasks such as scheduling the inspection, preparing to take the sample, cleaning the equipment, shipping the sample off to the lab, and entering the results into PHIS. Internal travel is the time for an inspector to travel inside of a facility such as the time for the inspector to walk from their office in one part of a facility to where a sample will be collected. External Travel is the time to travel to a facility or between facilities.

To account for indirect time, FSIS uses an indirect multiplier. This assumes that the indirect time is proportional to the direct time. Using this method, the indirect time is calculated as the product of the indirect multiplier and the direct time.

1.2 Fall 2013 Project History

During the Fall 2013 semester, a team of SEOR graduate students worked with FSIS to evaluate the indirect multiplier for the MT60 sampling task, which consists of the N60 and the 2 pound grab sampling methods. This team consisted of Chris Bang, Amanda Kryway, Scott Motter, and Karen Tung. Their work will be referred to as the Fall 2013 Project throughout this report.

The Fall 2013 Project decomposed the indirect sampling tasks and created a data collection sheet (DCS) to capture the time for both the direct and indirect times. FSIS performed a time study using the DCS and directions created by the Fall 2013 Project team. This time study did not include any of the Consumer Safety Inspectors (CSIs) due to Labor Management agreements. Instead, only supervisors participated in the study. From the time study, 107 DCSs were completed from 89 establishments. Of the 107 DCSs received, 13 were blank and 6 were unusable.

The results of the Fall 2013 Project showed no correlation between direct and indirect times. Also, the Fall 2013 Project recommended updates for a future time study, some of which were included in the Spring 2014 Project.

1.3 Spring 2014 Project Background

FSIS requested George Mason University to perform another study to validate the findings of the Fall 2013 Project. Unlike the Fall 2013 Project, this study would include CSIs. This study will be referred to as the Spring 2014 Project to distinguish it from the Fall 2013 Project. Furthermore, the Spring 2014 Project incorporated several suggestions into the time study that were suggested by the Fall 2013 Project group and FSIS management familiar with the N60 sampling method. As a result, the DCS that was sent to participants in the study included a more robust breakout of the tasks performed.

2 Objectives and Scope

As requested by FSIS, a time study was designed by the Spring 2014 Project team with CSI participation to validate the Fall 2013 Project findings. This study built upon the work performed by the Fall 2013 Project. As a result, the DCS that was sent to participants in the study included a more robust breakout of the tasks performed. Due to limited participation the study included both CSIs and supervisors. The data analysis considered both the Fall 2013 Project data and the Spring 2014 Project data.

2.1 Assumptions

- The inspectors have sufficiently experienced to not require training in completing the N60 sampling method, although they may not have recently performed the N60 sampling.
- The inspectors have sufficient experience using the PHIS system and do not require training.
- Inspectors could fill out the DCS and use a stopwatch while completing performing their duties.

2.2 Limitations

- The number of CSIs participating in the study was 22.
- Seventy-nine useable data collection sheets were returned.

3 Technical Approach

The recommendations from the Fall 2013 Project were carefully considered and incorporated into the study. The Fall 2013 Project noted that some of their study participants completed the steps in a different order than the order of steps on the DCS. A column was added to the DCS to allow participants to enter the order of step completion in cases where it differed from the DCS. Additional fields were also added to the DCS as discussed below in section 3.1. The Fall 2013 Project recommended providing training to the participants to reduce the number of data entry errors. Training was provided to participants through webinars. The impact of training is discussed in section 3.2.

Data collection approach is discussed in Section 3.3.

Data entry and data validation are discussed in sections 3.4.

Data analysis was performed on both the Fall 2013 Project data and the Spring 2014 Project data. The data analysis methodology is described in section 3.5.

3.1 DCS Update

Based on suggestions from the Fall 2013 Project and conversations with a Front Line Supervisor (FLS) at FSIS, the DCS was updated to more accurately reflect the process of indirect and direct times associated with MT55 and MT60 sampling tasks. Several updates were made to the individual sections of the DCS which are described below, but a new column was added for the majority of the sections. This column indicates what order the line item was completed, when applicable, within the section. This will hopefully lower confusion regarding any results where the time was not in sequential order because the inspector performed the steps in a different order than the DCS.

3.1.1 Section 1

Several modifications were made to Section 1 in order to capture more accurately information about the inspection. Since the 2lb Grab is eliminated from the Spring 2014 Project the line item with the option of N60 or 2lb Grab was removed and instead modified to include the prompt to specify if the sampling task is MT60 or MT55. Furthermore, a line item was added asking how often N60 has been performed at the plant in the past 12 months and how often the inspector has personally complete the task. This update is due to policy clarifications that resulted in more plants performing the MT55 sampling. Since some of the results will be from these new plants, it will be worthwhile to determine if the amount of experience the plant and/or inspector has with these sampling techniques affects the direct or indirect time. Finally, a line item was included that allows the inspector to select their title, which helps identify whether the person taking the sample was a bargaining unit employees or a non-bargaining unit employee.

3.1.2 Section 2

Due to suggestions from an FSIS FLS, the line item regarding the Questionnaire in PHIS was removed. This line item is presented to the inspectors as they schedule the inspection, but normally is completed after the sampling takes place. Furthermore, the section following the direct sampling line items already included timing of the Questionnaire. Likewise, additional language was added to the line item “Enter

Production Date, Product Name, Lot Held (Y/N), Lot Number" which indicates this step may be completed after sampling. The inspector is also prompted to identify when this line item was completed (before or after sampling).

3.1.3 Section 3

This now reflects any additional time the inspectors spend when scheduling the sampling task. Especially for the smaller plants, the production schedule is not known when the inspector gets their task assignments. Many times the inspector needs to coordinate with the plant to figure out when the necessary product is being produced so they know when to schedule the inspection. Since the inspector visits all plants on a daily basis, they normally discuss the scheduling with the manager at the plant. This section was designed to capture the amount of time it took to reschedule the task, but due to the nature of the conversations, only an estimate of time (in hours and minutes) will be collected since the conversations cannot be easily timed. Since this could take several days and subject to multiple rescheduling, a line item was included asking how many times the task had to be rescheduled.

3.1.4 Section 4

This section is comprised of the direct sampling times. There was only the need to move two line items, "Clean the Equipment" to before "Walk to Complete PHIS" as normally the inspector will clean up the equipment used in the sampling before going to the computer to finish entries in PHIS.

3.1.5 Section 5

This section is comprised of the indirect line items that are completed mainly after the direct sampling is done. One line item was added to this section and will appear twice in the DCS, "Enter Production Date, Product Name, Lot Held (Y/N), Lot Number" (2.e and 5.b). This step could be completed before or after the direct sampling takes place. Therefore it was added to Section 5 for the cases when the inspectors complete this after the direct sampling

3.1.6 Section 6

The inspector needs to check the Laboratory Information System (LIMS) daily in order to get the results of the sampling. The LIMS will display if the results are negative or positive. If the result is negative, the product can be released. In the event of a positive result, confirmatory testing is conducted. The purpose of this project will not include any time spent when the result is positive. Since it could take several days, a line item captures how many times they checked LIMS before they got the results. This will allow us to know how long it took to check each time and how many times they had to check.

3.1.7 Section 7

Inspectors also need to record the source information for each plant. Source information includes conversations with the plant management regarding where the product came from. This information will be collected on site when they are doing the sampling and then put into PHIS. Due to the nature of this process, the line item prompts for only an estimate of the amount of time it took to acquire this information (in hours and minutes) and the amount of time it took to input this information into PHIS.

3.1.8 Section 8

The address was updated that was used to send back the DCS.

Figure 3 shows the average time per line item for both the Fall 2013 Project and the Spring 2014 Project. While the average times for line items that were similar between the two time studies are relatively equal, the new sections (Sections 3, 6, and 7) that were added in the Spring 2014 Project have a relatively higher average time compared to the original tasks. This shows that the added line items represent a large amount of indirect time in the N60 sampling method.

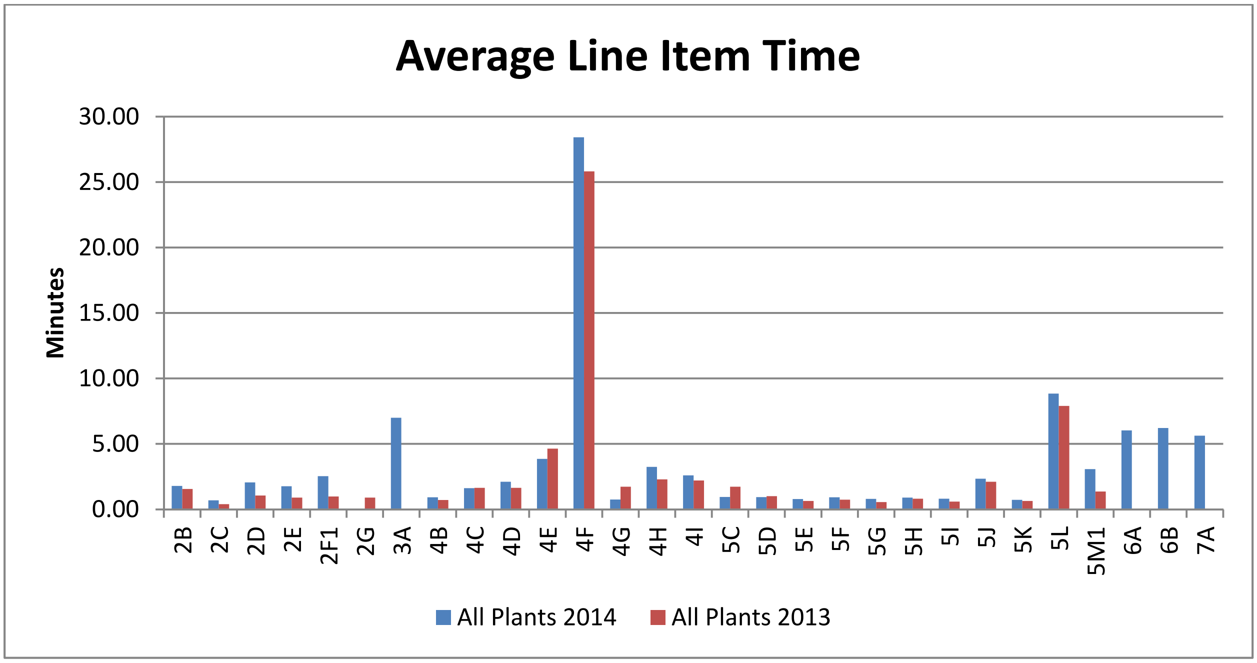


Figure 3: Average Line Item Time for Fall 2013 and Spring 2014 Projects

3.2 Training

The Spring 2014 Project team provided training sessions to the study participants using webinar conferences. An interactive walkthrough of the DCS was provided followed by a question and answer session. A total of seven training sessions were provided. Training sessions were given in the morning, afternoon, and late at night so that participants working different shifts could attend.

Training helped to increase the percentage of usable DCSs. The Fall 2013 Project was able to use 88 of 107 DCSs. For the Spring 2014 Project, 79 of 84 DCs were used in the analysis. The percentage of usable DCSs increased from 82% for the Fall 2013 study to 94% for the Spring 2014 Project.

3.3 Data Collection

Since the Spring 2014 Project was to include CSIs, a request was sent out through the union leadership asking for volunteers. While many CSI's responded, some of the volunteers were not able to participate because no N60 samples were scheduled at establishments on their patrol during the study period. To ensure that sufficient data could be collected for the study, FSIS also recruited supervisors to participate in the study.

The original dates for the time study were between March 4, 2014 and March 31, 2014. The study was subsequently extended through April 4, 2014, to allow additional time for sample collection.

Of the usable 79 usable DCSs for the Spring 2014 Project, 22 were completed by CSIs and 57 were completed by non-bargaining unit employees. FSIS categorizes facilities by Hazard Analysis and Critical Control Point (HACCP) sizes according to the facility revenue and number of employees. The HACCP sizes are large, small, and very small. The Spring 2014 Project received usable DCSs from 25 very small facilities, 28 small facilities, and 26 large facilities.

3.4 Data Entry, Cleaning, and Data Validation

Each DCS was mailed to the SEOR office at George Mason University. Upon receipt, each DCS was picked up by a member of the Spring 2014 Project team. Each DCS was assigned a unique identifier and entered into an Excel spreadsheet for analysis. The DCSs were also scanned into PDF documents and sent to FSIS. The data for each line item was then calculated and identified as a direct, indirect or internal travel.

For several of the DCSs, it was determined that the participants had written the minutes and seconds for the line item completion time in the hours and minutes fields. It was clear from the context of the line item being completed that this error had occurred. For example, the participant entered the time to log into the PHIS system as 1 hour and 2 minutes and the time to collect the sample as 17 hours and 22 minutes for DCS ID 041-14. When this error was identified, it was applied to all line items for the section being entered. These errors were corrected during data entry by entering the time as minutes and seconds in the Excel spreadsheet. This issue identified and corrected for the following DCSs: 019-14, 041-14, 076-14, 081-14, and 083-14.

There were also DCSs where the participants entered individual line item times instead of the elapse times within a section. For a correctly completed DCS, the line item times in each section of the DCS are entered sequentially without resetting the stopwatch to zero until the entire section is completed. The times within a section should increase with each line item until the end of the section. If the times entered in a DCS did not increase from one line item to the next within a section, it was determined that the participant had reset the stopwatch to zero after completing each line item. The data analysis accounted for the cases where line item times were entered instead of elapse times by adding each individual time to the prior time in that section. This was done in order to keep the data consistent with the other DCS that inputted elapsed time. It was determined that individual line item times were entered instead of elapse times for the following DCSs: 004-14, 021-14, 023-14, 030-14, 042-14, 045-14, 048-14, 063-14, 066-14, 067-14, 068-14, 069-14, 071- 14, 073-14, 081-14, and 083-14.

In cases where a DCS has a blank value for a line item, the line item was set equal to the prior task in the Excel spreadsheet. This allowed for the individual line item time to be calculated as 0 for the skipped line item.

Each completed DCS had an establishment identifier. This facility identifier was used by FSIS to provide the HACCP size and square footage for each establishment.

All data cleaning described above was discussed with FSIS and double checked by a member of the GMU Project team.

3.5 Data Analysis Methodology

Following data entry, data cleaning, and data validation, statistical data analysis was performed. Statistical data analysis was performed on the Fall 2013 Project data combine with the Spring 2014 Project data for line items common to both studies. Since the Spring 2014 Project had additional data fields which were not captured in the Fall 2013 Project, statistical data analysis was also performed on the Spring 2014 Project data to analyze the data fields unique to the Spring 2014 Project. For cases where a line item was not completed in a DCS, it was entered as 0 and included in the analysis.

Outliers were reviewed and included in the statistical data analysis. One of the outliers was DCS 043-14 had a direct time of 2 hours 34 minutes, and indirect time of 23 minutes accounting for only the Fall 2013 Project data fields and total indirect time of 40 minutes. DCS 043-14 was performed at a facility where the N60 had been competed between 2-9 times in the past 12 months and was completed by a CSI who had collected between 1-4 N60 samples in the past 12 months. Another outlier was DCS 004-14. DCS 004-14 had a direct time of 2 hours and 55 minutes, and indirect time of 1 hour and 9 minutes accounting for only the Fall 2013 Project data fields and a total indirect time of 1 hour and 24 minutes. For DCS 004-14, the inspector had not collected any N60 samples in the past 12 months and the facility had collected between 2-9 N60 samples in the past 12 months. Although the inspector for DCS 004-14 had not collected an N60 sample in the past 12 months, it was included in the analysis.

The details of the statistical analysis are presented in section 5 and section 6.

4 Risks

4.1 Delays to Receive Information

There is a risk that the plant personnel filling in the data collection sheets will not mail the sheets back to George Mason prior to the requested delivery date. This would cause a time constraint for the GMU team to compile, sanitize, and analyze the data. In order to allocate enough time for the data compilation and analysis to occur, an original end date of March 31, 2014 was set.

- Likelihood: 2
- Impact: 4

This risk was identified early in the project based on the experience of the Fall 2013 project team. The main concern was that after the data collection sheets were returned, the GMU team would take a significant amount of time to compile the data into Excel, clean the data in order to make all values consistent, validate any assumptions with the cleaned data by FSIS management, and then complete the actual data analysis. In order to mitigate this risk of limited data analysis time, the GMU team began to compile data sheets as they are received, and cleaned and verified the data assumptions on an as-needed basis with FSIS, which allowed for the maximum allowable time for final data analysis. This mitigation was so successful, a significant amount of time was made available to the project team, and the decision was made to extend the study by one week in order to collect an increased number of data points and ensure the statistical significance of our data.

4.2 Availability of CSI Volunteers

There was a risk that a sufficient number of Consumer Safety Inspectors (CSI) volunteers will not be available to conduct the data collection process.

- Likelihood: 3
- Impact: 3

This risk was identified early in the project based on conversations with FSIS management regarding the labor management agreement. This risk likelihood was later increased to five when it was determined by FSIS that the available CSI volunteers would not be able to collect a sufficient number of samples during the project period to create statistically significant findings. Therefore, FSIS also scheduled supervisory personnel at establishments to participate in the data collection. At that point, this risk was closed and considered overcome by events.

4.3 Availability of Data from Small and Very Small Plants

Due to the limited availability of CSI volunteers (Risk 2), there is an increased risk that not enough data sheets will be collected from small and very small processing plants in order to produce statistically significant analysis. It is understood by the GMU team that FSIS supervisory personnel are not constantly present at small and very small processing plants and, therefore, might have to travel to the plant if and when a production run is being made to collect the N60 sample.

- Likelihood: 4
- Impact: 3

In order to mitigate this risk, FSIS requested data from a larger number of plants. It was also planned that if enough data was not collected, analysis would be completed with the understanding that additional data would be needed from a future project team to ensure statistical significance. This risk was later reduced to a likelihood of one when it was determined that we were receiving a nearly even split of very small, small, and large establishment data.

5 Statistical Analysis

5.1 Analysis of Variance (ANOVA)

Analysis of Variance (ANOVA) is a test used to determine if the means across populations are statistically different. The analysis compares the variances, which is the measure of variability in the data, across different groups. The ANOVA analysis is derived by partitioning the variance into components due to variability “between the groups” and “within the groups”. The variance components are then tested for statistical significance by taking the ratio of variation “between the groups” over variation “within the groups”. When the ratio is close to one then the variation “between the groups” is negligible compared to “within the groups”, and we would conclude that the population means are not significantly different from each other. On the other hand, if the ratio is greater than one, then the variation “between groups” is greater compared to the variation “within the groups”, which will lead us to reject the null hypothesis, and conclude that population means are statistically different. Statistical test called F-test is conducted in the ANOVA analysis. The p-value of the test, showing the statistical significance of the test results, guide the conclusions. If the p-value is less than 0.05, we can reject the null hypothesis and conclude that the population means are not the same. In other words, we would be 95% confident that the population means are statistically different based on the sample data. However, a p-value greater than 0.05 indicates at there is not enough evidence to determine the means differ and the null hypothesis cannot be rejected. For this analysis, ANOVA Single Factor is used which tests only one variable in the data set. This test will be performed in Excel and checked in SAS 9.3.

5.2 Median Test

The assumptions for ANOVA include independence, normal or t-distribution, and homogeneity of variances. Independence is met based on how the data was collected. Each MT60 or MT55 task was done independently from other tasks. While some inspectors participated multiple times, their results are independent of a prior task. However, due to the limited sample size the time study was able to produce, testing the normal distribution assumption could produce inconsistent results. Hence, the non-parametric test, Median One-Way Analysis, is also included to help validate the ANOVA results.

The Median One-Way Analysis tests whether the population medians per group are the same. The Median One-Way Analysis assigns a 0 to each observation below the overall population median and a 1 if it’s above the population median. If the groups have the same median – so that the group medians are the same as the combined population median – then we would expect observations from the groups to be roughly equally lined up relative to the combined population median. However, if a group has a higher median than another, then more observations from this group would higher than the overall population median (that is to have a value of 1). Whereas the group with the smaller median would have more 0-s than 1-s as more observations from this group will be smaller than the median of the combined data. By summing the assigned numbers across each group, known as the sum of scores, it is compared to what the expected sum of scores would be if the null hypothesis were true. Similar to the ANOVA test, we can reject the null hypothesis if the p-value is below 0.05 and conclude that population medians are different. This test will be performed in SAS 9.3.

5.3 Box Plot

A box plot displays several descriptive statistics of a data set. Figure 4 shows the typical box plot that will be used in this report. The box portion represents the 1st and 3rd quartile of data, where the line through the box is the median value. The two whiskers are extended to the minimum and maximum values in the data set. The diamond represents the mean or average value. Box plots are useful as they show the amount of variability and distribution in the data as well as allow comparisons across several groups. These graphs will be constructed using SAS 9.3.

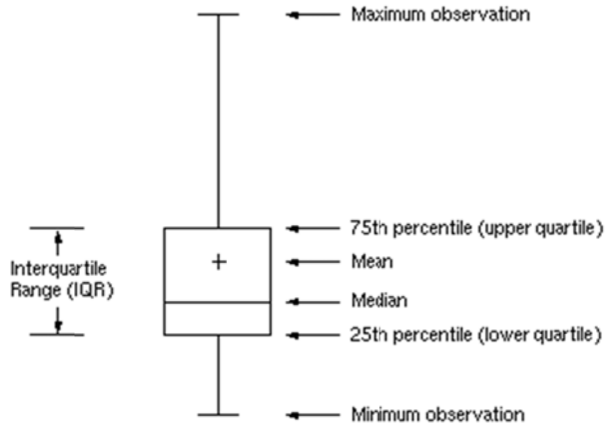


Figure 4: SAS Box Plot Description

5.4 Linear Regression

To determine the validity of the indirect multiplier, a linear regression will analyze the effect of direct time on indirect time. Indirect time is our dependent variable (y-axis) while direct time is our independent variable (x-axis). The fitted, or estimated, linear regression is defined as:

$$y_i = \widehat{\beta_0} + \widehat{\beta_1}x + e_i$$

Where

$\widehat{\beta_0} = fitted, or\ estimated, intercept$

$\widehat{\beta_1} = \ fitted, or\ estimated, slope$

$(or\ how\ much\ the\ mean\ of\ Y(indirect\ time)changes\ for\ one\ unit\ change\ in\ x\ (direct\ time))$

$e_i = error\ of\ the\ i^{th}\ observation$

Where the residual is the error in the fit of the estimated model to the i^{th} observation, or the difference in the actual value, y_i, compared to the predicted value based on the model, $\hat{y}_i$. Residuals are defined as:

$$e_i = y_i - \widehat{y_i}$$

Residuals are important when testing the adequacy of the model. Plotting the residuals helps in checking the normality of the data and if the data has any anomalies. Such anomalies could indicate that the data needs to be transformed, inequality of variances, or model inadequacy. A residual plot that shows randomness indicates there are no anomalies, while one with a clear defined pattern could indicate an anomaly.

The coefficient of determination, or R^2, is a method of determining how much the estimated model explains the variability of the data. The lower the R^2 implies the model does not explain much of the variability whereas the higher the R^2 the greater the model explains the variability. The R^2 is computed by the ratio of the error sum of squares over the regression sum of squares. Where those two variables added together is the total corrected sum of squares. Linear regression will be run in Excel and SAS 9.3.

6 Results

The objective is to verify if the use of the indirect multiplier is a valid way to determine the total time (direct and indirect) it takes to perform the N60 sampling. The results are broken into two sections; first will take the Fall 2013 Project data and combine it with the Spring 2014 Project data. The second will look at only the Spring 2014 Project data. The results are broken into two groups due to the addition of line items in the DCS, as mentioned in Section 3.1. By removing the appropriate line items between both Projects' data, the two data sets are left with comparative data that can be used to run analysis. The second analysis will only include the Spring 2014 Project data to show the effects of the new line items that were added to the DCS.

6.1 Fall 2013 Project and Spring 2014 Project Data Indirect Multiplier Analysis

In order to combine the data sets, sections 3, 6, and 7 were removed from the Spring 2014 Project data. Likewise, the line item 2.g. in the Fall 2013 Project data analysis was removed since it was removed in the Spring 2014 DCSs. With those line items removed, indirect times are plotted against direct times and represented in the scatter plot in Figure 5. The scatter plot and corresponding trend line (in black) shows the lack of a definite relationship between the direct and indirect time. The red line shows what the current multiplier of 0.8 would represent among that data. However, the scatter plot shows a positive increasing trend among indirect and direct time, which was not represented in the Fall 2013 Project data.

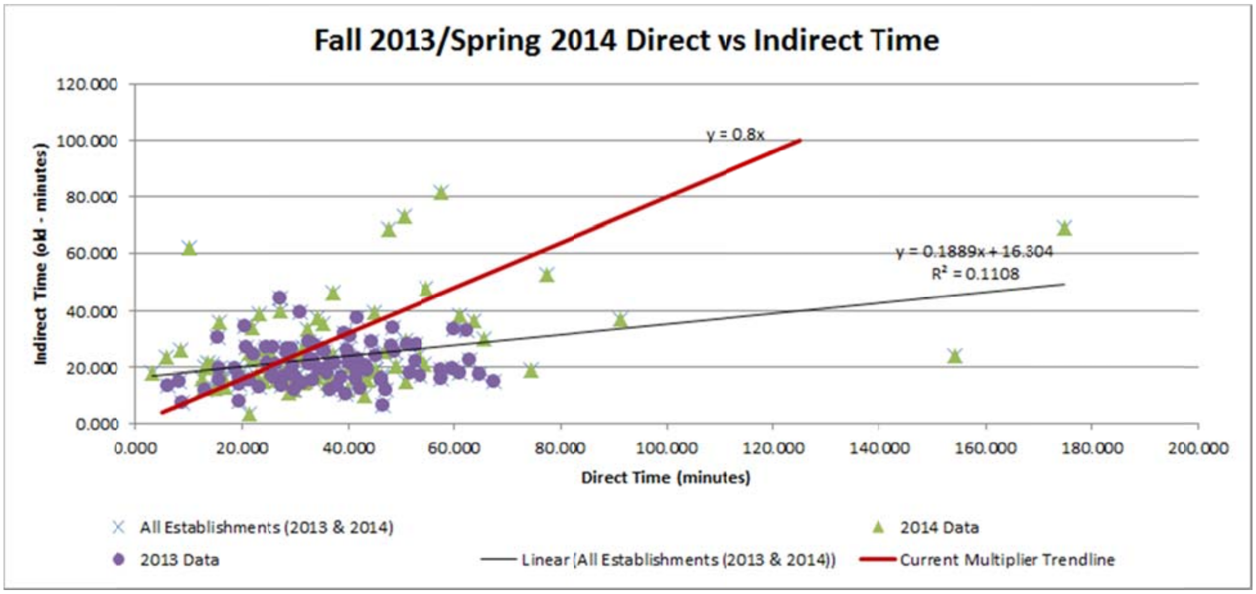


Figure 5: Fall 2013/Spring 2014 Projects Scatter Plot Indirect Time vs Direct Time

A linear regression model was run with the dependent variable, direct time, against the independent variable, indirect time, with the results presented in Table 1. The calculated R^2 value is 0.1108, indicating the regression only explains 11% of the variability in the data. An R^2 of 30%-40% is ideal when determining if there's a relationship between two variables. While the R^2 indicates little variation is being explained in this model, both the intercept and slope show very low p-values, indicating they are statistically significant in the model. Hence, there is some linear relationship between the two times. Figure 6 shows the residual plot to determine if there are any anomalies in the data that need to be corrected. The plot indicates a few outliers, as mentioned in Section 3.5. The points with high residuals (>40) indicate the potential of a statistical outlier in the data. Those points far to the right on the x-axis show some outliers, but their residuals are in line with the scatter of residuals on to the left. Due to the randomness of the scatter plot, it does not indicate any anomalies in the data.

Table 1: Fall 2013/Spring 2014 Projects Linear Regression

SUMMARY OUTPUT

Regression Statistics	
R Square	0.11077
Observations	167

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	16.30432	1.75847	9.27190	0.00000
Direct (Minutes)	0.18894	0.04167	4.53369	0.00001

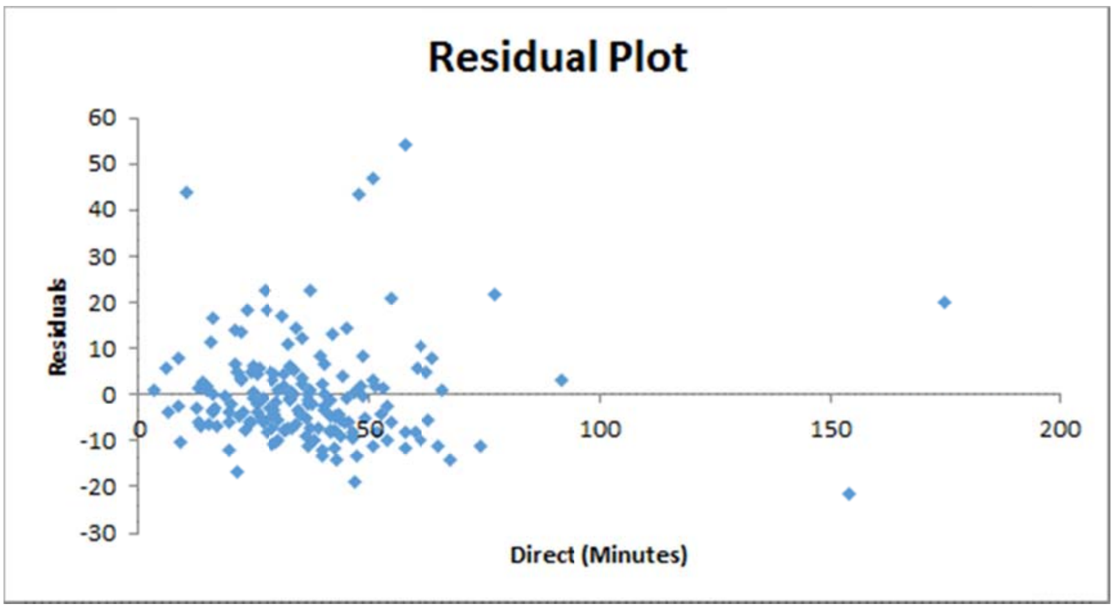


Figure 6: Fall 2013/Spring 2014 Residual Plot

Furthermore, the Spring 2014 Project data points show more variability in the scatter plot. Table 2 compares the descriptive statistics between the Fall 2013 Project data and the Fall 2013/Spring 2014 Projects combined data set. While the means between the two data sets are relatively close, the standard deviations in the combined data set are substantially higher. Three possible reasons are the introduction of bargaining unit employees, different establishments sampled compared to the Fall 2013 Project, and the inclusion of outliers. An objective of the Spring 2014 Project was to validate the Fall 2013 Project and to include bargaining unit employees. However, during the data collection process, the number of bargaining unit employees available to collect the sample was insufficient to generate statistically significant results. Hence, FSIS incorporated non-bargaining unit employees again in order to get a large enough data set, but roughly 27% of the Spring 2014 Project is comprised of bargaining unit employees. Secondly, the larger standard deviations could be due to the new establishments sampled. The goal was to sample across more establishments, which introduces new variations that may not have been picked up in the prior data. Finally, outliers were not removed from the Spring 2014 Project data. The outliers were kept in the data in order to show the variability of the sampling process. When reviewing the outliers in the combined data set, there were no indications that these data points were beyond the scope of what could happen to an inspector during the N60 sampling process. Furthermore, Section 6.2 shows why some of these outliers cannot be removed once the Spring 2014 line items are included again.

Table 2: Fall 2013/Spring 2014 Descriptive Statistics

	2013 Average	2013 Std. Dev.	95% CI	99% CI	Sensitivity
		Fall 2013 Data			
Direct Time	36.1	13.7	2.9	3.9	0.9
Indirect Time	21.0	7.2	1.5	2.0	0.5
Total Time	57.1	16.4	3.5	4.6	1.1
		Fall 2013 and Spring 2014 Data			
Direct Time	36.7	20.9	3.2	4.2	1.0
Indirect Time	23.2	11.9	1.8	2.4	0.6
Total Time	59.9	27.2	4.2	5.5	1.3

From the Fall 2013 and Spring 2014 Projects combined data, the results indicate a weak linear relationship between indirect and direct time. Based on the average time, the results indicate that indirect time represents 63% of the direct time, in line with the Fall 2013 Project result of 61%.

6.2 Spring 2014 Data Analysis Indirect Multiplier Analysis

As mentioned in Section 2, the Spring 2014 Project added three new sections to the DCS that were recommended after discussions with FSIS. In this Section, the analysis is focused on only the Spring 2014 Project data, to determine if the new line items affect the indirect multiplier. This includes sections 3, 6 and 7; regarding the scheduling, sample source and LIMS. Table 3 shows the descriptive statistics for the data set and indicates a much higher average indirect time and standard deviation. Based on the Spring 2014 Project data, the indirect time constitutes 128% of the direct time, indicating the average indirect time has doubled with the inclusion of the new line items.

Table 3: Spring 2014 Project Descriptive Statistics

	Observation	Average	95% CI	Standard Dev.	Median
Indirect Time	79	47.8	6.7	29.8	38.4
Direct Time	79	37.3	6.0	26.8	32.3
Total Time	79	85.2	10.1	45.1	71.8

The scatter plot in Figure 7 compares direct time to indirect time. With the addition of the new DCS line items, those outliers previously seen are less obvious in the Spring 2014 Project data set compared to the Fall 2013/Spring 2014 Projects combined data. For this reason, the outliers were left in the analysis. It is evident that the data has become more scattered and spread out compared to the combined scatter plot. Similar to the prior scatter plot, the black line represents the trend line based on the data while the red line represents the current multiplier used of 0.8. In Figure 4, the current multiplier trend line shows the majority of the observations above the line whereas in Figure 2 the observations were more scatter around the current multiplier.

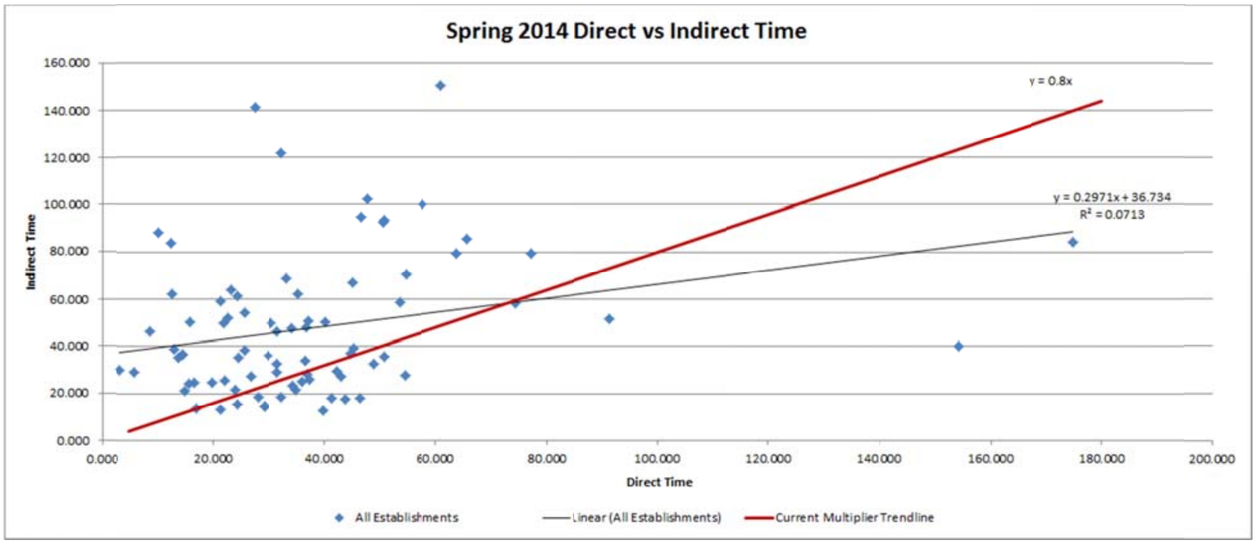


Figure 7: Spring 2014 Project Scatter Plot Direct Time vs Indirect Time

The scatter plot and corresponding linear regression, shown in Table 4, for the Spring 2014 Project data still does not show a strong relationship between direct and indirect time. In fact, the R^2 value on the trend line decreases from 11% in the combined analysis to 7%, implying that the linear regression model explains even less variability than the combined data set. However, it is important to note that the slope and intercept of the model are statistically significant, implying there is some relationship between direct and indirect.

Table 4: Spring 2014 Project Linear Regression

Regression Statistics	
R Square	0.07134
Observations	79

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	36.73427	5.60177	6.55762	0.00000
Direct (Minutes)	0.29710	0.12216	2.43217	0.01733

As mentioned in Section 5.4., residual plots are necessary to determine the adequacy of the linear regression model. Figure 8 shows the residual plot for the Spring 2014 Project. The pattern of the residual plot can indicate if there are any anomalies in the data. Based on Figure 8, the residual plot does not show any evident patterns. While there are some outliers on the x-axis, they remain within range on the y-axis.

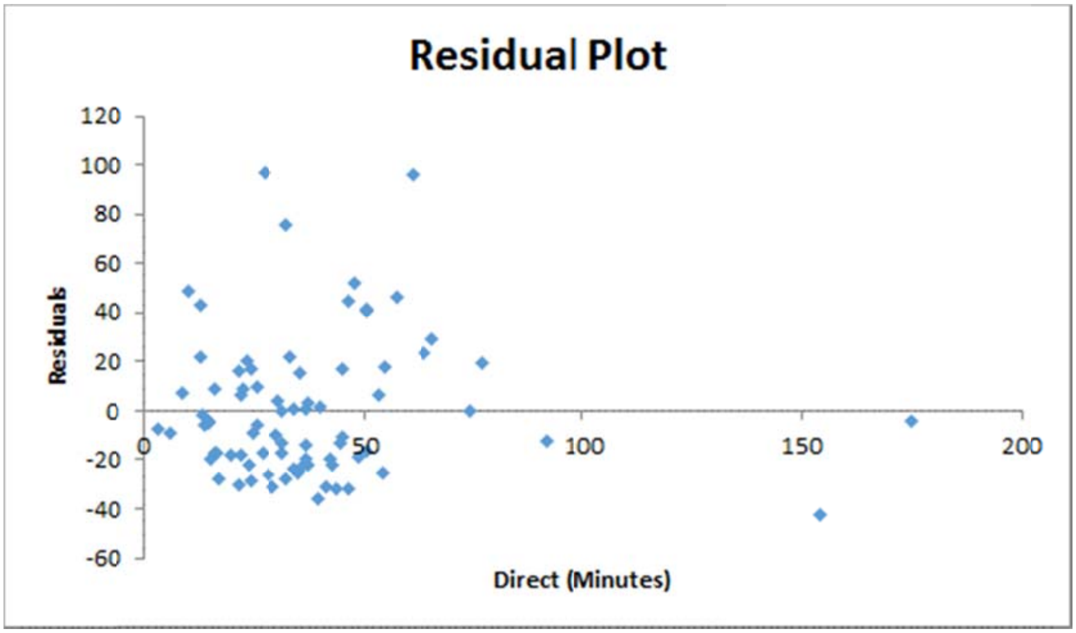


Figure 8: Spring 2014 Residual Plot

With the addition of the new line items in the DCS, the data does not show a strong relationship between indirect and direct time. Based on the averages, indirect time now takes 128% of the direct time and includes wide standard deviations implying large variations that take place when performing the line item. Furthermore, as evident in the scatter plot, the variations in the line item times are usually much higher instead of lower. Therefore an average indicator for the amount of time it takes to complete the N60 sampling may not capture the true variability that exists. The next few Sections break out several parameters to test if there's any pattern that better determines the amount of time it takes to perform the sampling task.

6.3 Analysis of Parameters across Task Time

Similar to the Fall 2013 Project, several parameters are tested to determine if there's a difference in task time. Both the ANOVA Single Factor and Median One-Way tests will be used to determine if the means are statistically different on direct and indirect time across the parameters below:

- HACCP Size vs Time
- Plant Size vs Time
- Internet Connection vs Time
- Facility Experience vs Time
- Inspector Experience vs Time
- District vs Time

6.3.1 HACCP size

A new initiative for the Spring 2014 Project was to analyze the data across HACCP establishment sizes. The HACCP size is determined by the revenue and number of employees at an establishment.

Figure 9 breaks out the average line item time per HACCP establishment size. Note that line item 2G was removed from the Spring 2014 Project as it was repeated in Section 5 of the DCS. From the bar chart, there are some sections of the DCS that seem to have a difference in average line item times across HACCP establishment sizes. Most notable is Section 3, which deals with scheduling the sample collection. The possible difference in scheduling time is further explored in Section 6.4. Other sections with noticeable difference are 5L and 5M, dealing with the shipping of the product, and Section 6, which deals with supplier information.

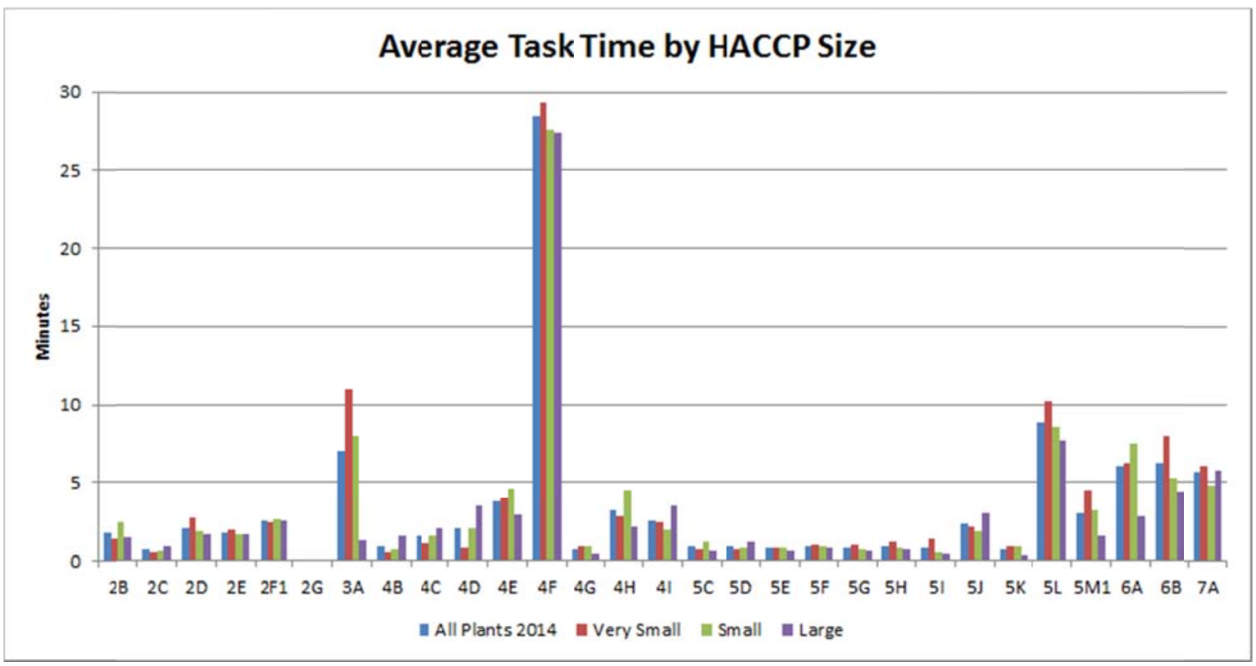


Figure 9: Average Line Item Time Spring 214 Project by HACCP Size

6.3.1.1 Direct Time

Figure 10 shows the box plot for direct time across HACCP sizes. It is evident from the graph that very small and small establishments see a wider distribution in the maximum amount of time it takes to perform the direct line items. For the large establishments though, the maximum and minimum ranges are much tighter around the mean. This indicates that very small and small plants have much greater variability in how long the line item can take compared to large establishments. However, the boxes for each HACCP size are roughly the same size and values. Running ANOVA analysis, Table 5, the high p-value indicates the null hypothesis cannot be rejected, indicating there is no difference between the average direct time across HACCP establishments. But, it is worth noting that very small and small plants could take much longer than the average compared to large establishments. Likewise, the Median analysis results in Table 6 indicates there is statistically no difference in the median direct time across HACCP establishment sizes.

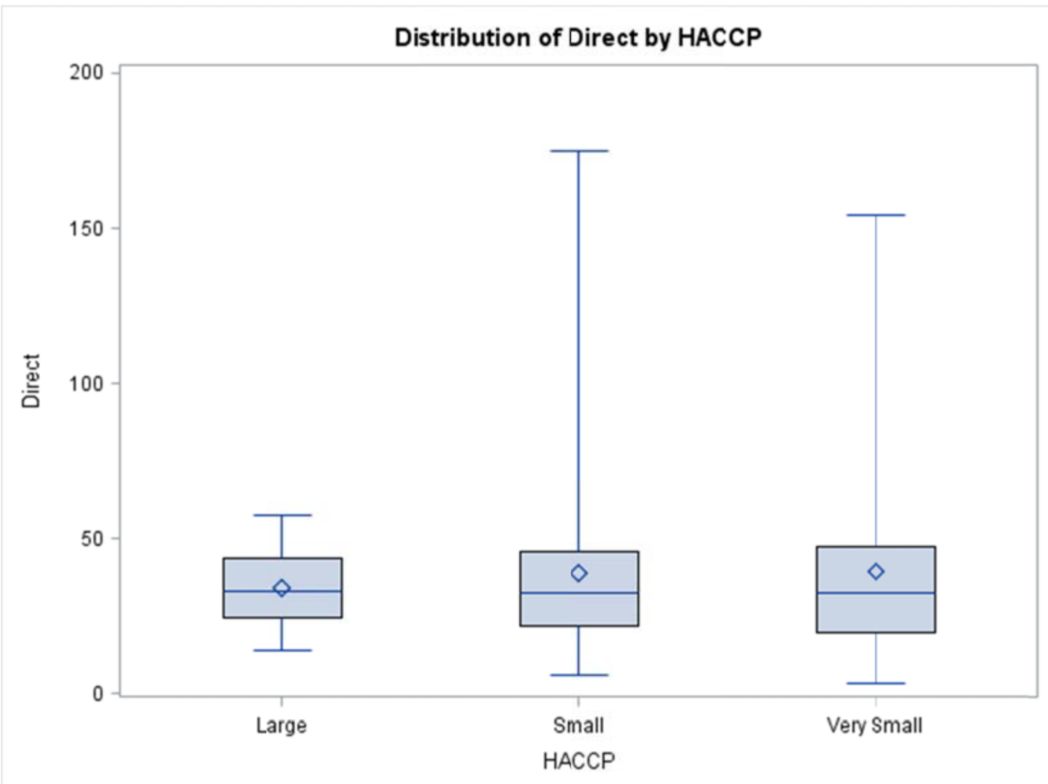


Figure 10: Spring 2014 HACCP Direct Box Plot

Table 5: Spring 2014 HACCP Direct ANOVA

HACCP Direct Time	**p-value =**	**0.7478**		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
Very Small	25	982.08	39.28	32.44
Small	28	1,083.18	38.69	31.19

Large	26	885.37	34.05	12.61

Table 6: Spring 2014 HACCP Direct Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**0.027**
Pr> Chi-Square	**0.9866**

6.3.1.2 Indirect Time

Figure 11 represents the box plot for indirect time across HACCP sizes. With indirect time, a pattern across HACCP sizes becomes evident. Similar to direct time, very small and small establishments present wider whiskers for the maximum value, showing again more variation in their data, but all three boxes are different sizes and values. Table 7 shows the ANOVA test result and due to the very low p-value, we can reject the null hypothesis that the means are the same, indicating at least one of the means is statistically different. The Median analysis for indirect time across HACCP size also results in a statistical significant difference between the median indirect times, shown in Table 8. However, the two tests only indicate that at least one of the groups' could be statistically different. By pairing up the analysis into groups of two and rerunning ANOVA, as shown in Table 9, it is evident that the average indirect time in very small and large establishments is statistically different but that pattern is not seen when comparing small to either very small or large establishments. Due to the similarities between very small and small establishments, these two groups are combined and compared to large establishments. From the results, it is evident there is a difference in the average indirect time between very small/small and large establishments. This analysis will be explored further in Section 6.4 regarding scheduling time.

This result indicates that there is a meaningful difference between amount of time it takes to perform indirect task items and the HACCP establishment size. Therefore, it might be worth exploring the option of taking HACCP establishment size into account when determining how many MT60 and MT55 tasks to assign to each inspector. Also, as evident in the data, very small and small establishments have wide swings in the amount of time it can take to perform both the direct and indirect line items. As such, it may be beneficial to adjust the amount of time further if the assignment includes primarily very small and small establishments, as the results suggest that a greater likelihood that the task could sometimes take well above the average time.

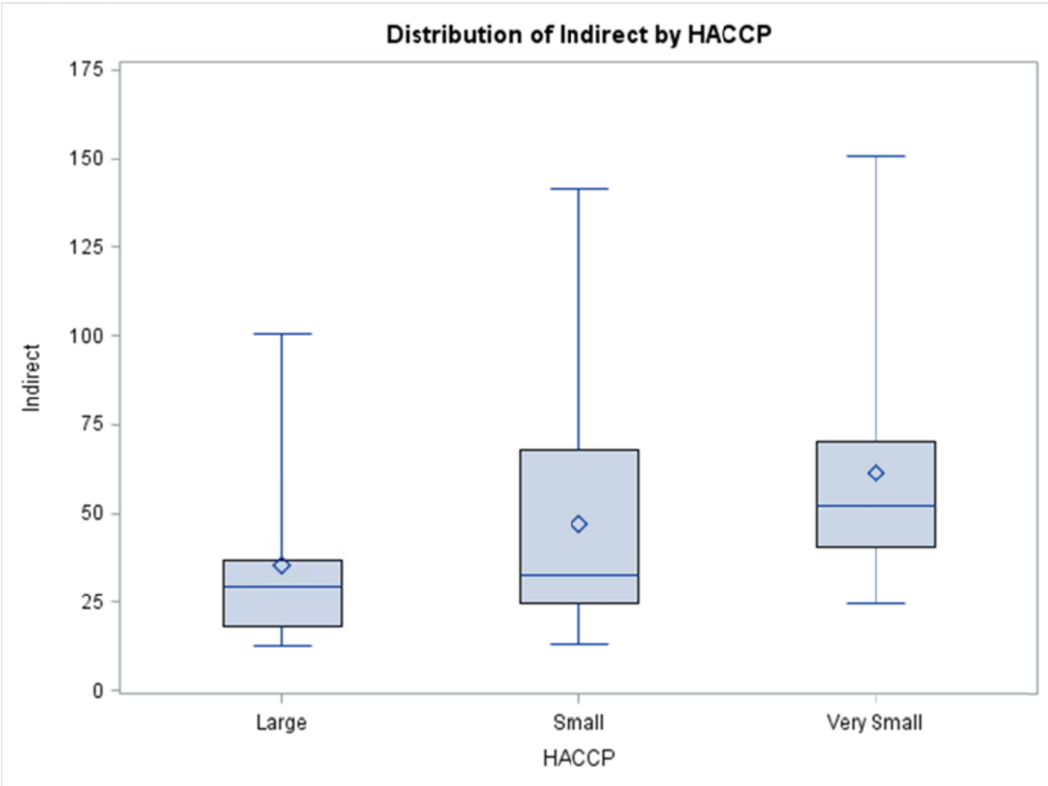


Figure 11: Spring 2014 HACCP Indirect Box Plot

Table 7: Spring 2014 HACCP Indirect ANOVA

HACCP Indirect Time	**p-value =**	**0.0055**		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
Very Small	25	1,540.72	61.63	29.62
Small	28	1,320.53	47.16	31.45
Large	26	917.40	35.28	22.42

Table 8: Spring 2014 HACCP Indirect Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**19.4115**
Pr> Chi-Square	**<.0001**

Table 9: Spring 2014 HACCP ANOVA Analysis

HACCP Size	P-value
Very Small vs Small	0.095
Very Small vs Large	0.000
Small vs Large	0.119
Very Small/Small vs Large	0.008

6.3.2 Plant Size (Square Footage)

Similar to the Fall 2013 Project, the inclusion of the square footage of each plant may affect how long it takes to perform the tasks. Establishment square footage was indicated by the inspector on the DCS and compared to the information in PHIS. There were eight establishments that did not have the square footage listed in PHIS. Likewise, there were several where the inspectors' square footage did not match what was in PHIS. The inconsistency of data could be due to the inspector indicating the entire plants square footage, or just the inspection area. When in doubt, the data represented in PHIS was used for the analysis. The plants were broken into three sizes; small (<= 5,000 sqft), medium (>5,000 sqft, <= 30,000 sqft), and large (> 30,000 sqft). While the plant size (i.e., area) is not directly correlated to HACCP size (i.e., revenue and number of employees), there are inevitably some similarities, as establishments with greater revenue or number of employees will also tend to be physically larger as well.

6.3.2.1 Direct Time

Figure 12 shows the box plot for direct time across plant sizes. While the whiskers on the small plants decrease as the plant size increases, the average and median time is relatively the same. The ANOVA and Median tests results in Table 10 and 11 confirm that theory. The p-value indicates the null hypothesis cannot be rejected so there is not enough evidence to determine the means and medians are different.

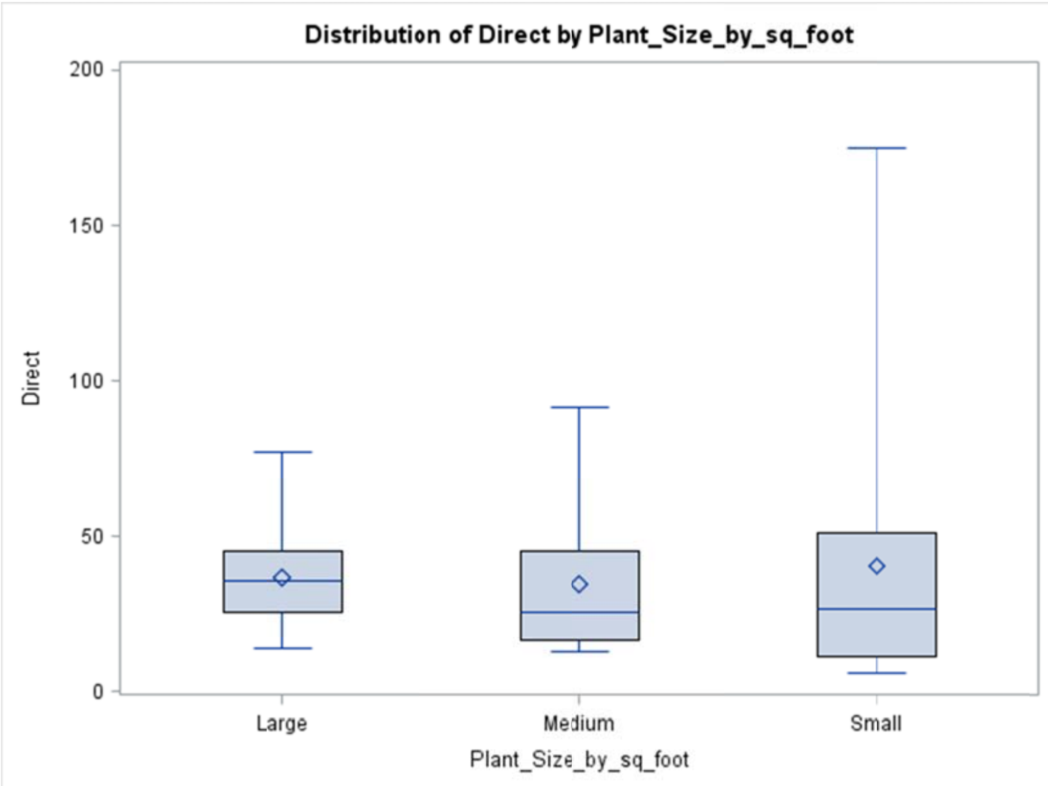


Figure 12: Spring 2014 Plant Size by Square Foot Direct Time Box Plot

Table 10: Spring 2014 Plant Size by Square Foot Direct ANOVA

Plant Size Direct Time	**p-value =**	**0.8138**		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
Small	12	482.92	40.24	46.58
Medium	19	655.10	34.48	21.81
Large	40	1,462.55	36.56	14.17

Table 11: Spring 2014 Plant Size by Square Foot Direct Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**1.1764**
Pr> Chi-Square	**0.5553**

6.3.2.2 Indirect Time

Figure 13 shows the box plot of indirect time across plant size. The indirect time across plant size is slightly different compared to the HACCP size distribution. The whiskers for the small plants are relatively evenly distributed around the box. Meanwhile, the medium size plant shows the highest variability in the indirect time and the large plants have a wider distribution of data. The ANOVA and

Median test results shown in Tables 12 and 13 indicate that the null hypothesis can be rejected indicating the average and median indirect times differ across plant size.

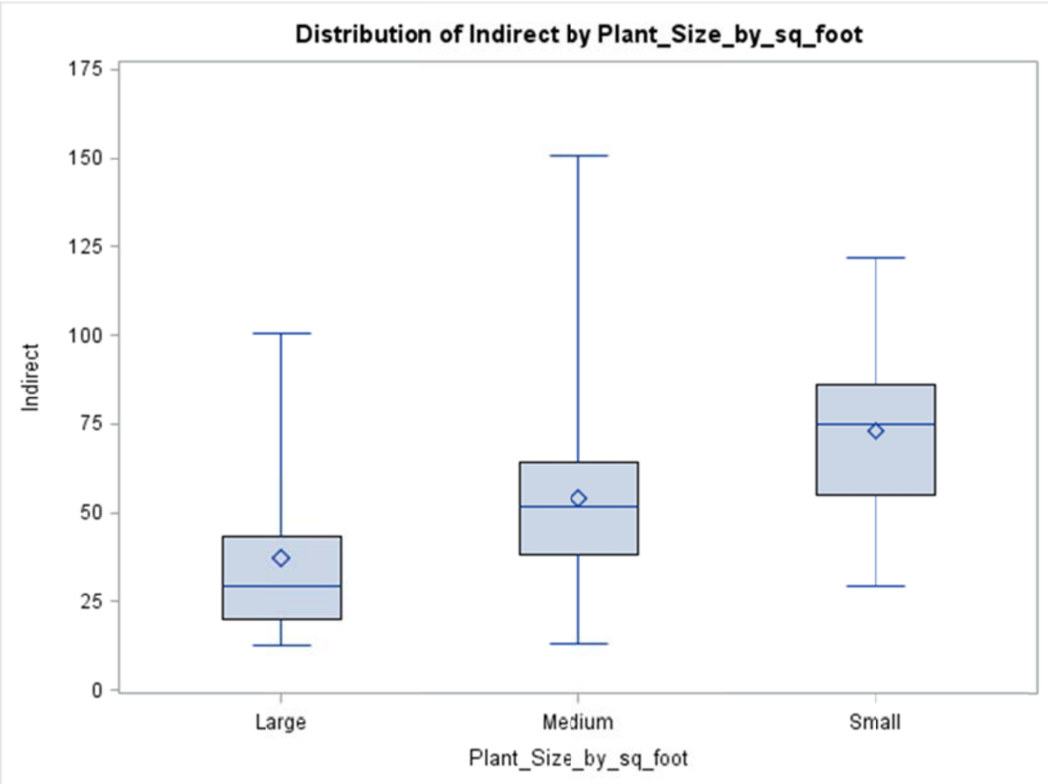


Figure 13: Spring 2014 Plant Size by Square Foot Indirect Box Plot

Table 12: Spring 2014 Plant Size by Square Foot Indirect ANOVA

Plant Size Indirect Time	**p-value =**	**0.0002**		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
Small	12	877.95	73.16	25.63
Medium	19	1,027.72	54.09	30.33
Large	40	1,488.17	37.20	23.78

Table 13: Spring 2014 Plant Size by Square Foot Indirect Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**22.2688**
Pr> Chi-Square	**<.0001**

The statistically significant results in plant size suggest that this variable could be included in PHIS methodology for determining the scheduling of inspectors. As indicated earlier, however, several plants were missing this information in PHIS and could not be included in the above analysis. As such, to include this parameter would entail making sure the square foot data in PHIS for each plant is up to date and is updated if the plant makes any changes.

6.3.3 Internet Connection

While at the establishment, inspectors need to interact with PHIS in order to complete several of the indirect line items indicated in the DCS. This implies the need for an internet connection while onsite which could affect how long the online line items take. In the DCS, the inspectors chose from a list which internet connection was available at the establishment; DSL, 3G or 4G air card (EVOD), T1, or WIFI.

6.3.3.1 Direct Time

Figure 14 shows the box plot between direct time and the internet connection. The majority of the plants connections were either through DSL or air cards, which skews the T1 and WIFI results. As such, looking at just the DSL and air card box plots, the size of the boxes and whiskers are relatively the same. The ANOVA and Median test, Table 14 and 15, indicate there is no statistical difference between means and medians of connection type compared to direct time. This finding is not surprising, as the direct line items do not involve any interaction with the internet.

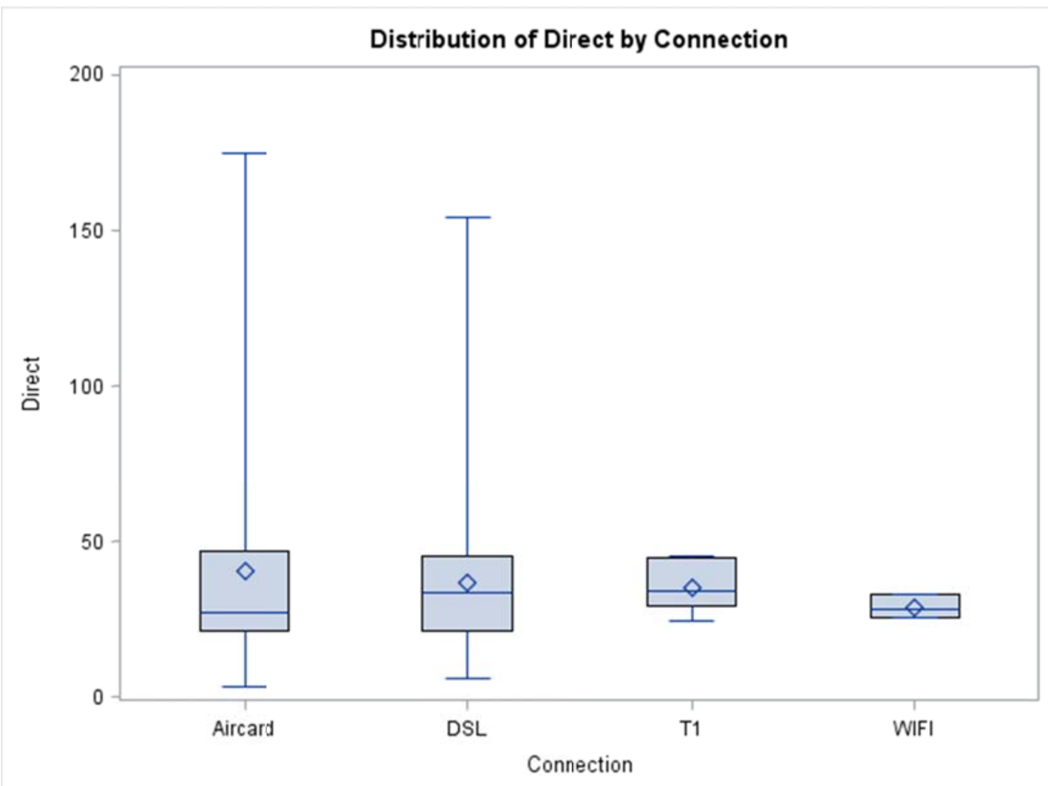


Figure 14: Spring 2014 Connection Type Direct Box Plot

Table 14: Spring 2014 Connection Type Direct ANOVA

Direct Time Connection Type	p-value =	0.9008		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
DSL	50	1,828.42	36.57	23.82
Aircard	17	688.97	40.53	41.07
T1	7	246.78	35.25	7.63
WIFI	3	86.78	28.93	3.87

Table 15: Spring 2014 Connection Type Direct Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**1.0589**
Pr> Chi-Square	**0.787**

6.3.3.2. Indirect Time

Figure 15 represents the box plot of indirect time across internet connection type. Similar to direct time, the whiskers on DSL and air cards are relatively the same, but the boxes are now shifted. Air cards seem to on average take longer than DSL. However, the ANOVA test does not indicate the null hypothesis can be rejected, shown in Table 16. However, the Median test p-value of 0.0562, Table 17, is relatively close to the minimum of 0.05 that would reject the null hypothesis. This result indicates the Median test is indeterminate if the null hypothesis can be rejected or not. In Section 9, further analysis into connection type is recommended as there is some evidence there is a relationship between the median indirect time and connection type. Also recommended is better data quality on the connection type. In the Spring 2014 Project study, the inspector was only asked what the connection type was at the establishment where the sample was taken. In reality, the indirect line items that involve PHIS may take place at separate establishments, as scheduling may be completely elsewhere compared to line items that are completed after the sample. Hence, it would be beneficial to base the connection type analysis off of what connection was available at each PHIS interaction during completion of the indirect line items. Also, the Spring 2014 DCS included new line items that don't directly interact with PHIS. Section 3 of the Spring 2014 DCS involves discussions with the establishment managers to determine the scheduling of the specific product. These line items don't involve PHIS and should not be included in a further study.

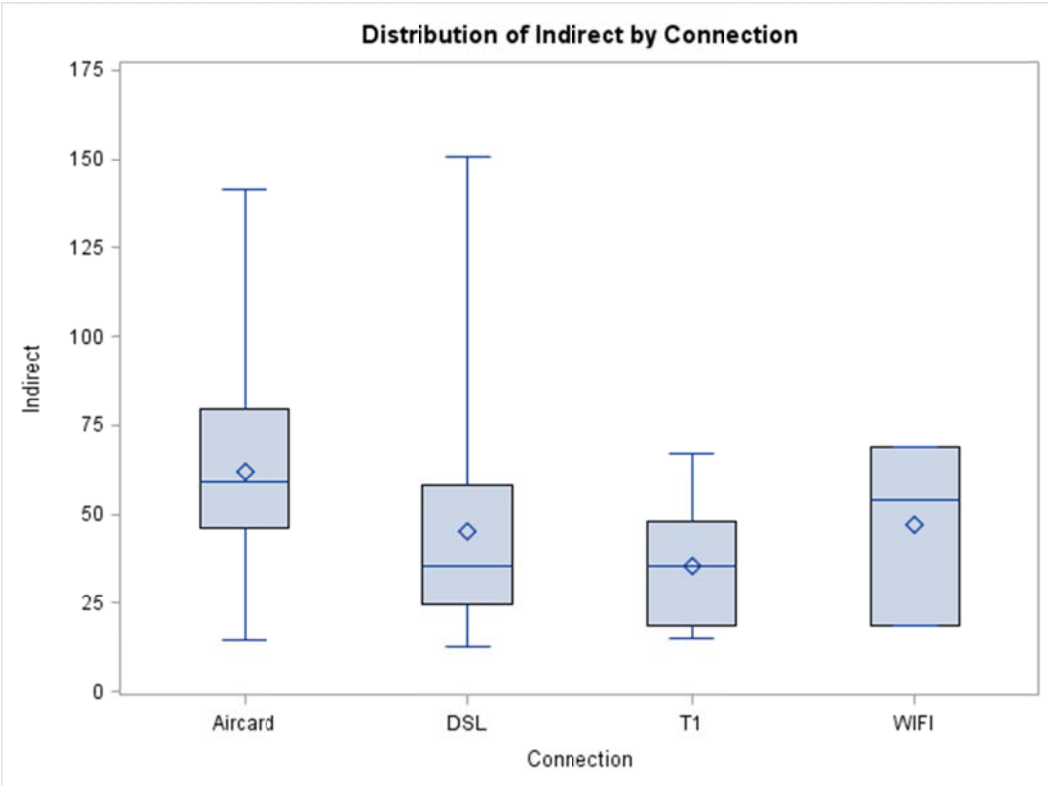


Figure 15: Spring 2014 Connection Type Indirect Box Plot

Table 16: Spring 2014 Connection Type Indirect ANOVA

Indirect Time Connection Type	p-value =	**0.1617**		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
DSL	50	2,269.73	45.39	30.66
Aircard	17	1,050.17	61.77	30.45
T1	7	248.85	35.55	17.95
WIFI	3	141.55	47.18	25.78

Table 17: Spring 2014 HACCP Connection Type Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**7.5527**
Pr> Chi-Square	**0.0562**

6.3.4 Facility Experience with MT60/MT55

New in the Spring 2014 DCS was a field requesting the amount of experience the establishment had with MT60 or MT55 sampling. During our conversations with FSIS, they indicated that a new regulation would increase the number of plants required to perform MT55. As such, the DCS included a question regarding the number of times the establishment has performed MT60 or MT55 tasks in the past 12 months, to determine if there was a learning curve present in the plants with little current experience. The inspectors had an option of choosing between the following options: Never, Once, 2-9 and 10+ times. These break outs were suggested by FSIS as an appropriate way to determine the amount of establishment experience. These results should be used cautiously as this was based on the inspector's knowledge of how many times these tasks were performed and is subjective to human error.

6.3.4.1 Direct Time

Figure 16 shows the box plot of direct time by establishment experience. Counter intuitively, those establishments that have performed the task 2-9 times had the greatest variability in the direct time. Furthermore, the majority of the establishments had a decent amount of experience as more than half had done the MT60 or MT55 sampling task 10 or more times in the past year. Tables 18 and 19 show the ANOVA and Median test results, which indicate that the null hypothesis cannot be rejected implying the average and median direct time does not differ across establishment experience.

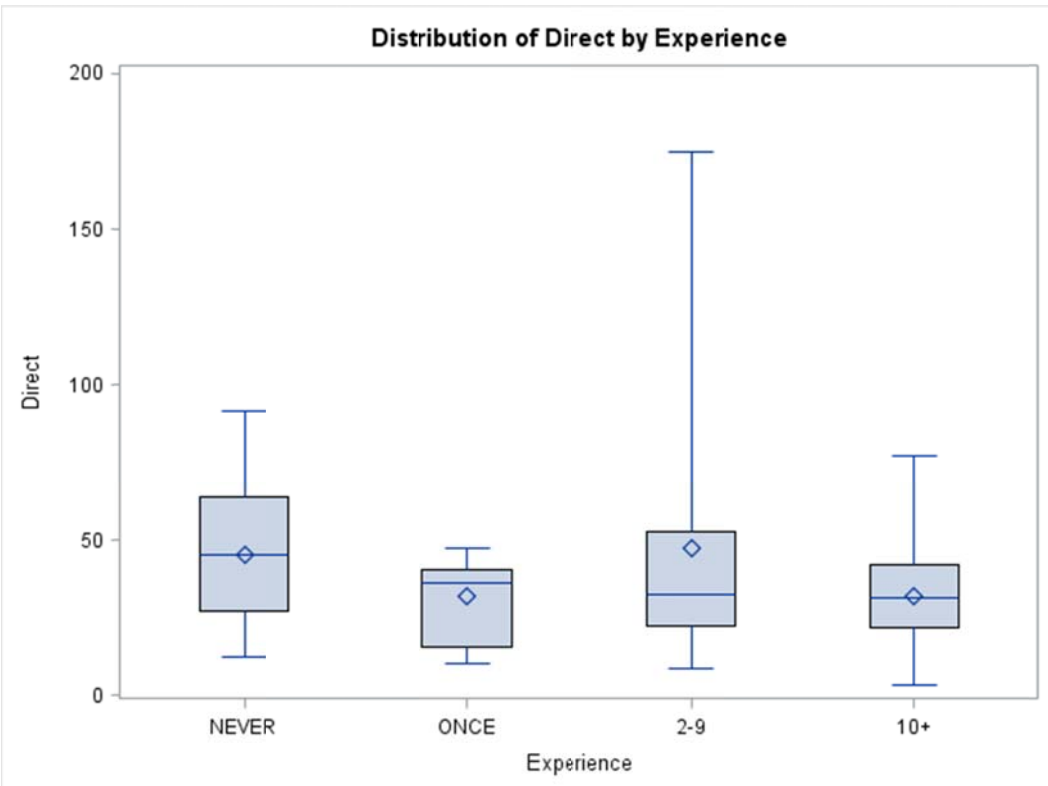


Figure 16: Spring 2014 Facility Experience Direct Box Plot

Table 18: Spring 2014 Facility Experience Direct ANOVA

Direct Time	p-value =	0.1400		
Groups	*Count*	*Sum*	*Average*	*Standard Dev*
Never	9	407.82	45.31	25.37
Once	7	222.18	31.74	13.56
2-9	20	942.62	47.13	43.79
10+	43	1,378.02	32.05	14.89

Table 19: Spring 2014 Facility Experience Direct Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**1.941**
Pr> Chi-Square	**0.5847**

6.3.4.2 Indirect Time

Figure 17 shows the box plot of indirect time across establishment experience. The results are similar to direct time as those in the 2-9 range have a wider distribution of data, but for indirect time, the less experienced facilities also show some variability in the data. The ANOVA results, Table 20, show that the null hypothesis can be rejected for average indirect times while the Median test, Table 21, validates this result, indicating a difference in the median indirect time depending on the establishments experience.

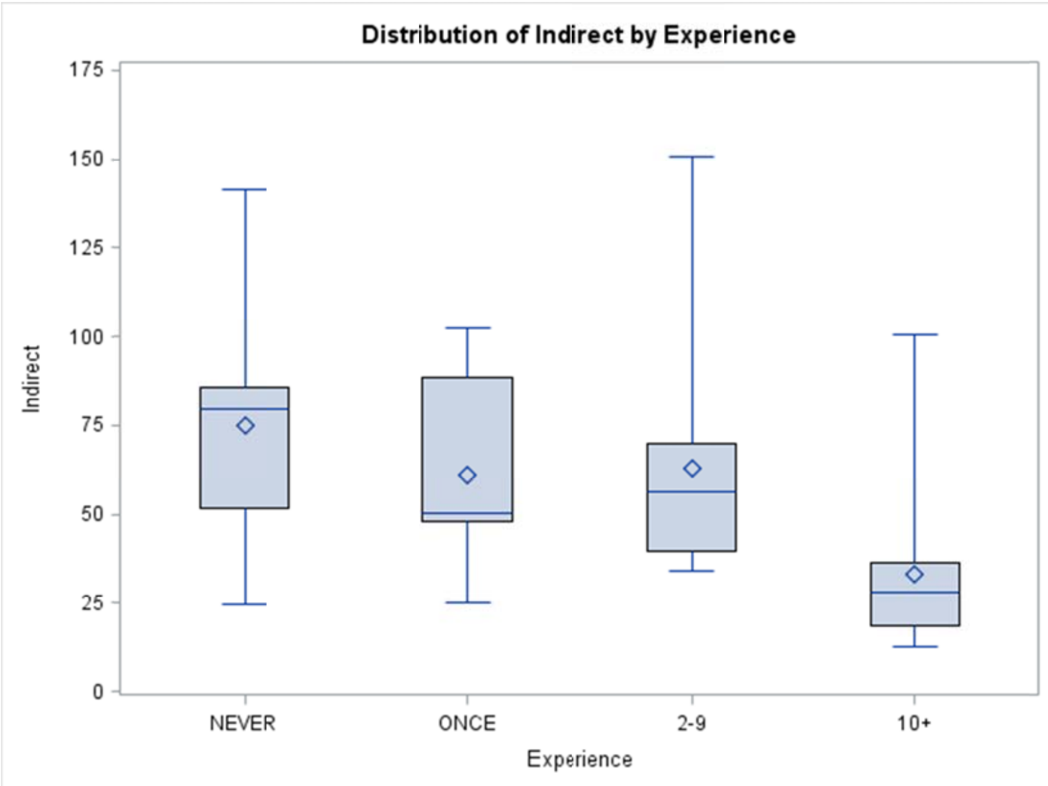


Figure 17: Spring 2014 Facility Experience Indirect Box Plot

Table 20: Spring 2014 Facility Experience Indirect ANOVA

Indirect Time	p-value =	0.0000		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
Never	9	673.85	74.87	33.43
Once	7	426.95	60.99	26.35
2-9	20	1,260.88	63.04	30.23
10+	43	1,416.97	32.95	19.99

Table 21: Spring 2014 Facility Experience Indirect Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**35.3097**
Pr> Chi-Square	**<.0001**

6.3.5 Inspector Experience with MT60/MT55

Similar to Section 6.3.4., the Spring 2014 DCS included a field requesting the amount of experience the inspector had with the MT60 or MT55 process in the past 12 months. The inspectors who participated in the time study had the option to indicated how many times they had performed either the MT60 or

MT55 task in the past 12 months by selecting Never, 1-4, 5-10, 11-19 or 20+ times. These break outs were suggested and validated by FSIS as an appropriate way to determine inspector experience. These results should be used cautiously as they are subjective to human error.

6.3.5.1 Direct Time

Figure 18 shows the box plot of direct time based on the inspector's experience over the past 12 months. Not surprisingly, the shorter the amount of experience they have the wider the variation in the amount of time it takes to complete the line items compared to more experienced inspectors. Based on the ANOVA and Median test results in Table 22 and 23, the p-value indicates we cannot reject the null hypothesis that there is any difference between the average and median time to complete direct task items. However, it is worth noting that the majority of the inspectors fall within the first two categories, never and 1-4, indicating that on average the experience is low for many inspectors for the MT60 and MT55 tasks.

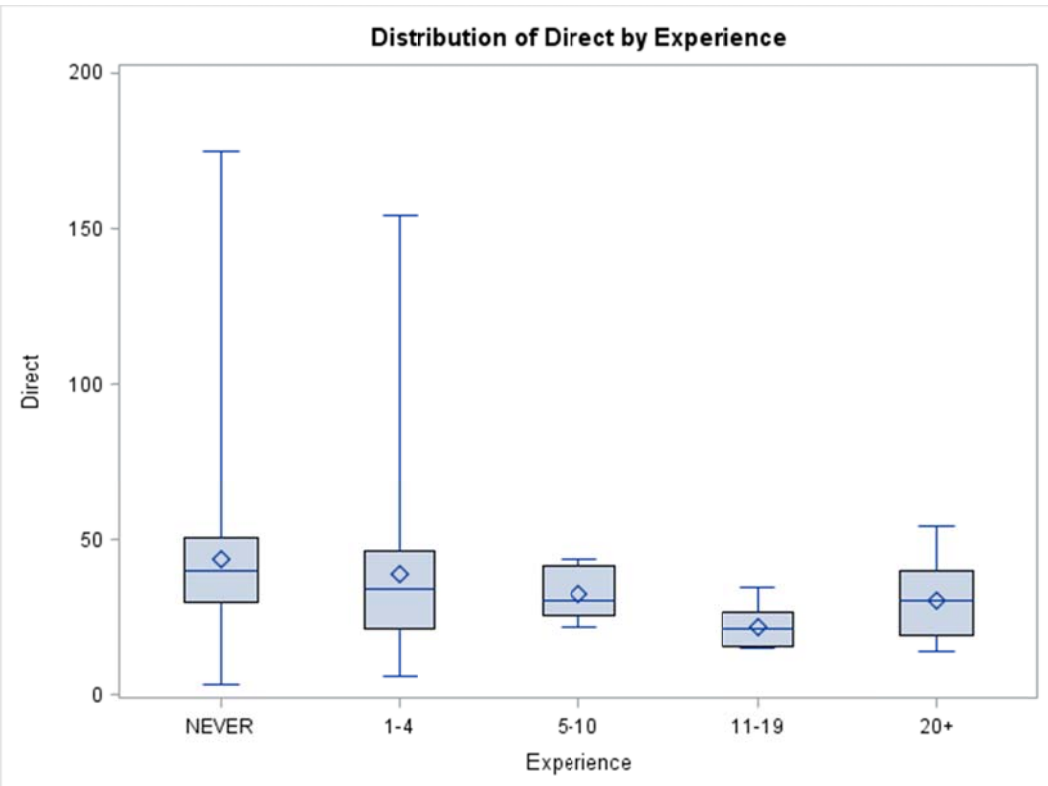


Figure 18: Spring 2014 Inspector Experience Direct Box Plot

Table 22: Spring 2014 Inspector Experience Direct ANOVA

Direct Time	p-value =	0.2912		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
Never	29	1,265.15	43.63	31.07
1-4	25	972.42	38.90	30.80
5-10	6	193.90	32.32	8.72
11-19	7	153.82	21.97	7.20
20+	12	365.35	30.45	12.99

Table 23: Spring 2014 Inspector Experience Direct Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**4.7342**
Pr> Chi-Square	**0.3157**

6.3.5.2 Indirect Time

Figure 19 shows the box plot for the indirect time by inspector experience. The results are similar to that for direct time, showing the less experience the wider the variation on the amount of time it takes to complete indirect line items. Both the ANOVA and Median test results in Tables 24 and 25 indicate a p-value of less than 0.05 which rejects the null hypothesis. Therefore there is statistically significant evidence that the average and median indirect times are different based on the inspectors experience.

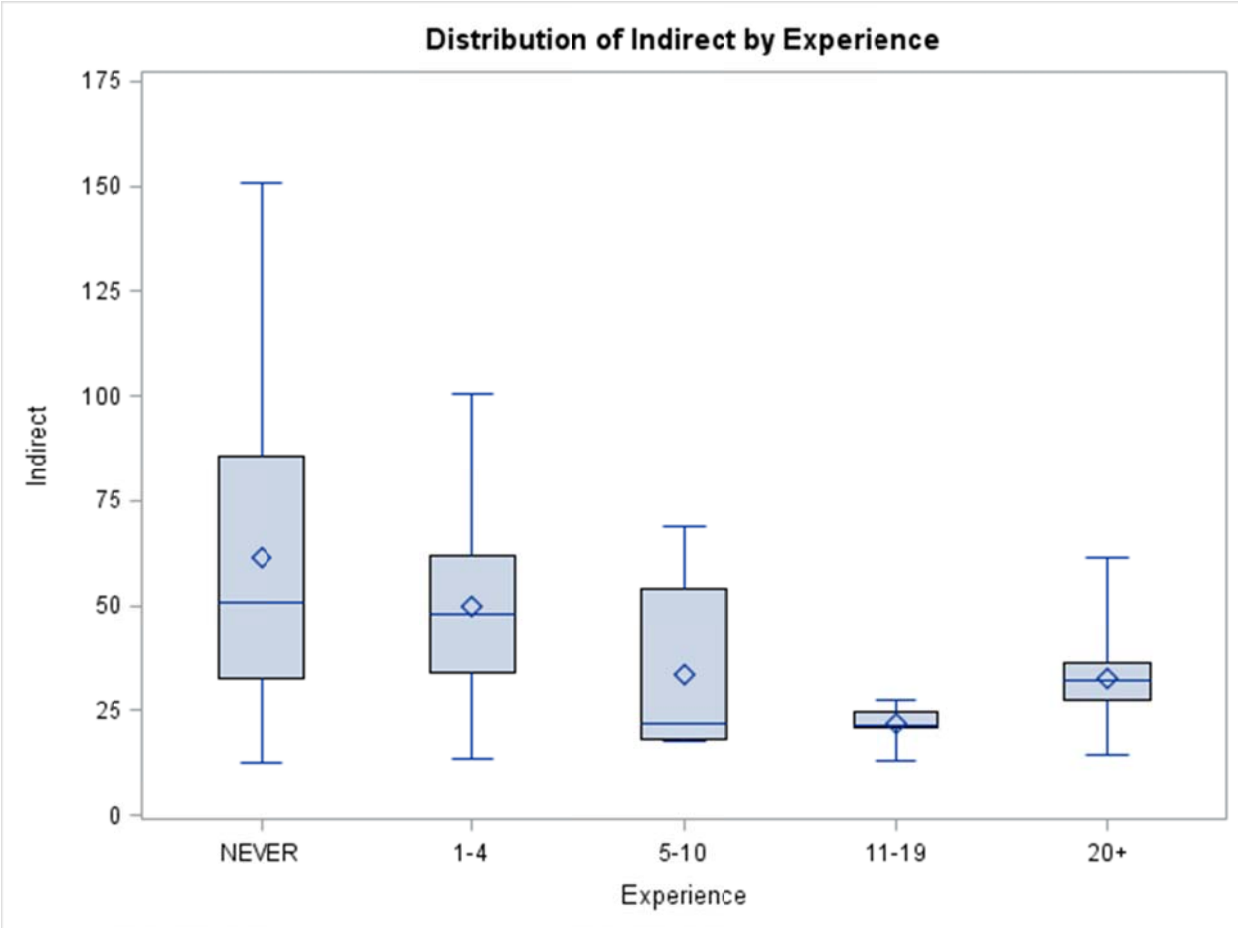


Figure 19: Spring 2014 Inspector Experience Indirect Box Plot

Table 24: Spring 2014 Inspector Experience Indirect ANOVA

Indirect Time	p-value =	0.0017		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
Never	29	1,787.77	61.65	36.55
1-4	25	1,242.07	49.68	23.79
5-10	6	202.60	33.77	22.14
11-19	7	153.92	21.99	4.55
20+	12	392.30	32.69	11.22

Table 25: Spring 2014 Inspector Experience Indirect Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**21.7452**
Pr> Chi-Square	**0.0002**

While it's important, and intuitive, to note that new or less experienced inspectors may on average take longer to perform tasks or have more volatility in the amount of time it takes, it is not feasible to track and incorporate that data into the methodology. But, perhaps for newly hired inspectors or ones moving into a new rotation where MT60 and MT55 is more prevalent than their previous circuit, a learning curve can be applied to the overall methodology.

6.3.6 District

FSIS categorizes all the establishments across the country into 10 geographical districts. The number and distribution of establishments, including product type and establishment HACCP size, varies among the districts. These differences (e.g., more beef production) could affect the amount of time it takes to perform the MT60/MT55 task.

6.3.6.1 Direct Time

Figure 20 shows the box plot of direct time across districts. Due to the limited sample size of DCS and the large number of districts, the data is spread relatively thin across each district. However, it is evident that some districts see more volume of MT60 and MT55 sampling tasks. District 60 saw the highest number of observations and also has the largest variation in data. Based on the ANOVA test, Table 26, the null hypothesis can be rejected but based on the Median test, Table 27, the p-value is above the 0.05 threshold indicating the null hypothesis cannot be rejected. The conflicting information is not surprising as the number of observations across the districts is too small to make a meaning analysis of the average time it takes to perform the direct line items.

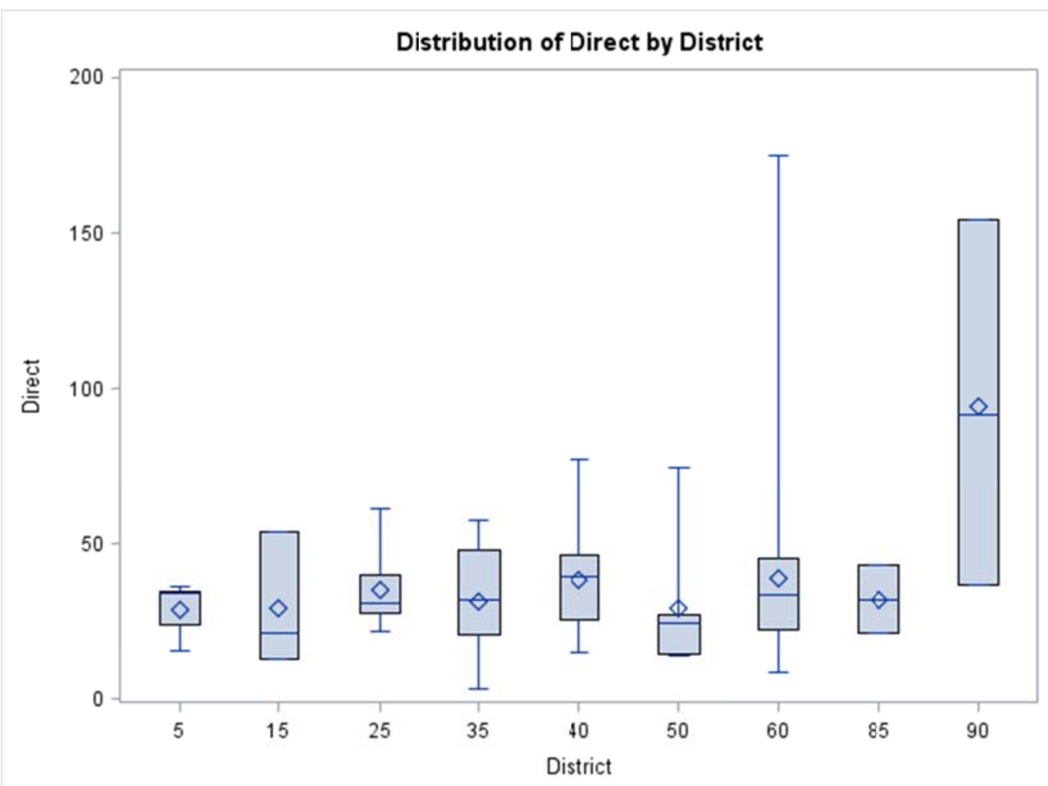


Figure 20: Spring 2014 District Direct Box Plot

Table 26: Spring 2014 District Direct ANOVA

Direct Time	p-value =	0.0348		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
5	5	144.88	28.98	8.89
15	3	87.37	29.12	21.55
25	12	420.77	35.06	12.13
35	12	379.13	31.59	17.61
40	14	538.97	38.50	18.04
50	9	264.88	29.43	20.32
60	18	704.33	39.13	36.69
85	2	64.17	32.08	15.34
90	3	282.37	94.12	58.81

Table 27: Spring 2014 District Direct Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**7.6875**
Pr> Chi-Square	**0.4646**

6.3.6.2 Indirect Time

Figure 21 shows the indirect time across districts. As opposed to direct time, more districts see a higher variation in indirect time, including district 25, 35, and 50. The ANOVA and Median tests, Tables 28 and 29, both cannot reject the null hypothesis implying that the average and median indirect time does not differ across districts.

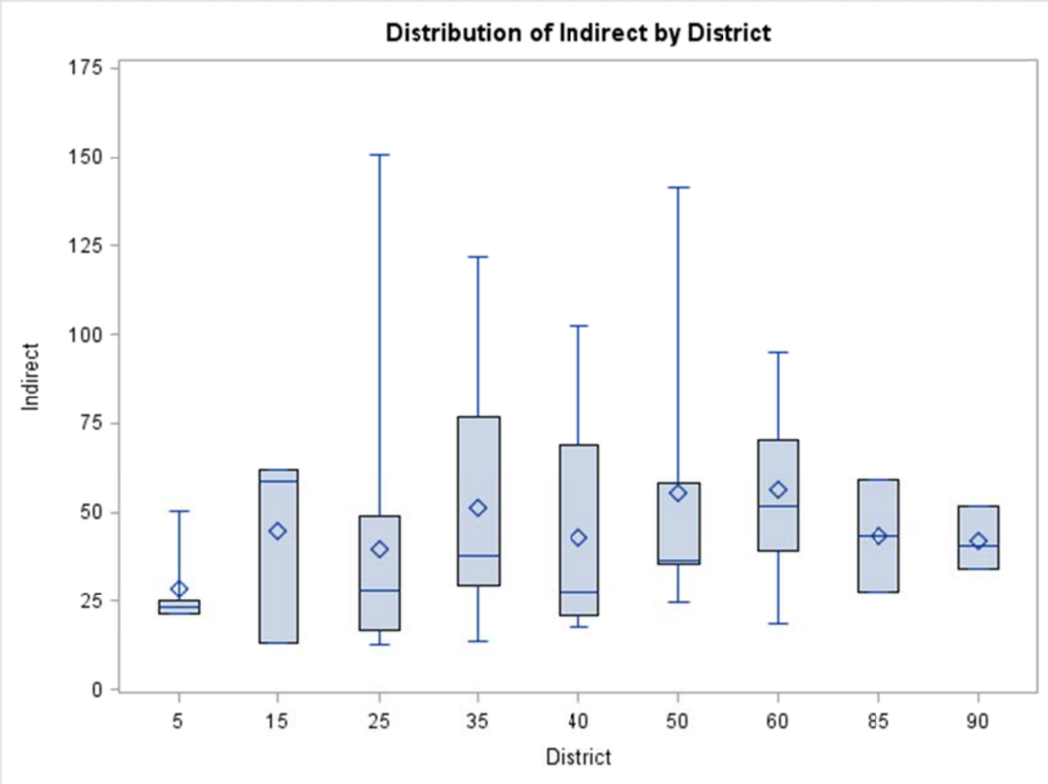


Figure 21: Spring 2014 District Indirect Box Plot

Table 28: Spring 2014 District Indirect ANOVA

Indirect Time	p-value =	0.6774		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
5	5	141.93	28.39	12.45
15	3	133.83	44.61	27.37
25	12	475.45	39.62	37.57
35	12	616.97	51.41	35.29
40	14	602.72	43.05	29.25
50	9	499.93	55.55	38.12
60	18	1,016.43	56.47	21.98
85	2	86.33	43.17	22.34
90	3	125.63	41.88	8.96

Table 29: Spring 2014 District Indirect Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**10.4735**
Pr> Chi-Square	**0.2334**

6.4 Scheduling Time

Another initiative requested by FSIS was to look at specific scheduling time across HACCP sizes and internet connection type. The steps that involve scheduling the task are all indirect line items from Sections 2 and 3 on the DCS.

6.4.1 HACCP Size

Based on the information from FSIS regarding the scheduling process, very small and small facilities may not readily have a schedule for when certain products will be available in their establishment. As such, inspectors may need to get more information from the establishment management in order to schedule the MT60/MT55 task. The Spring 2014 data indicated that only very small and small establishments needed to reschedule their MT60/MT55 sampling tasks. Of the 25 very small establishments, seven needed to reschedule for a total of 11 times. For small establishments, out of the 28 in the data set, three needed to reschedule for a total of four times. However, large establishments never needed a reschedule.

Running the analysis on just the scheduling components of the DCS will give an idea of whether or not scheduling time differs across HACCP size. Figure 22 shows the box plot of the scheduling time across HACCP size. The results are similar to indirect time across HACCP size regarding the average time, but the distribution of data is large in both small and very small this time. Table 30 shows the ANOVA results indicating that the null hypothesis can be rejected, implying the average times are not the same across HACCP sizes. However, based on the Median test the p-value in Table 31, while somewhat low, does not break the 0.05 threshold and we cannot reject the null.

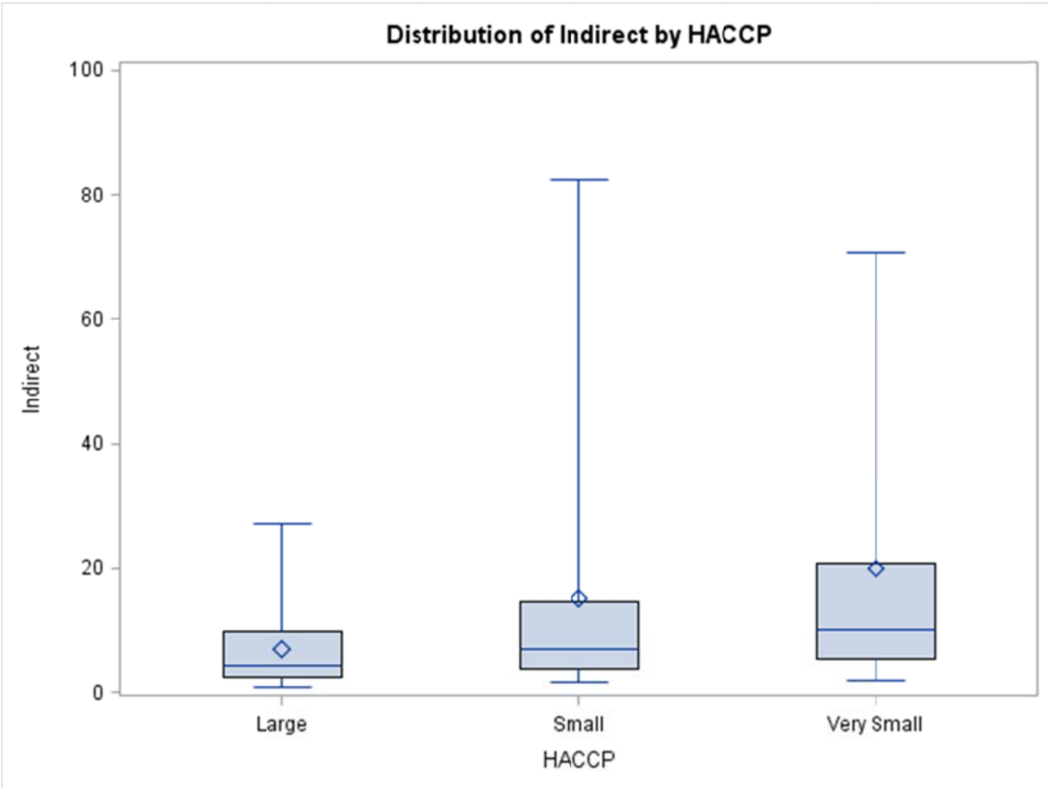


Figure 22: Spring 2014 HACCP Scheduling Time Box Plot

Table 30: Spring 2014 HACCP Scheduling Time ANOVA

HACCP Scheduling Time	**p-value =**	**0.0332**		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
Very Small	25	498.22	19.93	21.65
Small	28	423.30	15.12	20.14
Large	26	182.03	7.00	6.72

Table 31: Spring 2014 HACCP Scheduling Time Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**4.3538**
Pr> Chi-Square	**0.1134**

Going further, from the box plot in Figure 23, we can see very small and small plants having a similar distribution. Therefore, the observations for very small and small were grouped together and compared to large establishments. The ANOVA results, Table 32, indicate as well that the average scheduling times for very small and small plants is different from large plants, while the Median test, Table 33, gives indeterminate results. While more research is needed regarding just scheduling time, there is enough evidence that indicates a difference in scheduling time for different HACCP size establishments. As such, FSIS has already indicated a new directive into exploring a different way to schedule very small and small plants.

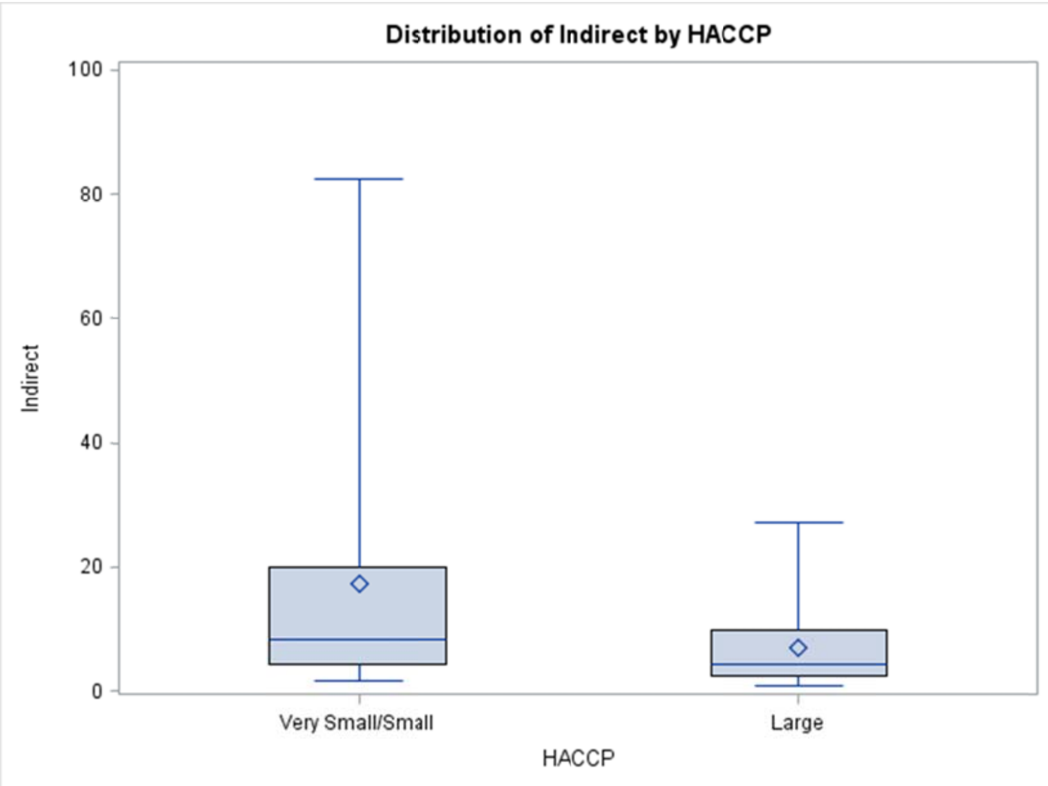


Figure 23: Spring 2014 HACCP Scheduling Time (Very Small/Small vs Large) Box Plot

Table 32: Spring 2014 HACCP Scheduling Time (Very Small/Small vs Large) ANOVA

HACCP Scheduling Time	**p-value =**	**0.0155**		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
Very Small/Small	53	921.52	17.39	20.80
Large	26	182.03	7.00	6.72

Table 33: Spring 2014 HACCP Scheduling Time (Very Small/Small vs Large) Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	3.3312
Pr> Chi-Square	0.068

6.4.2 Internet Connection

As mentioned in Section 6.3.2.3., the type of internet connection can vary across HACCP establishment sizes. When determining if the internet connection also has an effect on how long the scheduling can take, the ANOVA and Median test results, Tables 34 and 35, cannot reject the null hypothesis implying there is not enough evidence that the connection type means and medians are different. This result is not surprising as the data that was collected specified to indicate what type of connection was at the establishment were the sample was taken, which is not necessarily the same location where the scheduling was performed. In Section 9 we discuss future recommendations to analyze the internet connection based on where each line item was performed.

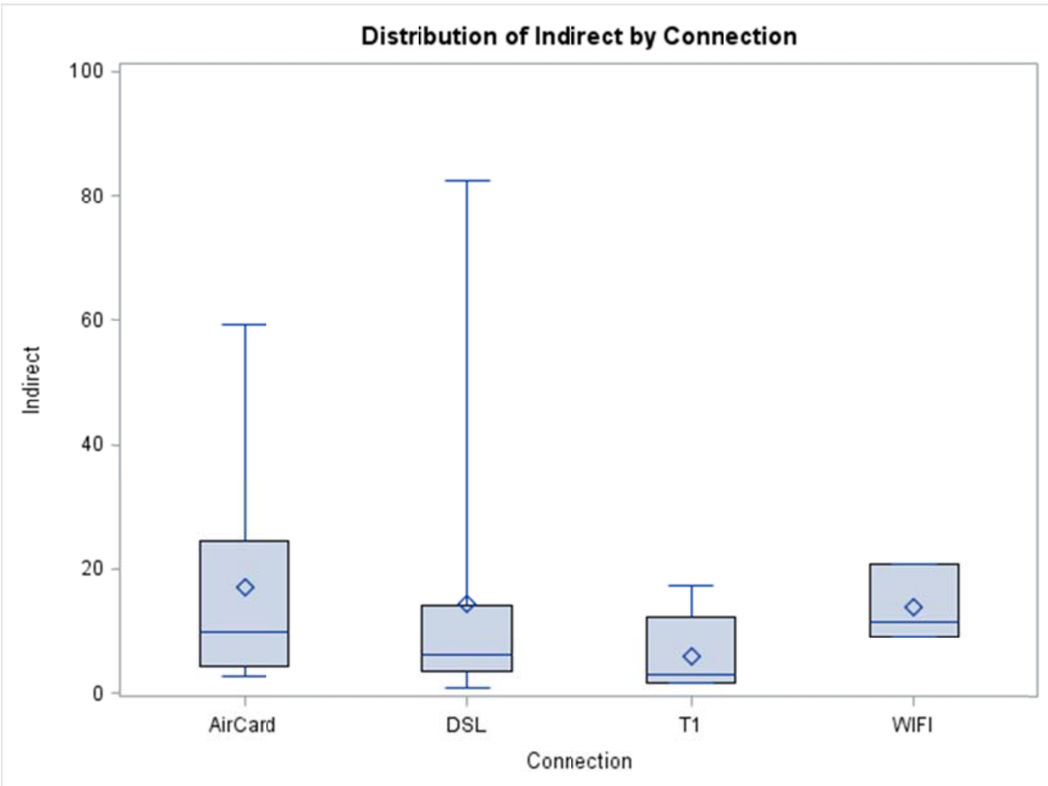


Figure 24: Spring 2014 Connection Type Scheduling Time Box Plot

Table 34: Spring 2014 Connection Type Scheduling Time ANOVA

Connection Scheduling Time	**p-value =**	**0.6027**		
Groups	***Count***	***Sum***	***Average***	***Standard Dev***
DSL	50	714.38	14.29	19.77
Aircard	17	290.80	17.11	18.25
T1	7	40.80	5.83	6.26
WIFI	3	41.47	13.82	6.15

Table 35: Spring 2014 Connection Type Scheduling Time Median One-Way Analysis

Median One-Way Analysis	
Chi-Square	**5.0565**
Pr> Chi-Square	**0.1677**

7 Project Outcomes

As discussed in the prior section, the data does not suggest a strong linear relationship between indirect and direct time. Basing the amount of time it takes to perform indirect line items on the length it takes to perform direct line items does not capture the wide amount of variability in the data. As such, the average indirect time based on the Spring 2014 Project data was roughly 48 minutes, more than twice as long as the average indirect time concluded by the Fall 2013 Project. However, the standard deviation of the Spring 2014 Project increased roughly by a magnitude of four, from 7 minutes to 30 minutes. It's evident that the line item can take much longer than the average amount of time. Based on the Spring 2014 Project, the average indirect line item time represents 128% of the average direct time of 37 minutes, compared to 61% from the Fall 2013 Project. The large difference in indirect average time and standard deviation indicates the new line items added in the Spring 2014 Project present a significant portion of the time study and introduces a large amount of variability to the study.

By focusing on the affect different parameters have on times, changes could be made to the methodology to better represent the time it takes to perform indirect and direct line items. Table 36 shows the outcome of each parameter tested and if it can or can't reject the null hypothesis that the means for each group are the same. When the null hypothesis is rejected, it indicates that the average time is different across that parameter and could present a change needed to the methodology.

Table 36: Summary of Parameters vs Time

Parameter	Indirect (ANOVA)	Direct (ANOVA)	Indirect (Median)	Direct (Median)
HACCP Size	Reject	Can't Reject	Reject	Can't Reject
Connection Type	Can't Reject	Can't Reject	Indeterminate	Can't Reject
Plant Size (sq foot)*	Reject	Can't Reject	Reject	Can't Reject
Facility Experience	Reject	Can't Reject	Reject	Can't Reject
Inspector Experience	Reject	Can't Reject	Reject	Can't Reject
District**	Can't Reject	Reject	Can't Reject	Can't Reject

Several parameters indicate that for indirect time the null hypothesis can be rejected which implies the means across the groups are not the same. However, the HACCP size parameter represents the best promise for being able to implement a change into the methodology due to its reliability and common use within PHIS. As discussed, plant size is another parameter that represents statistically significant differences in the means, but the data is not as reliable as HACCP in PHIS. The facility and inspector experience also indicates a difference across means, but again, obtaining this information is not very reliable and hard to capture across all the establishments and inspectors.

8 Recommendations

8.1 Updated Methodology

The lack of a relationship between indirect and direct time indicates that the methodology for determining how long it takes to perform the N60 sampling indirect time should be updated. One way to update the methodology would be to include flat indirect times instead of basing them off of direct time. The updated time would ideally capture the variability in performing the line items. From the parameters tested, the most promising lead is to differentiate the time based on the HACCP size. The average indirect time for very small establishments is 62 minutes, for small establishments 47 minutes and for large establishments 35 minutes. Using the indirect time averages based on HACCP size can help account for the difference that was seen in the very small and small establishments.

Another update to the methodology might be to determine the HACCP size breakout of an inspector's assignment, and if there are several very small or small plants, adjusting the variation in the amount of time it takes to perform the task. If an inspector visits more very small and small plants, then they have a higher probability of experiencing higher variation in the task time.

Finally, the data suggests that there is a difference in the average amount of time it takes to perform indirect tasks based on the experience of the inspector and at the facility. However, the data does not indicate any meaningful difference of direct time based on experience. While this parameter could be difficult to implement in a methodology, there could be a slight learning curve associated with the indirect tasks more than the direct tasks.

8.2 Scheduling Time

Part of the analysis was to determine any difference in scheduling time across HACCP size. It seemed that very small and small HACCP size establishments take longer to schedule on average and deal with rescheduling more frequently than large establishments. While some of the statistical analysis showed mixed results between ANOVA and Median One-Way tests, it would be beneficial to adjust the scheduling of tasks for very small and small establishments.

8.3 Product Unavailable

Several of the DCS were returned blank since the product was not being produced at the establishment during the time study window. And as discussed in Section 8.2., determining the product availability in the smaller establishments on average takes longer compared to larger establishments with more defined schedules. Therefore, the ability for the establishments to make their schedule known to the inspector (e.g., through PHIS) could increase the efficiency of scheduling and completing the assigned tasks.

8.4 Lab Availability

Lack of available lab capacity has also lead to DCS being returned blank. in some instances, available lab capacity has already been fully allocated by the time the inspector knows the establishment's product schedule and can schedule the sampling task. If there is no lab availability, then the N60 sample cannot be taken at that time. One solution might be to reserve lab slots for very small and small plants that see a lot of product rescheduling. That way those inspectors may have a chance to get last-minute lab availability if their establishment changes their product schedule.

9 Future Work

- Perform further analysis on Scheduling and Connection Type.
  - Determine if the scheduling tasks can be further decomposed.
  - Analyze the connection type based on what connection was available when scheduling as made as well as when PHIS documentation was completed.
- Analyze whether HACCP Size or Plant Size (by square foot) is better correlated with indirect time
  - Explore which measurement is a more efficient way to determine differences in the average amount of time it takes to perform indirect tasks.
- Explore other task time methodologies.
  - Explore if a fixed time for indirect time would better represent the actual times than a multiplier.
  - Would inclusions of certain parameters better represent the total task times
- Perform Time study with representative sample.
  - Use a representative sample of inspectors and facilities:
    - Select from a pool of volunteer CSIs, a sample that has the same portion of total number of years of experience and also the same amount of experience performing the specific task as the CSIs in the field.
    - Select a sample of facilities that is the same proportion of the facilities in the field based on HACCP size, District, and number of times the task has been completed.
  - Design study to include cases where the CSIs have scheduled the task but are unable to complete the task.
- Analyze PHIS for cases where tasks have not been completed and the reasons.

10 References

Applied Statistics and Probability for Engineers, Fifth Edition. Montgomery, Douglas C and George C Runger. Hoboken, NJ: Wiley, 2011.

Bang, Christopher, Amanda Kryway, Scott Motter, and Karen Tung. *MT60 Case Study - Final Report*. Rep. George Mason University, 13 Dec. 2013. Web.

Calculating Assignment Workloads in the Public Health Inspection System, TRAINING FOR LOCAL UNION, OFFICIALS, presented by USDA FSIS OFFICE OF FIELD OPERATIONS, AUGUST 5, 2013 - AUGUST 12, 2013 - AUGUST 19, 2013.

Fall 2013 MT60 Data Collection Spreadsheet. 13 Dec. 2013. Raw data. George Mason University, Fairfax, Virginia.

N=60 Sampling. Beef Industry Food Safety Council, 2008. CD-ROM.

Tan, Regina PhD, The Food Safety and Inspection Service Office of Field Operations Work Measurements Proposal to George Mason University, January 2014.

USDA Food Safety and Inspection Service. N.p., n.d. Web. 2014.
www.fsis.usda.govAppendices:

Appendix 1: Earned Value Management

The Earned Value Management Metrics for the project as a whole and the major groups of subtasks are shown below. Figure 25 shows the EVM Metrics for the project as a whole, the schedule variance (SV) is $0 and the cost variance (CV) is -$2,506.01. The SV of $0 indicates all tasks have been completed. Since the rate for labor is set at $50 per hour, the CV of -$2,506.01 indicates that the completion of tasks is approximately 50 hours longer than the baselined schedule. Figures 26 through 30 show the EVM Metrics for each major group of subtasks. Figure 29 shows that $1,506 of the additonal cost occurred during data analysis. Figure 30 shows that the remaining $1,000 of additional cost occurred in the creation of the final documentation.

GANTT CHART

	Task Name	Duratic	Start	Finish	% Work	Actual Work
1	**USDA FSIS Work Measurements**	**71.19 days**	**Mon 2/3/14**	**Fri 5/9/14**	**100%**	**539.08 hrs**
2	**GMU Deliverables**	**71.19 day**	**Mon 2/3/14**	**Fri 5/9/14**	**100%**	**79 hrs**
3	Preliminary Problem Definition	1.88 days	Mon 2/3/14	Tue 2/4/14	100%	15 hrs
4	Final Project Scope	1 day	Mon 2/3/14	Mon 2/3/14	100%	25 hrs
5	Project Proposal	3.75 days	Tue 2/11/14	Fri 2/14/14	100%	16 hrs
6	Project Progress Report 1	1.88 days	Tue 3/4/14	Wed 3/5/14	100%	10 hrs
7	Project Progress Report 2	1.88 days	Tue 3/25/14	Wed 3/26/1	100%	10 hrs
8	Final Report	0.19 days	Mon 5/5/14	Mon 5/5/14	100%	1 hr
9	Final Website	0.19 days	Mon 5/5/14	Mon 5/5/14	100%	1 hr
10	Final Presentation	0.19 days	Fri 5/9/14	Fri 5/9/14	100%	1 hr
11	**Sponsor Deliverables**	**61.2 days**	**Tue 2/4/14**	**Wed 4/30/1**	**100%**	**60 hrs**

	Task Name	Planned Value - PV (BCWS)	Actual Cost	Earned Value - EV (BCWP)	SV	CV	EAC	Baseline Cost
1	**USDA FSIS Work Measurements**	**$24,398.00**	**$26,954.01**	**$24,398.00**	**$0.00**	**($2,506.01)**	**$26,959.14**	**$24,448.00**

Figure 25: USDA FSIS Work Measurements - EVM Metrics

GANTT CHART

	Task Name	Duration	Start	Finish	% Work Complete	Work	Resource Names
1	**USDA FSIS Work Measurements**	**70 days**	**Mon 2/3/14**	**Fri 5/9/14**	**100%**	**694.4 hrs**	
2	**GMU Deliverables**	**69.19 day**	**Mon 2/3/14**	**Fri 5/9/14**	**100%**	**79 hrs**	
3	Preliminary Problem Definition	1.88 days	Mon 2/3/14	Tue 2/4/14	100%	15 hrs	Graduate Student
4	Final Project Scope	1 day	Mon 2/3/14	Mon 2/3/14	100%	25 hrs	Graduate Student
5	Project Proposal	3.75 days	Tue 2/11/14	Fri 2/14/14	100%	16 hrs	Graduate Student
6	Project Progress Report 1	1.88 days	Tue 3/4/14	Wed 3/5/14	100%	10 hrs	Graduate Student
7	Project Progress Report 2	1.88 days	Tue 3/25/14	Wed 3/26/14	100%	10 hrs	Graduate Student
8	Final Report	0.19 days	Mon 5/5/14	Mon 5/5/14	100%	1 hr	Graduate Student
9	Final Website	0.19 days	Mon 5/5/14	Mon 5/5/14	100%	1 hr	Graduate Student
10	Final Presentation	0.19 days	Fri 5/9/14	Fri 5/9/14	100%	1 hr	Graduate Student
11	**Sponsor Deliverables**	**69 days**	**Tue 2/4/14**	**Fri 5/9/14**	**100%**	**105 hrs**	
12	Final Project Scope	2.5 days	Tue 2/4/14	Thu 2/6/14	100%	8 hrs	Graduate Student
13	Sampling Framework / Data Collection	2.02 days	Thu 2/6/14	Fri 3/7/14	100%	14 hrs	Graduate

	Task Name	Planned Value - PV (BCWS)	Actual Cost	Earned Value - EV (BCWP)	SV	CV	EAC	Baseline Cost	VAC
2	**GMU Deliverables**	**$3,566.67**	**$3,950.00**	**$3,566.67**	**$0.00**	**$0.00**	**$3,950.00**	**$3,950.00**	**$0.00**

Figure 26: GMU Deliverables - EVM Metrics

GANTT CHART

	Task Name	Duration	Start	Finish	% Work	Actual Work
11	**Sponsor Deliverables**	**61.2 days**	**Tue 2/4/14**	**Wed 4/30/1**	**100%**	**60 hrs**
12	Final Project Scope	2.5 days	Tue 2/4/14	Thu 2/6/14	100%	8 hrs
13	Sampling Framework / Data Collection Plan	2.02 days	Thu 2/6/14	Fri 3/7/14	100%	14 hrs
14	Final Project Proposal	2 days	Tue 2/11/14	Wed 2/12/1	100%	16 hrs
15	Data Collection Sheet	2.5 days	Fri 2/14/14	Tue 2/18/14	100%	12 hrs
16	Data Collection Training / Instructions	5 days	Fri 2/21/14	Thu 2/27/14	100%	10 hrs
17	Final Report	0 days	Wed 4/30/1	Wed 4/30/1	100%	0 hrs
18	**Project Schedule and Activities**	**65.05 days**	**Mon 2/3/14**	**Sat 5/3/14**	**100%**	**322.08 hrs**
19	**Project Management**	**25 days**	**Mon 2/3/14**	**Fri 3/7/14**	**100%**	**118 hrs**
20	Introductory Meeting	1.25 days	Mon 2/3/14	Tue 2/4/14	100%	10 hrs
21	Develop/Finalize Problem Statement	6.5 days	Tue 2/4/14	Wed	100%	15 hrs

	Task Name	Planned Value - PV (BCWS)	Actual Cost	Earned Value - EV (BCWP)	SV	CV	EAC	Baseline Cos
11	**Sponsor Deliverabl**	**$3,000.00**	**$3,000.00**	**$3,000.00**	**$0.00**	**$0.00**	**$3,000.00**	**$3,000.00**

Figure 27: Sponsor Deliverables - EVM Metrics

GANTT CHART

	Task Name	Duratic	Start	Finish	% Work	Actual Work
31	**Data Collection**	**26.33 day**	**Tue 2/4/14**	**Wed 3/12/1**	**100%**	**99 hrs**
32	**N60 Data Collection**	**26.33 day**	**Tue 2/4/14**	**Wed 3/12/1**	**100%**	**99 hrs**
33	Develop Sampling Framework	12 days	Tue 2/4/14	Fri 2/21/14	100%	18 hrs
34	Develop Data Collection Sheet	8.96 days	Thu 2/13/14	Wed 2/26/14	100%	20 hrs
35	Develop Data Collection Training / Instructions	7.58 days	Wed 2/26/14	Fri 3/7/14	100%	26 hrs
36	FSIS Finalize Participating Plants	2.8 days	Thu 2/13/14	Mon 3/10/14	100%	15 hrs
37	FSIS Data Collection and Delivery	3.73 days	Tue 2/18/14	Wed 3/12/14	100%	20 hrs
38	**Data Analysis**	**39.05 days**	**Tue 3/11/14**	**Sat 5/3/14**	**100%**	**105.08 hrs**

	Task Name	Planned Value - PV (BCWS)	Actual Cost	Earned Value - EV (BCWP)	SV	CV	EAC	Baseline Cost
31	**Data Collection**	**$4,950.02**	**$4,950.02**	**$4,950.02**	**$0.00**	**$0.00**	**$4,950.02**	**$4,950.02**

Figure 28: Data Collection - EVM Metrics

GANTT CHART

	Task Name	Duratic	Start	Finish	% Work	Actual Work
38	**Data Analysis**	**39.05 days**	**Tue 3/11/14**	**Sat 5/3/14**	**100%**	**105.08 hrs**
39	**N60 Data Analysis**	**39.05 days**	**Tue 3/11/14**	**Sat 5/3/14**	**100%**	**105.08 hrs**
40	Visit Slaughterhouse / Plant	1.19 days	Fri 3/14/14	Mon 3/17/14	100%	11 hrs
41	Analysis Preparation for Live Data	3 days	Tue 3/11/14	Thu 3/13/14	100%	16.08 hrs
42	Compile Datasheets	8.4 days	Fri 4/4/14	Wed 4/23/14	100%	45 hrs
43	Statistical Analysis - Multiplier Validity	4.1 days	Thu 4/24/14	Wed 4/30/14	100%	22 hrs
44	Document Analysis Process for USDA Reproduction	2.05 days	Thu 5/1/14	Sat 5/3/14	100%	11 hrs

	Task Name	Planned Value - PV (BCWS)	Actual Cost	Earned Value - EV (BCWP)	SV	CV	EAC	Baseline Cost
38	**Data Analysis**	**$3,747.99**	**$5,254.00**	**$3,747.99**	**$0.00**	**($1,506.01)**	**$5,254.00**	**$3,747.99**

Figure 29: Data Analysis - EVM Metrics

GANTT CHART

	Task Name	Duration	Start	Finish	Work	Actual Work
45	**Final Documentation**	**28 days**	**Mon 3/31/14**	**Mon 5/5/14**	**100%**	**78 hrs**
46	Develop Website	3.73 days	Mon 4/21/14	Fri 5/2/14	100%	20 hrs
47	Deliver Final Website	0.37 days	Sun 5/4/14	Mon 5/5/14	100%	2 hrs
48	Develop Final Presentation	3.73 days	Mon 3/31/14	Fri 4/4/14	100%	20 hrs
49	Dry Run of Final Presentation	0.38 days	Tue 4/22/14	Tue 4/22/14	100%	3 hrs
50	Deliver Final Presentation	0.19 days	Mon 5/5/14	Mon 5/5/14	100%	1 hr
51	Finalize Report	5.6 days	Wed 4/30/14	Mon 5/5/14	100%	30 hrs

	Task Name	Planned Value - PV (BCWS)	Actual Cost	Earned Value - EV (BCWP)	SV	CV	EAC	Baseline Cost
45	**Final Documentatic**	**$2,900.00**	**$3,900.00**	**$2,900.00**	**$0.00**	**($1,000.00)**	**$3,900.00**	**$2,900.00**

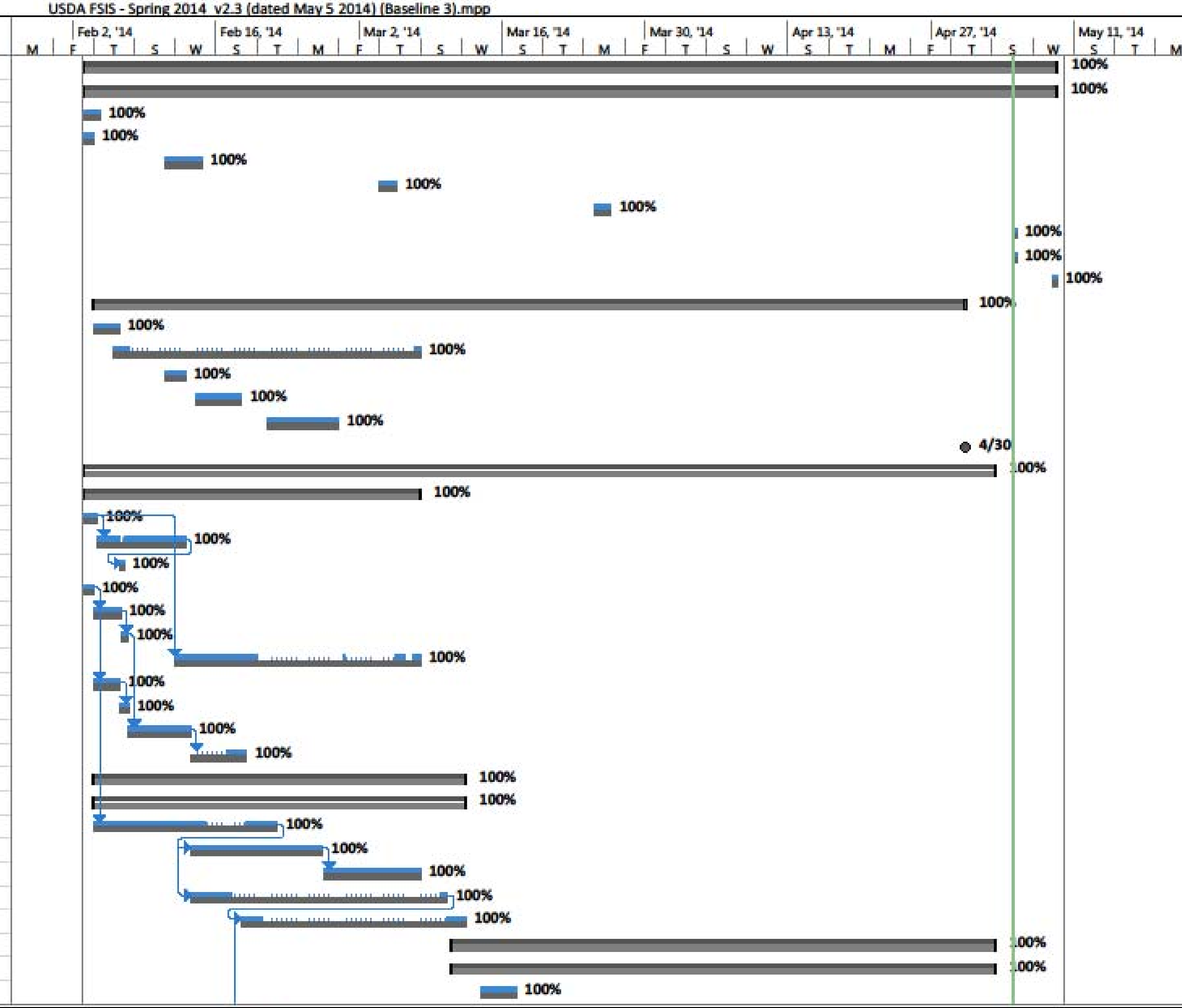
Figure 30: Final Documentation

Appendix 2 Project Schedule

(Please see following pages)

USDA FSIS - Spring 2014 v2.3 (dated May 5 2014) (Baseline 3).mpp

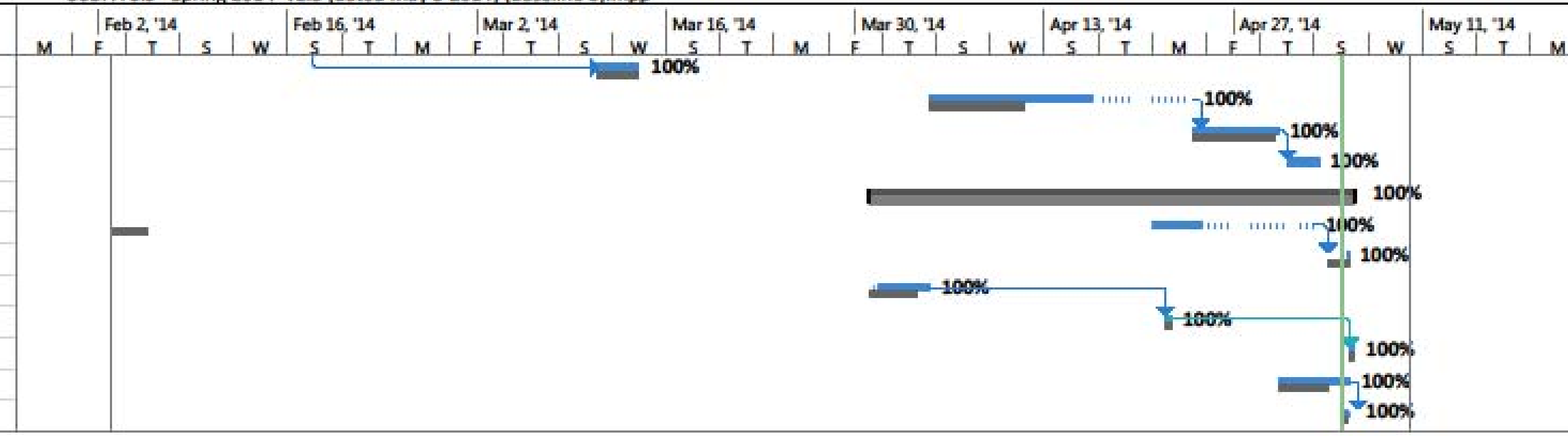
ID	Task Name	Duration	Start	Finish	% Work Complet	Actual Work
1	**USDA FSIS Work Measureme**	**71.19 d**	**Mon 2/3/**	**Fri 5/9/14**	**100%**	**539.08 hrs**
2	**GMU Deliverables**	**71.19 d**	**Mon 2/3/**	**Fri 5/9/14**	**100%**	**79 hrs**
3	Preliminary Problem Def	1.88 da	Mon 2/3/	Tue 2/4/1	100%	15 hrs
4	Final Project Scope	1 day	Mon 2/3/	Mon 2/3/	100%	25 hrs
5	Project Proposal	3.75 da	Tue 2/11/	Fri 2/14/1	100%	16 hrs
6	Project Progress Report 1	1.88 da	Tue 3/4/1	Wed 3/5/	100%	10 hrs
7	Project Progress Report 2	1.88 da	Tue 3/25/	Wed 3/26	100%	10 hrs
8	Final Report	0.19 da	Mon 5/5/	Mon 5/5/	100%	1 hr
9	Final Website	0.19 da	Mon 5/5/	Mon 5/5/	100%	1 hr
10	Final Presentation	0.19 da	Fri 5/9/14	Fri 5/9/14	100%	1 hr
11	**Sponsor Deliverables**	**61.2 da**	**Tue 2/4/1**	**Wed 4/30**	**100%**	**60 hrs**
12	Final Project Scope	2.5 days	Tue 2/4/1	Thu 2/6/1	100%	8 hrs
13	Sampling Framework / D	2.02 da	Thu 2/6/1	Fri 3/7/14	100%	14 hrs
14	Final Project Proposal	2 days	Tue 2/11/	Wed 2/12	100%	16 hrs
15	Data Collection Sheet	2.5 days	Fri 2/14/1	Tue 2/18/	100%	12 hrs
16	Data Collection Training ,	5 days	Fri 2/21/1	Thu 2/27/	100%	10 hrs
17	Final Report	0 days	Wed 4/30	Wed 4/30	100%	0 hrs
18	**Project Schedule and Activ**	**65.05 d**	**Mon 2/3/**	**Sat 5/3/1**	**100%**	**322.08 hrs**
19	**Project Management**	**25 days**	**Mon 2/3/**	**Fri 3/7/14**	**100%**	**118 hrs**
20	Introductory Meeting	1.25 da	Mon 2/3/	Tue 2/4/1	100%	10 hrs
21	Develop/Finalize Prob	6.5 days	Tue 2/4/1	Wed 2/12	100%	15 hrs
22	Present Problem State	0.25 da	Thu 2/6/1	Thu 2/6/1	100%	2 hrs
23	Project Scope Discussi	1 day	Mon 2/3/	Mon 2/3/	100%	8 hrs
24	Develop/Finalize Proj	2.8 days	Tue 2/4/1	Thu 2/6/1	100%	15 hrs
25	Present Project Scope	0.37 da	Thu 2/6/1	Fri 2/7/14	100%	2 hrs
26	Analyze Fall '13 Data	8.05 da	Wed 2/12	Fri 3/7/14	100%	15 hrs
27	Develop POA&M	2.61 da	Tue 2/4/1	Thu 2/6/1	100%	14 hrs
28	Baseline POA&M	0.75 da	Thu 2/6/1	Fri 2/7/14	100%	4 hrs
29	Develop/Finalize Proje	4.29 da	Fri 2/7/14	Thu 2/13/	100%	23 hrs
30	Present Project Propo	2 days	Thu 2/13/	Tue 2/18/	100%	10 hrs
31	**Data Collection**	**26.33 d**	**Tue 2/4/1**	**Wed 3/12**	**100%**	**99 hrs**
32	**N60 Data Collection**	**26.33 d**	**Tue 2/4/1**	**Wed 3/12**	**100%**	**99 hrs**
33	Develop Sampling F	12 days	Tue 2/4/1	Fri 2/21/1	100%	18 hrs
34	Develop Data Collec	8.96 da	Thu 2/13/	Wed 2/26	100%	20 hrs
35	Develop Data Collec	7.58 da	Wed 2/26	Fri 3/7/14	100%	26 hrs
36	FSIS Finalize Particip	2.8 days	Thu 2/13/	Mon 3/10	100%	15 hrs
37	FSIS Data Collection	3.73 da	Tue 2/18/	Wed 3/12	100%	20 hrs
38	**Data Analysis**	**39.05 d**	**Tue 3/11/**	**Sat 5/3/1**	**100%**	**105.08 hrs**
39	**N60 Data Analysis**	**39.05 d**	**Tue 3/11/**	**Sat 5/3/1**	**100%**	**105.08 hrs**
40	Visit Slaughterhouse	1.19 da	Fri 3/14/1	Mon 3/17	100%	11 hrs



Critical	Split	Finish-only	Baseline Milestone	Manual Summary	Inactive Task
Critical Split	Task Progress	Duration-only	Milestone	Project Summary	Inactive Milestone
Critical Progress	Manual Task	Baseline	Summary Progress	External Tasks	Inactive Summary
Task	Start-only	Baseline Split	Summary	External Milestone	Deadline

USDA FSIS - Spring 2014 v2.3 (dated May 5 2014) (Baseline 3).mpp

ID	Task Name	Duration	Start	Finish	% Work Complete	Actual Work
41	Analysis Preparatio	3 days	Tue 3/11/	Thu 3/13/	100%	16.08 hrs
42	Compile Datasheets	8.4 days	Fri 4/4/14	Wed 4/23	100%	45 hrs
43	Statistical Analysis -	4.1 days	Thu 4/24/	Wed 4/30	100%	22 hrs
44	Document Analysis	2.05 da	Thu 5/1/1	Sat 5/3/14	100%	11 hrs
45	**Final Documentation**	**28 days**	**Mon 3/31**	**Mon 5/5/**	**100%**	**78 hrs**
46	Develop Website	3.73 da	Mon 4/21	Fri 5/2/14	100%	20 hrs
47	Deliver Final Website	0.37 da	Sun 5/4/1	Mon 5/5/	100%	2 hrs
48	Develop Final Presentati	3.73 da	Mon 3/31	Fri 4/4/14	100%	20 hrs
49	Dry Run of Final Presenta	0.38 da	Tue 4/22/	Tue 4/22/	100%	3 hrs
50	Deliver Final Presentatio	0.19 da	Mon 5/5/	Mon 5/5/	100%	1 hr
51	Finalize Report	5.6 days	Wed 4/30	Mon 5/5/	100%	30 hrs
52	Deliver Final Report	0.37 da	Mon 5/5/	Mon 5/5/	100%	2 hrs



Critical	Split	Finish-only	Baseline Milestone	Manual Summary	Inactive Task
Critical Split	Task Progress	Duration-only	Milestone	Project Summary	Inactive Milestone
Critical Progress	Manual Task	Baseline	Summary Progress	External Tasks	Inactive Summary
Task	Start-only	Baseline Split	Summary	External Milestone	Deadline