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Maquiladoras in Central America: An Analysis of Workforce Schedule, Productivity and Fatigue.

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MAQUILADORAS IN CENTRAL AMERICA: AN ANALYSIS OF WORKFORCE
SCHEDULE, PRODUCTIVITY AND FATIGUE

A Thesis
Presented to
The School of Engineering and Applied Sciences
Western Kentucky University
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In Partial Fulfillment
Of the Requirements for the Degree
Master of Science

By
Jose Barahona

August 2019

MAQUILADORAS IN CENTRAL AMERICA: AN ANALYSIS OF WORKFORCE
SCHEDULE, PRODUCTIVITY AND FATIGUE

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Textile factories or Maquiladoras are very abundant and predominant in Central American economies. However, they all do not have the same standardized work schedule or routines. Most of the Maquiladoras only follow schedules and regulations established by the current labor laws without taking into consideration many variables within their organization that could affect their overall performance. As a result, the purpose of the study is to analyze the current working structure of a textile Maquiladora and determine the most suitable schedule that will abide with the current working structure but also increase production levels, employee morale and decrease employee fatigue.

A Maquiladora located in el Salvador, C.A. has been chosen for the study. It currently provides finished goods to one of the leading textile industries in the United States of America. The study will consist of collecting production numbers for two of their manufacturing cells for five consecutive days. In addition, a questionnaire will be administered to measure employee fatigue. Once all data have been collected, the data will be analyzed to determine the best working structure that will benefit the employee and the employer.

Introduction

Background/ Overview

A Maquila or Maquiladora is a “production system based on a contract form under which, the intermediate inputs and raw materials imported are transformed through processes that add value. Afterwards, the added-value products are outbound and sent back as finished products to the country of origin for marketing.” (Vargas-Hernández & Núñez-López, 2011). The first Maquiladoras established in Latin America were in Mexico during the mid-1960’s. However, they did not reach a high growth of exports until the 1990’s when international treaties such as NAFTA (North American Trade Agreement) emerged. According to Valadez and Cota (1996), Maquiladoras in Mexico during the 1960’s represented only 11.7% of the manufacturing industry. By 1996 (2 years after NAFTA was established) the Maquilas represented 73.1% of the manufacturing industry (p. 1).

Once the Maquiladora industry was saturated in Mexico, the movement started to spread throughout Central America. Like Mexico, Maquiladoras in Central America started to increase dramatically in a short period of time. By 1996, about 25-30 percent of the workforce in Central America was employed in the Maquiladora industry and around 45 to 60% of these were owned by private investors. (Vargas-Hernández & Núñez-López, 2011). This sudden increase in Mexico and Central America was mainly due to Korean industries moving their facilities to these countries. Korea started introducing many new rules and

regulations imposed by the state that forced them to search for new sites of production; Central America was one of them.

Although the sudden influx of Maquiladoras was very beneficial for the Latin American economy, it also brought other problems. The new style of management was not very popular with its employees. They would often complain that there was a lack of communication with management and that they were constantly being mistreated and overworked (Goldín, 2011, p. 146). Additionally, they would all have different management styles, there were no standardized practices across the industry and none had proved to know the correct and most efficient way to operate.

Statement of the Research Problem

Not a lot has changed since Maquiladoras first opened in Central America. They still face the same issues they had when they first started. Although these Maquiladoras have problems of their own, the factor that is shared amongst all is *high turnover*. According to Goldín (2011), the “industrial labor turnover across sectors in Latin America fluctuates between 20 and 35 percent per year (p. 139). High turnover can result in lower levels of productivity, higher levels of defects due to inexperienced employees, increased hours spent in recruiting and training new employees and subsequently a reduction of economic profitability.

The problem presents 2 questions: why are employees quitting their jobs and what do they need to do to improve it? The literature suggests that many employees leave their jobs due to harsh working conditions, Maquilas not following the labor laws established by their countries and because of high levels

of fatigue. The Labor code of El Salvador, which is very similar to the rest of the Central American countries, states that daytime working hours shall not exceed eight hours per *day* and the daytime working *week* shall not exceed forty-four hours. (Ministerio de Trabajo y Previsión Social, 2010). However, not all Maquiladoras follow these standards. Some are allowed to have 10 or 12 hour shifts as long as they do not exceed the forty-four hours a week regulation. Others, for example, completely disregard the regulations and require employees to “not leave the plant until the job is complete. This may take two or three days (up to thirty-six hours without sleep)” (Goldín, 2011).

Need or Significance

Even though Maquiladoras have had many criticisms about harsh working conditions and overworking their employees, they continue to be one of the main pillars of the Central American economy. Maquiladoras provide thousands of jobs to the community and would cause a large economic impact if they were to lose this sector of the industry. They need to continue striving for better results to keep being one of the leading sectors for economic growth.

Few studies have been conducted about Maquiladoras in Central America. The few that have studied this sector have not addressed all their issues. They have either focused on a certain sector of the industry (e.g., working conditions) or they would only analyze data from either the employer or the employee; hardly ever both combined. (de la Vega Bustillos & Orrantia, 2004, p. 65). The employer and the employee need to be on the same page if they plan to run a successful operation. The employer wants to have high levels of

productivity and thus generate more revenue. On the other hand, employees want to have job security, fair wages, and work in a place that follows current labor laws and are not overworked.

The first step to solve this problem is to analyze the current work structure, determine the most suitable route that will abide with the current labor laws and maximize their overall performance. An in-depth analysis of the current work structure that includes both sides of the spectrum (employer and employee) in Central America may uncover many issues other studies have not detected. The study can also help identify the most efficient work schedule for their employees and as a result, increase employee satisfaction.

Purpose of the Study

The purpose of the study is to analyze and determine the most suitable work schedule for employees in the Maquiladora sector. It does not have a standardized employee work schedule. Each organization has determined what they think is the correct schedule for their company and their employees. However, research has shown that the main problem Maquiladoras face is the way in which their work schedule has been structured. This is partially due to inexperienced investors or using management styles that are not congruent to the needs of employees in Central America. Maquiladoras that moved their facilities from Asia to Central America are still using the same management style that they did back in their country of origin. What may have worked there is not consistent with the countries labor laws and employees are not used to current working conditions.

A thorough analysis of the employee work schedule and employee opinions about their current job may provide many details missed from previous studies. The data collected from the study will serve to restructure their current work structure and potentially standardize it throughout Maquiladoras in Central America.

Research Questions or Hypothesis

Research has suggested that the reasons for high turnover include: harsh working conditions, long working hours, low employee satisfaction, and high levels of fatigue. These problems can be corrected by improving the current employee work structure. Analyzing the employee work structure will help explain many of the reasons why employees are not satisfied and what is needed to fix the problem.

The data for this research will be collected by both the employer and the employee of a Maquiladora. The productivity and efficiency of the Maquiladoras will be determined through hourly measurements provided by the employer. This will help determine which are the most productive hours of the day and which are not. Moreover, it will help the employer understand the root cause of the problem and develop counter measures that will increase productivity and employee satisfaction.

On the employees' side, a questionnaire will be administered to help determine the level of fatigue employees feel throughout the day. The levels of fatigue will be measured by asking employees how fatigued they feel on a scale of 1-10.

Once all measurements have been conducted, an analysis will be examined to determine the best and most suitable employee work structure that will suit the employee and the employer. Finding a common ground between both sides of the field will generate greater productivity for the Maquiladora while still maintaining high levels of employee satisfaction.

Assumptions, Limitations, and Delimitations

Assumptions. There are many assumptions that must be made for the research to be conducted. First, the Maquiladora being analyzed for this study is assumed to provide correct and unbiased information. To ensure accuracy, the Maquiladora has agreed to use an intern who has not been a supervisor or employed in the actual manufacturing process of the plant. This will provide an unbiased eye when recording the data. Additionally, the Maquiladora is committed to provide the most accurate information, as they plan to use this information for their own company development. Second, the research will assume that employees will answer truthfully to all the questions. The Maquiladora will explain to its employees that anonymity and confidentiality will be preserved. No employee will be affected by their responses and honesty will be reinforced throughout the study. Lastly, the study will assume the sample is representative to the population. To ensure that this is the case, two groups will be analyzed simultaneously doing the same activities. One group of relatively young employees with little to no experience in working in a Maquiladora. The other group of employees will have more experience and be older in age.

Limitations. There are several limitations present in the current research. The first limitation is time itself. The Maquiladora being analyzed has only agreed to collect data throughout one regular working week. Furthermore, the time of the year can also play a role on the data collected. Different months can cause more stress on employees and as a result, affect the Maquiladora's production numbers.

Delimitations. The study will be based on hourly production measurements and female employee opinion in a textile Maquiladora in El Salvador. The textile industry in El Salvador is a representative to the population as it has shown that the majority of the Maquiladoras are in the textile industry and female workers are the predominant gender in this area. (Quintana, Deras Robles, & Torres, n.d.).

Review of Literature

The purpose of the article "Measuring Productivity" is to analyze United Kingdom's manufacturing facilities and determine issues that they face when trying to improve productivity. It used historic data from articles and metrics from the last 25 years (1985-2009) and online surveys to determine their results. During the article's analysis of historic data, it is stated that the major factor affecting productivity is skill and education. However, during the survey analysis, it was stated that the root cause differed depending on the size of manufacturing facility and its employees. For example, it states that the primary root cause in productivity for micro companies is managerial skills. And for larger companies, it is competition. Although, the article provides a broad perspective on productivity

and manufacturing, it provides a correlation between employees and their influence in affecting productivity rather than linking it to equipment and technology. The article likely would have been more useful if it measured employee statistics such as: age, education level, gender, and employee fatigue to narrow down the factors affecting employees and productivity. Also, dividing the industries into subcategories (textile, automotive, electronics, etc.) would have been more conclusive and could give different results given their sectors. (Mclaughlin, 2014)

The article “Uniform Maker Sews Up for Success with Scorecard” is an article about a Maquiladora in Mexico that was suffering production issues and how the CEO managed to turn around the situation and get closer to their established goals. The CEO explained that they used the balanced scorecard (BSC) to determine and deploy corrective measures. They first started by asking middle and top management employees to come up with critical factors that were affecting their production. Once the critical factors were created, the company developed a 5-category action plan: flawed fabric, improper cutting, damaged or lost parts, efficiency reports and quality points. Given the 5-action plan, the articles provided a general idea of where problems were occurring in a Maquiladora and how the newly created counter measures are helping increase productivity. What is interesting about the article is that it focused on creating counter measures for these reoccurring mistakes, but never really investigated why these problems were occurring in the first place. For example, the article explains that to prevent employees from improper cutting, they were being held

accountable for their actions by signing a cutting report based on production orders. Although this was a quick fix at the beginning, the important question should have been “Why is the employee making this careless mistake?” Another example is that the study stated that they increased the employees working hour up to the maximum allowed Mexican Law. However, they never increased their wages. While this strategy could have increased their productivity temporarily, there was no measurement to substantiate that this strategy will be effective in a longer period. The study provides the basic ideas of which areas to focus on a Maquiladora in Latin America, but also lacks additional strategies to counteract employee fatigue, morale, turnover and absenteeism. (Gordon, 2006)

The article “Impact of Central American Maquiladoras in Economic Growth and Employment” analyzes the positive and negative effects Maquiladoras have caused in Central America. It starts by describing Maquiladoras as a female operated industry (87% of working women) and how it provided millions of jobs to the Central American population. However, these jobs are considered to be low in wages, have lack of respect for labor laws, poor working conditions, and high turnover rate due to textile recessions. Maquiladoras created in developing countries can get away with breaking many labor laws, given their poverty rate, in exchange for providing jobs to a very large group of unemployed women in the area. Given the lack of enforcement of labor laws, Maquiladoras have abandoned the emphasis on the workforce and have focused solely on the industry itself. The article provides an understanding on how Maquiladoras are

created, operated and the impact on employee and country's economic growth. (Vargas-Hernández & Núñez-López, 2011)

The article "Exploitation or Choice? Exploring the Relative Attractiveness of Employment in the Maquiladoras" explores how the current perception of labor in Maquiladoras differs when seen from the employee's perception. The article begins by providing a brief history on how Maquiladoras are often accused of exploiting its workers by not providing equal compensation and long hours of work without abiding to the current labor laws. However, when the authors conducted an interview by using 59 production level Maquiladora workers, the results were quite the opposite. Even though Maquiladoras offered a lower wage, its employees preferred working in this type of industry due to the availability of entry level jobs and better working conditions when compared to construction, agriculture, or similar outdoor jobs. The article provides an interesting approach by interviewing their current employees rather than analyzing the actual working conditions, adherence to labor laws, wages, benefits, etc. Although the findings were different than the general view of Maquiladoras, the validity of the research could be inconclusive as most of these employees may not have the knowledge of the current labor laws and what labor exploitation really means. Additionally, most employees, have either: not worked at another place, have only worked in outdoor jobs, or the job availability in combination with the necessity to work due to poverty have given them no choice but to accept the current working conditions. (Sargent & Matthews, 1999)

The article “New Ways of Organizing for Women Workers in the Maquilas” discusses the negative effects of labor in Maquiladoras due to the emergence of the NAFTA agreement between the U.S.A. and Mexico. It further explains that the NAFTA agreement is composed of U.S. companies seeking to invest in developing countries to increase productivity, but also decrease their operating costs. Although the NAFTA agreement has provided many jobs in Mexico, it has seen a steady decline in worker compensation, working environments, labor law adherence, domestic textile industry, health and safety, and many other associated attributes. Thus, women (composed of 70% of the Maquiladora industry) have begun to organize into union groups to defend their rights and eliminate the current exploitation in the work force. They have had continued struggles including corrupt “phantom” unions, Maquiladora moving to a different country, and lack of government enforcement in labor laws. The article suggests that Maquiladoras are created with lower standards than U.S. based companies and that if they see resistance from the employees, they will move onto another country that will accept their current operating standards. (Valadez & Cota, 1996)

The article “The effects of a medical hypnotherapy (MH) on clothing industry employees suffering from chronic pain” analyses the advantages of using hypnotherapy on work related disorders; such as chronic pain. The research consisted in administering a before and after questionnaire to 350 employees (300 sewers and 50 cutters) from a clothing store to determine the efficacy of the treatment. The research concluded that MH does in fact relieve many work-related pains from its employees. Even though the article primarily focuses on

the efficacy of MH and disorders, it also illustrates interesting conditions that most employees suffer from working under the Maquiladora industry. For example, employees reported that the job demand was physically exhausting, extensive work, high work speed and too many job tasks at once. These characteristics help us understand that the Maquiladora industry is not well organized in terms of number of hours worked, breaks, and intensity of work. Additionally, it promotes further investigation of the labor force to determine the root cause of the problem rather than trying to treat an already developed disorder. (Roja, Kalkis, Roja, & Kalkis, 2013)

The article “La rotación de trabajadores en las Maquiladoras, con especial atención en la experiencia de Tijuana” examines the possible reasons for high employee turnover in the Maquiladora industry in various cities of México. Their conclusion suggests that most of the turnover could be reduced by actions taken by the company. First, by improving the current labor conditions. And second, by refining their recruitment process. The first conclusions provide insight on how current working conditions are not suitable for the employees, and these employees are constantly moving from one Maquiladora to the other expecting better results. Unfortunately, the working conditions tend to be the same throughout all Maquiladoras and employees end up looking for employment in a different industry. The authors divided the Maquiladoras into 3 different sectors: electronics, automotive, and textile or clothing. Interestingly, the textile Maquiladoras were the ones that had the highest percentages of employee turnover. The article supports the idea that Maquiladoras in Latin America are

currently not evaluating or concerned in improving the working conditions for their employees. Thus, experienced employees will leave seeking employment elsewhere creating a major effect on quality and productivity for the Maquiladora industry. It would have been helpful if the article described the working conditions and how each one was affecting which factors. (Verduzco, 1998)

“Efectos Cuantitativos del turno de trabajo de 12 horas” is an article that focuses on analyzing the effects of productivity, quality and fatigue during a 12-hour day instead of the regular 8-hour days. The 12-hour shifts consist in working 4 days a week (Monday – Thursday) and 3 days off (Friday – Sunday). Although 12-hour days are not very prevalent in the Maquiladora industry, they are increasing in popularity and can become the norm soon. Additionally, the study suggests that the measurements of fatigue, quality and productivity regardless on the number of hours worked, can help determine what type of fatigue (general body fatigue, muscular fatigue, or mental fatigue) is most affected and provide some insight on how to counteract these conditions. The article took measurements 3 times a day for a total of 5 minutes every time. During these 5 minutes, the company would count the number of pieces produced and rejected for productivity and quality respectively. It first concluded that fatigue and productivity were not affected by the different days of the week being worked; they were all determined to have the same statistical measurements. Second, it concluded that fatigue and productivity decreased as the amount of worked hours increased. Third, quality was not affected throughout all measurements as the Maquiladora had very strict error proofing techniques and the tasks were

simple, easy to learn and did not require too much mental attention. Finally, it concluded that the major symptoms for fatigue were: sleepiness due to monotony of task, physical fatigue and mental fatigue. The article provides a better understanding on which types of fatigue are more prevalent in the Maquiladora industry and how fatigue plays a major role in the productivity of employees. The research could have been more conclusive if the measurements were taken every hour instead of 3 times a day to be able to determine which are the worst and best hours of productions. By analyzing the entire employee work schedule, the study could provide additional information that was not obtained by only having 3 measurements a day. (de la Vega Bustillos & Orrantia, 2004).

The article “Maquiladoras y Condiciones Laborales. Entre la precariedad y el trabajo digno. El caso de México.” reviews the history of Maquiladoras in Mexico and later in Central America and how the working conditions have been throughout the years. It analyzes two Mexican Maquiladoras located at the border with the United States. One has been manufacturing for many years and the other is relatively new to the industry. Their research indicates that the working conditions of both Maquiladoras are the same regardless of how many years they have been operating. However, the Maquiladora with much more experience showed to have better qualifications regarding employee satisfaction and overall productivity. The working conditions were measured by analyzing the adherence to governmental laws and those created by the union. The article also explains that adherence to the governmental laws is not enough to provide a decent working condition for their employees. Thus, creating a high rate of

turnover. The union, on the other hand, may provide better working conditions and high employee pay but it is not currently working at its full potential. Even though the article talks about employee turnover and their working conditions, this is also a factor that affects productivity. Poor working conditions creates extra work for employees and time spent retraining employees and their quality standards decreased due to inexperienced workers. The article suggests that Maquiladoras are currently not concerned enough about the employee needs and are only doing what is mandated by the government and unions. (Quintero Ramírez, n.d.)

The article “Investigación sobre la determinación de fatiga en trabajadoras de la industria textil del norte de Sinaloa” evaluates the level of employee fatigue in a textile Maquiladora in Mexico. The Maquiladora’s schedule consists of 10 working hours a week for five consecutive days (Monday through Friday). This method is a compressed week since a regular week in Mexico is composed of 6 days for 8 hours a day. The method used to determine fatigue was by using two types of instruments: The Yoshitake Questionnaire and the Corlett and Bishop Map”. The results were that employees started feeling fatigue during the fourth day of work and the fifth day (Friday) being the day with extreme fatigue.

Although the study determines that the fifth day of work is the one with most extreme fatigue, the study gives only one recommendation; try to eliminate the fifth day of work. This may solve the problem but there is not enough information to determine how to structure the work week. It also does not evaluate the type of activities that are causing the most fatigue. In addition, the method used in this

study centralizes on measuring fatigue for each day of the week rather than measuring the level of fatigue throughout different times of the day. While the article lacks many variables to consider in the study, it does provide a basis to conduct a study in terms of design, instruments and analysis. (Meza Ruiz & Ramírez Leyva, n.d.)

Like the previous article (“Investigación sobre la determinación de fatiga en trabajadoras de la industria textil del norte de Sinaloa”), the article “Trabajo, Fatiga, calidad y Productividad” also analyzes employee fatigue using the same type of instruments (The Yoshitake Questionnaire and the Corlett and Bishop Map) during a compressed week (higher labor hours per day with less day to work a week). One of the few differences is that employees worked 12 hour shifts for 4 consecutive days instead of 10 hours for 5 days. The other difference that employee’s performance and fatigue was measured multiple times through the day. Although the level of measurement in this study is more detailed, the actual instruments used to measure are based solely on the employee’s opinion. They are based on questions on how employees feel through the day. Although this is a good qualitative measurement, it would have been good to also use this measurement and compared it with a quantitative measurement such as productivity and quality numbers. The study does provide a good design as an example to follow for the qualitative section. However, it does not provide any possible reasons on how to counteract these measures and which specific factors are the ones causing the most employee fatigue. (Orrantia & De la Vega Bustillos, n.d.)

“Offshore employment practices: An empirical analysis of routines, wages and labour turnover” is an article that analyzes the turnover rates depending on what type of Maquiladora the employee is working. The article explains that there are three types of Maquiladoras: first, second, and third generation. The first being a Maquiladora that employs unskilled labor, the second with some type of experience and the third being the one who employs skilled laborers. The results suggest that the Maquiladora with higher wages (third generation) have the lower turnover rates. Although there is a direct correlation between turnover and low wages, it does not measure their employee morale. Employees could stay longer at the third-generation Maquiladora but it does not provide enough information to determine if they are satisfied with their work or working conditions. Additionally, it does not measure productivity or efficiency of the company; it is solely analyzed through turnover. The data for the article was obtained through the plant manager and/ or the Human Resource managers. There was no interaction with employees to determine their level of satisfaction. Nevertheless, it showed the interesting fact in which first and second-generation Maquiladora had about the same percentage of turnover. If wage compensation was the major factor for turnover, why would first and second-generation Maquiladoras have different statistics? Additional research could have been conducted to determine these variables. These could have included: employee satisfaction, comparison on how intense the labor varied from different generation Maquiladoras, and how effective was management at resolving issues. The statistical data for turnover in this study is very important but begs for more research to be done to determine

the reasons other than simply correlating it to wage compensation. (Loess, Miller, & Yoskowitz, 2008)

The article “Labor turnover among Maquiladora workers of Highland Guatemala: Resistance and semi proletarianization in global capitalism” is a study carried out in Guatemala for period of 3 years (2006-2009). The study’s focus was to determine the rate of turnover in the Maquila industry. The study used both: a quantitative method and a qualitative method to measure their results. For the quantitative section, the study created 3 waves of data. The first wave gathered the total amount of employees in the Maquila industry. Each subsequent wave documented how many workers remained working for the Maquila industry after a six-month period. For the qualitative section, the study used a series of interviews with employees to determine the reasons for employee turnover. This mixed method approach to document employee turnover is much more effective as it also considers the employee’s opinions rather than just taking the information from the employer’s side. Although the study identifies possible procedures to conduct a study, it lacks in defining how to counteract these situations, providing additional data that suggests the reasons for turnover and how these are affecting the Maquiladora industry. (Goldín, 2011)

The “Código de Trabajo de la Republica de El Salvador” is the labor code of El Salvador created by the Ministry of Labor and Social Security. This is a document that provides the legal rights and obligations for employers and employees. This document will be used throughout the research to understand

how Maquiladoras are structured, their limitations, severance pay, employee schedules, temporary employment regulations and many other regulations currently in practice by the Maquiladoras in El Salvador. (Ministerio de Trabajo y Previsión Social, 2010)

The article “La Industria Maquiladora en El Salvador” provides a detailed history on how Maquiladoras started and how they become predominant in developing countries. It first starts by explaining that the abundance of Maquiladoras emerged due demand and treaties between the United States and the European Union. As a result, the demand for Maquiladoras in Central America was very minimal. The initial movement of Maquiladoras in these countries started during the 1970’s. However, the Maquiladora industry began to thrive until the late 1990’s. This data suggested that these Maquiladoras are still relatively young and need much more experience to achieve their full potential. The article provided several details on how companies have tried to increase employee development but none of them have been standardized throughout the area. Additionally, none of them have been proved effective (Quintana, Deras Robles, & Torres, n.d.).

Methodology

Research Design

The study was conducted using a mixed method research (quantitative and qualitative) for a textile Maquiladora in El Salvador, Central America. The mixed method research is the most favorable approach as it collected data from two different perspectives: the employer and the employees. The Maquiladora

analyzed is owned by one of the largest American textile companies but operates under an independent entity which assumes full responsibility from the legal perspective.

The quantitative data for the research was collected through the Maquiladora's hourly production numbers. The Maquiladora agreed to assign one person to collect production measurements for a total of 5 consecutive days (Monday – Friday) using two of their manufacturing cells. The data collected in this section will capture the employer's side of the business. It will help determine the most and least productive hours between a day and throughout the working week.

The qualitative data represent the employee's side of the business. It consists of asking employees how tired they feel every production hour within the two cells being analyzed. The objective of this section is to determine another level of measurement that includes the employee's opinion about how tired they feel.

These two types of measurements will help identify any correlations between both sets of data and both cells. Additionally, it will help determine any countermeasures needed to increase production number and decrease employee fatigue.

Participants and Data Sets

The sample for the research will consist of analyzing two cells within the same department of the Maquiladora. Each cell is composed of 10 female

employees and both cells will be performing the same activities on the same work schedule for a period of 5 consecutive days. Cell A will consist of employees between the ages of 20-25 years of age who have one year or less of experience performing this specific task. Cell B will comprise employees between 30-35 years of age and have 3 or more years of experience performing this specific task.

An all-female sample is representative to the population as all cells in this department are comprised of female employees. In addition, 81% of the entire hourly population (1,425 employee) are female. Likewise, the age and years of experience for the chosen sample represent a total of 78% of the population. The range between 20-29 and less than 1 year of experience is 27% and the range between 30-39 with 3 or more years of experience is 51%.

The intention to analyze two distinct cells (i.e., young and inexperienced versus older and more experienced employee) in this manner is to uncover any potential differences such as: fatigue and physiological needs. Older employees might get tired faster but may be more productive as they have more experience. In contrast, younger employees might not get tired as fast but may not be as productive due to their lack of experience.

Data Collection and Instrumentation

Employees will be fully aware that all qualitative (questionnaire) and quantitative (production numbers) data will be collected anonymously and confidentially. They will be made aware that all the data collection will not affect

their employment with the company and that their truthful answers will help the Maquiladora detect and correct any deficiencies that they may have.

The quantitative data was collected through observation and was be divided into 3 categories:

1. The number of produced garments per hour (by the dozen) for the entire cell.
2. The number of rejected garments and their reasons. These reasons include: machine, method, material, negligence, and other.
3. The observed delays for every working hour. The observed delays were divided into 2 subcategories:
 - a. Personal delays: Bathroom, drink water, break, lunch, throw trash, infirmary, meetings, instructions, pick material, and other.
 - b. Work delays: Problems with sewing machine, lack of supplies, change of batch, rejected batch, repairs, and other.

The qualitative data consisted of measuring employee's levels of fatigue. The method of administration was by asking the employee every hour how tired they felt (on a scale form 1-10) at the same time and by the same person who is collecting the productivity numbers.

Data Analysis

Quantitative data. The quantitative data determined the efficiency of each cell for every working hour of the day and the amount of delays incurred

throughout the work day. The cell efficiency was calculated through the following factors: Standard Allowed Minutes (SAM), Hours Produced (HP), Hours Worked (HW), Personal Delays (PD) and Work Delays (WD).

Standard allowed minutes (SAM). SAM is a fixed figure calculated by the Maquiladora that determines that amount of time allowed to complete a dozen of the same garments.

Hours produced (HP). HP was calculated by multiplying the number of dozens produced by the SAM. To keep the numbers consistent, SAM was converted into hours instead of minutes. The formula is:

$$\text{Hours Produced} = \text{Dozens Produced} \left(\frac{\text{SAM}}{60} \right).$$

Hours Worked (HW). HW was calculated by multiplying the number of employees working in a cell by the amount of available time. The available time was also converted into hours to remain consistent. The formula is as follows:

$$\text{HW} = \# \text{ of employees} \left(\frac{\text{Beginning time} - \text{end time}}{60} \right).$$

Personal Delays (PD) and Work Delays (WD). Both delays were calculated by getting the sum of all individual delays and divided by 60 to convert it into hours. The percentage was then calculated dividing the result by the amount of available time.

$$\text{PD or WD} = \left(\frac{\text{Delay 1} + \text{Delay 2} + \text{Delay 3} \dots}{60} \right)$$

Efficiency. Once all the other factors were calculated, efficiency was determined. The formula for Efficiency was calculated as follows:

$$\text{Efficiency} = \frac{\text{Hours Produced}}{\text{Hours Worked}}$$

Once all calculations were generated for each cell, both sets were compared to each other to identify any differences or correlations amongst them. Lastly, conclusions were drawn from the findings.

Qualitative data. A person was assigned to ask every employee on both cells how fatigued they feel on a scale from 1 – 10. Once all data was collected, an average was calculated for every hour on each cell.

The finding between the quantitative and qualitative data was then compared to each other by using a simple OLS regression in excel to identify any differences or correlations. The regression model had efficiency as the dependent variable. The treatment variable is fatigue and other controls such as delays that could potentially affect their efficiency. Some examples of delays may include: Bathroom breaks, drinking water, repairs.

The model will be constructed the following way:

$$\text{Efficiency} = \alpha + \beta_1 * \text{Fatigue} + \beta_2 * \text{Delay 1} + \beta_3 * \text{Delay 2} + \beta_4 * \text{Delay 3} + \beta_5 * \text{Delay 4} + \beta_6 * \text{Delay 5} + \beta_7 * \text{Delay 6} + \varepsilon$$

And to complete, conclusions and recommendations were drawn from the findings.

Threats to Validity

One threat to the validity of the research is the truthfulness of the employee answers and work performance. Employees might perform better than they normally would just by knowing that they are being observed and evaluated. This includes supervisors being stricter as they will also think their performance is being evaluated. To counteract these factors, the person assigned to collect that data will be instructed to constantly reinforce employees that the measurements being collected will always remain anonymous and confidential. No employee will be affected by the results.

Another variant that can affect validity is the time of the year. The quantitative data will only be measured during a specific time of the year. Many factors can affect employee performance during different times of the year. For example, summer can be warmer than other months and create employee discomfort. Another example is special seasons such as Christmas. Christmas can create more stress as they need to prepare to receive family members and spend money on gifts.

Results and Findings

The data collection process for the Maquiladora started on Monday, November 11th, 2018 and ended Friday, November 23rd, 2018. A person was assigned to collect the data for two cells every hour of the working day. One cell was composed of 10 people, younger in age and with an average of 0.92 years of experience. The second cell was also composed of 10 operators, older in age and with an average experience of 5.70 years. Both cells were constructing the

same garment; Boxer Briefs. For more details on tasks and specific years of experience for each cell, refer to Table 1.0 from the appendix.

Data Collection Segments

The data collection is divided into 4 segments: Produced Numbers, Personal Delays, Work Delays, and Fatigue Survey.

Produced Numbers. The assigned person went to each cell at the end of every hour and recorded the amount of time worked during the hour (would only change during break hour and lunch hour(s)) and how many dozens of Boxer Briefs were produced during that hour. Once the data was recorded, the “Hours Produced”, “Hours Worked”, and Efficiency was calculated. Refer to the Data Analysis for description on how these numbers were calculated. Table 2.1 and Table 3.1 from the appendix shows the actual recorded production numbers for both cells’ numbers.

Personal Delays. The “Personal Delays” section consists of all delays considered unavoidable and mostly related to human necessities. These delays include: Bathroom Breaks, Drinking Water, Throwing Trash, Clinic Visits, Asking Questions, Receiving Instructions, and bringing material. The detailed numbers recorded for these delays can be seen in Table 2.2 (Experienced Cell) and Table 3.2 (Younger Cell) from the appendix.

Work Delays. The “Work Delays” section consists of potentially avoidable delays. These delays are mostly related to machine failure, lack of machine maintenance and training. The delays include: Machine Down, Lack of Supplies, Change of Batch, Rejected Garments, and Repairs. The details for all the

recorded numbers can be seen in Table 2.3 (Experienced Cell) and Table 3.3 (Younger Cell) from the appendix.

Fatigue Survey. The Fatigue Survey was recorded by asking each operator, and the end of every hour how fatigued they feel from a 1-10 scale. The recorded numbers can be seen Table 4.1 (Experienced Cell) and Table 4.2 (Younger Cell) from the appendix.

Analysis and Findings

OLS Regression. An OLS regression equation was created using variables from all 4 segments of recorded data to find any relations between Efficiency, fatigue and the distinct types of personal and work delays. The full details of the regression can be seen in Table 5.1.

Inspection of the results from the regression analysis revealed two significant variables for the prediction of Production Efficiency. The first was is Fatigue, which had an unstandardized regression coefficient of -5.01, $p < .05$. The regression coefficient for Fatigue indicates that for every one-point increase in fatigue, efficiency decreased by 5.01 units. The second variable with a significant regression coefficient was Machine Down, which had an unstandardized regression coefficient of -.36, $p < .05$. The regression coefficient for Machine Down indicates that for every one-minute increase in this specific delay, efficiency will decrease by 0.36 units.

Hourly Efficiency. An hourly efficiency chart was created to compare the Experienced Cell with the less experienced cell. This was created by calculating

the average percentages of the same hour throughout the 5 days recorded. This can be seen in Table 6.1 in the appendix.

In this chart, there are two sections of interest. The first one is between 8:00 AM - 9:00 AM. During this time, there is an increase in productivity for both cells. Also, a break of 15 minutes has been included during this time. This means that instead of the regular 60 minutes of production, employees were only allowed 45 minutes of production time. The average efficiency percentage for this time frame is of 124.30%, the highest of any of the other production hours. The break time allotted during this time frame is the most obvious reason why it is positively affecting the efficiency levels of production. As a result, the Maquiladora can start experimenting with the usage of additional break times during hours where efficiency seems to be declining.

The second considerable time frame is between 11:00 AM and 12:00 PM. The Efficiency percentages of the cells differs considerably. The Experienced Cell increases from a 97.35 % between 11:00 AM and 12:00 PM and to its highest peak at 119.30% between 12:00 PM – 1:00 PM. On the other hand, the Less Experienced Cell increases at a 100.13% between 11:00 AM and 12:00 and to its lowest level at 73.02% between 1:00 PM – 2:00 PM. The differences between the two cells imply that they should not be treated the same. Given the positive results from the previous analysis, a break time could potentially increase their efficiency levels. The Maquiladora can experiment by applying an additional break time at the lowest efficiency levels of each cell.

The current break time for both cells can be seen in Table 8.1 from the appendix. The proposed hourly schedule can be seen in table 8.2 from the appendix.

On the proposed schedule, the first break remains the same as it has shown to help increase efficiency for both cells. An additional 15-minute break has been added for both cells. The Experienced cell receive the additional one between 2:30 PM – 2:45 PM. And for the Younger cell, the additional 15-minute break was added between 1:30 PM – 1:45 PM.

The lunch break remained the same for the experienced cell as this is the time frame where it increases the most efficiency. The Younger cell, since their decline start between 11:00 AM – 12:00 PM, the lunch break was changed to start at 10:35 AM and end at 11:10 AM.

Daily Efficiency. According to the Labor Code of El Salvador, the weekly Work Schedule should not exceed 44 hours. The labor Code of El Salvador states that the preferred work schedule should be composed of 8 hours from Monday – Friday and 4 hours on Saturday. (Ministerio de Trabajo y Previsión Social, 2010, p. 87). However, Maquiladora from El Salvador has received special approval that allows them to modify their schedule as long as they do not exceed the 44 hours a week. Their current schedule can be seen in Table 7.1 of the appendix.

A daily efficiency chart was created to compare both cells. This can be seen in table 6.2 of the appendix. According to the chart, the Experienced cell performs best on Tuesday's (112.05% efficiency) and its worst on Wednesdays

(88.47% efficiency). On the other hand, The Younger cell performs better on Fridays (101.59% efficiency) and its worst on Thursday's (81.57% efficiency).

To counteract these declines a proposed weekly schedule has been created. This can be seen in Table 7.2 from the appendix. In order to increase efficiency for Experienced cell, an 8-hour day has been applied to their least efficient day, Wednesday (88.47% efficiency). As a result, the schedule from Friday has been modified from an 8-hour day to a 9-hour day.

In contrast, the Younger cell's least efficient day was Thursdays (81.57% efficiency). As a result, the work schedule for Thursday has been modified from a 9-hour day to an 8-hour day and Friday is now a 9-hour day.

Conclusion

After reviewing all the findings, The OLS Regression shows that Fatigue and Machine Down are the most significant variables affecting the overall efficiency of the Maquiladora. Both of these variables are manageable in contrast to a variable such as "Physiological Needs" which are completely unavoidable. The "Machine Down" variable can easily be reduced by implementing a routine preventative maintenance schedule, changing equipment after a certain amount of time, and looking into buying better equipment that could potentially reduce the time that the machine is down. The routine preventive maintenance can be made during the break times, including the additional one that was proposed in Table 8.2 from appendix.

Additional studies are recommended to compare the impact of alternative work schedules for each cell and its relationship to Fatigue. If the additional

studies suggest that efficiency fluctuates based on the assigned work schedule the data collected in Tables 6.1 and 6.2 can be used to view efficiency per cell. These tables reveal that distinct experience levels (Experienced and Less Experienced Cell) experience efficiency inclines and declines during different hours of the day and on different days of the week. A recommendation that could be trialed would be to add an additional break as proposed in Table 8.2. The additional break would be scheduled at a time that the cell normally experiences lower efficiency levels. As a result, the cell should see an efficiency incline when returning to work, like the incline seen after the first break. Other recommendations would be to alter the number of hours worked per day. For example, Table 7.2 proposes a schedule with a decrease in the number of hours worked on the least efficient days for each cell. There are just a few of many examples of how alternative schedules can be used to increase efficiency. While these alternative schedules can serve as a valuable starting point for the Maquiladora when experimenting with the effects alternative work schedules have on Fatigue, supplementary studies and trials would be required to find the schedule that complements each cell. The Maquiladora will also have to keep management in mind when experimenting with alternate work schedules in order to accommodate different production cells assigned to one supervisor.

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Appendix

Table 1.0 (Experience Averages)

4450-0A (Younger Cell)			
Operator	Cell	Task	Years of Experience Doing Current Job
1	A	Attach Elastic	1
2	0	Attach Elastic	1
3	0-A	Flat lock	1
4	0	Hem Leg	0.66
5	0	Hem Leg	0.5
6	0-A	Ink Pad	1
7	0	Join Panel	1
8	0-A	Join Panel	1
9	A	Join Panel	1
10	0-A	Tube Fly	1
AVERAGE:			0.92 Years

4495-1B (Experienced Cell)			
Operator	Cell	Task	Years of Experience Doing Current Job
1	1	Attach Elastic	6
2	B	Attach Elastic	4
3	1-B	Flat lock	8
4	1	Hem leg	5
5	B	Hem leg	7
6	1-B	Ink pad	5
7	1	Join Panel	3
8	1-B	Join Panel	6
9	B	Join Panel	6
10	1-B	Tube Fly	7
AVERAGE:			5.70 Years

Table 2.1 (Experienced Cell: Production Numbers)

Experienced Cell								
Day	Time	Break / Lunch	Available Time	Dozens	Standard Allowed Minutes (SAM)	Hours Produced (HP)	Hours Worked (HW)	Efficiency
Monday	7:00 - 8:00		1.0 Hours	32	19.5576	10.43	10.00	104.31%
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	25	19.5576	8.15	7.50	108.65%
	9:00 - 10:00		1.0 Hours	36	19.5576	11.73	10.00	117.35%
	10:00 - 11:00		1.0 Hours	40	19.5576	13.04	10.00	130.38%
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	24	19.5576	7.82	7.50	104.31%
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	24	19.5576	7.82	6.67	117.35%
	13:00 - 14:00		1.0 Hours	32	19.5576	10.43	10.00	104.31%
	14:00 - 15:00		1.0 Hours	24	19.5576	7.82	10.00	78.23%
	15:00 - 16:00		1.0 Hours	36	19.5576	11.73	10.00	117.35%
16:00 - 16:35		0.58 Hours	16	19.5576	5.22	5.83	89.41%	
Tuesday	7:00 - 8:00		1.0 Hours	36	19.5576	11.73	10.00	117.35%
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	34	19.5576	11.08	7.50	147.77%
	9:00 - 10:00		1.0 Hours	37	19.5576	12.06	10.00	120.61%
	10:00 - 11:00		1.0 Hours	30	19.5576	9.78	10.00	97.79%
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	24	19.5576	7.82	7.50	104.31%
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	24	19.5576	7.82	6.67	117.35%
	13:00 - 14:00		1.0 Hours	34	19.5576	11.08	10.00	110.83%
	14:00 - 15:00		1.0 Hours	30	19.5576	9.78	10.00	97.79%
	15:00 - 16:00		1.0 Hours	36	19.5576	11.73	10.00	117.35%
16:00 - 16:35		0.58 Hours	16	19.5576	5.22	5.83	89.41%	
Wednesday	7:00 - 8:00		1.0 Hours	28	19.5576	9.13	10.00	91.27%
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	12	19.5576	3.91	7.50	52.15%
	9:00 - 10:00		1.0 Hours	12	19.5576	3.91	10.00	39.12%
	10:00 - 11:00		1.0 Hours	31	19.5576	10.10	10.00	101.05%
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	24	19.5576	7.82	7.50	104.31%
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	24	19.5576	7.82	6.67	117.35%
	13:00 - 14:00		1.0 Hours	33	19.5576	10.76	10.00	107.57%
	14:00 - 15:00		1.0 Hours	40	19.5576	13.04	10.00	130.38%
	15:00 - 16:00		1.0 Hours	16	19.5576	5.22	10.00	52.15%
16:00 - 16:35		0.58 Hours	16	19.5576	5.22	5.83	89.41%	
Thursday	7:00 - 8:00		1.0 Hours	40	19.5576	13.04	10.00	130.38%
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	40	19.5576	13.04	7.50	173.85%
	9:00 - 10:00		1.0 Hours	36	19.5576	11.73	10.00	117.35%
	10:00 - 11:00		1.0 Hours	30	19.5576	9.78	10.00	97.79%
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	20	19.5576	6.52	7.50	86.92%
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	24	19.5576	7.82	6.67	117.35%
	13:00 - 14:00		1.0 Hours	28	19.5576	9.13	10.00	91.27%
	14:00 - 15:00		1.0 Hours	28	19.5576	9.13	10.00	91.27%
	15:00 - 16:00		1.0 Hours	32	19.5576	10.43	10.00	104.31%
16:00 - 16:35		0.58 Hours	16	19.5576	5.22	5.83	89.41%	
Friday	7:00 - 8:00		1.0 Hours	28	19.5576	9.13	10.00	91.27%
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	32	19.5576	10.43	7.50	139.08%
	9:00 - 10:00		1.0 Hours	30	19.5576	9.78	10.00	97.79%
	10:00 - 11:00		1.0 Hours	26	19.5576	8.47	10.00	84.75%
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	20	19.5576	6.52	7.50	86.92%
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	26	19.5576	8.47	6.67	127.12%
	13:00 - 14:00		1.0 Hours	32	19.5576	10.43	10.00	104.31%
	14:00 - 15:00		1.0 Hours	32	19.5576	10.43	10.00	104.31%
	15:00 - 15:35		0.58 Hours	12	19.5576	3.91	5.83	67.05%

Table 2.2 (Experienced Cell: Personal Delays)

Experienced Cell											
Day	Time	Break / Lunch	Available Time	Personal Delays							
				Bathroom Breaks	Drink Water	Throw Trash	Clinic Visits	Asking Questions	Receiving Instructions	Bring Materials	
Monday	7:00 - 8:00		1.0 Hours	0.00 min	2.66 min	0.00 min	0.00 min	0.00 min	0.00 min	1.71 min	4.58 min
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	0.00 min	4.31 min	0.00 min	12.86 min	0.00 min	2.25 min	0.00 min	1.86 min
	9:00 - 10:00		1.0 Hours	3.51 min	0.68 min	0.00 min	2.70 min	0.00 min	0.80 min	0.00 min	1.03 min
	10:00 - 11:00		1.0 Hours	4.13 min	2.01 min	2.96 min	0.00 min	0.00 min	0.00 min	0.00 min	1.36 min
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	23.94 min	1.50 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	2.76 min
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	2.50 min
	13:00 - 14:00		1.0 Hours	14.35 min	1.53 min	0.00 min	0.00 min	1.66 min	0.00 min	0.00 min	0.00 min
	14:00 - 15:00		1.0 Hours	6.56 min	1.75 min	0.00 min	0.00 min	6.68 min	0.00 min	0.00 min	2.50 min
	15:00 - 16:00		1.0 Hours	9.85 min	2.57 min	5.23 min	0.00 min	2.70 min	0.00 min	0.00 min	1.86 min
	16:00 - 16:35		0.58 Hours	6.88 min	1.46 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
Tuesday	7:00 - 8:00		1.0 Hours	2.50 min	0.00 min	0.00 min	0.00 min	1.20 min	0.00 min	0.00 min	0.78 min
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	3.50 min	0.00 min	0.00 min	3.38 min	0.00 min	0.00 min	0.00 min	0.00 min
	9:00 - 10:00		1.0 Hours	15.33 min	1.50 min	0.00 min	0.00 min	0.00 min	2.00 min	0.00 min	2.00 min
	10:00 - 11:00		1.0 Hours	4.91 min	3.06 min	3.18 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	19.77 min	1.73 min	0.00 min	0.00 min	7.75 min	0.00 min	0.00 min	1.15 min
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	5.18 min	3.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.68 min
	13:00 - 14:00		1.0 Hours	17.72 min	2.71 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	1.24 min
	14:00 - 15:00		1.0 Hours	7.68 min	3.71 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	15:00 - 16:00		1.0 Hours	13.42 min	2.45 min	4.05 min	0.00 min	0.00 min	0.00 min	0.00 min	0.66 min
	16:00 - 16:35		0.58 Hours	8.81 min	1.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
Wednesday	7:00 - 8:00		1.0 Hours	0.00 min	1.50 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.75 min
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	9:00 - 10:00		1.0 Hours	2.38 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	4.09 min
	10:00 - 11:00		1.0 Hours	0.00 min	0.00 min	2.99 min	0.00 min	0.00 min	0.00 min	0.00 min	6.51 min
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	20.75 min	2.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	1.98 min
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	5.01 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	13:00 - 14:00		1.0 Hours	8.00 min	1.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	4.70 min
	14:00 - 15:00		1.0 Hours	16.35 min	1.75 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.88 min
	15:00 - 16:00		1.0 Hours	8.16 min	4.17 min	1.35 min	0.00 min	0.00 min	0.00 min	0.00 min	1.96 min
	16:00 - 16:35		0.58 Hours	9.63 min	1.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
Thursday	7:00 - 8:00		1.0 Hours	4.23 min	5.05 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	4.43 min
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	4.70 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	1.70 min
	9:00 - 10:00		1.0 Hours	4.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	7.62 min
	10:00 - 11:00		1.0 Hours	12.15 min	1.11 min	2.80 min	0.00 min	7.35 min	2.98 min	0.00 min	18.32 min
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	32.43 min	1.50 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	6.33 min
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	4.46 min	3.64 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	7.49 min
	13:00 - 14:00		1.0 Hours	13.77 min	3.63 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	10.98 min
	14:00 - 15:00		1.0 Hours	6.95 min	2.00 min	0.00 min	4.77 min	0.00 min	0.00 min	0.00 min	10.37 min
	15:00 - 16:00		1.0 Hours	22.23 min	3.91 min	4.86 min	0.00 min	0.00 min	1.85 min	0.00 min	6.69 min
	16:00 - 16:35		0.58 Hours	9.63 min	1.30 min	0.00 min	0.00 min	1.50 min	0.00 min	0.00 min	6.72 min
Friday	7:00 - 8:00		1.0 Hours	0.00 min	1.62 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	8.98 min
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	13.66 min	4.71 min	1.68 min	0.00 min	1.00 min	3.87 min	0.00 min	12.46 min
	9:00 - 10:00		1.0 Hours	15.41 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	3.18 min
	10:00 - 11:00		1.0 Hours	19.18 min	5.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	5.18 min
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	0.00 min	10.00 min	0.00 min	0.00 min	0.00 min	5.00 min	0.00 min	0.56 min
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	5.21 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	11.43 min
	13:00 - 14:00		1.0 Hours	5.43 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	14:00 - 15:00		1.0 Hours	11.91 min	4.10 min	1.50 min	0.00 min	0.00 min	0.00 min	0.00 min	13.46 min
15:00 - 15:35		0.58 Hours	7.85 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	5.01 min	

Table 2.3 (Experienced Cell: Work Delays)

Experienced Cell								
Day	Time	Break / Lunch	Available Time	Work Delays				
				Machine Down	Lack of Supplies	Change of batch	Rejected Garments	Repairs
Monday	7:00 - 8:00		1.0 Hours	0.00 min	8.54 min	41.85 min	3.60 min	12.53 min
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	0.00 min	15.40 min	20.04 min	4.00 min	4.72 min
	9:00 - 10:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	6.99 min
	10:00 - 11:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	9.85 min
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	4.28 min	0.00 min	0.00 min	0.00 min	2.93 min
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	0.00 min	0.00 min	0.00 min	5.63 min	1.25 min
	13:00 - 14:00		1.0 Hours	0.00 min	0.00 min	0.00 min	3.50 min	7.37 min
	14:00 - 15:00		1.0 Hours	0.00 min	0.00 min	0.00 min	4.00 min	8.56 min
	15:00 - 16:00		1.0 Hours	0.00 min	0.00 min	0.00 min	4.18 min	2.30 min
	16:00 - 16:35		0.58 Hours	13.99 min	0.00 min	0.00 min	11.64 min	2.10 min
Tuesday	7:00 - 8:00		1.0 Hours	0.00 min	1.05 min	0.00 min	0.00 min	12.52 min
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	0.00 min	0.00 min	13.55 min	19.96 min	16.32 min
	9:00 - 10:00		1.0 Hours	0.00 min	3.05 min	25.51 min	0.00 min	25.63 min
	10:00 - 11:00		1.0 Hours	0.00 min	0.00 min	15.74 min	9.71 min	13.59 min
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	0.00 min	0.00 min	0.00 min	0.00 min	9.05 min
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	0.00 min	6.91 min	0.00 min	2.23 min	22.09 min
	13:00 - 14:00		1.0 Hours	0.00 min	0.00 min	5.58 min	0.00 min	8.08 min
	14:00 - 15:00		1.0 Hours	0.00 min	2.60 min	36.34 min	0.00 min	3.91 min
	15:00 - 16:00		1.0 Hours	0.00 min	0.00 min	3.43 min	8.49 min	0.00 min
	16:00 - 16:35		0.58 Hours	2.68 min	0.00 min	29.34 min	0.00 min	3.40 min
Wednesday	7:00 - 8:00		1.0 Hours	6.58 min	2.46 min	0.00 min	0.00 min	12.34 min
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	0.00 min	0.45 min	0.00 min	12.64 min	21.32 min
	9:00 - 10:00		1.0 Hours	19.05 min	0.00 min	0.00 min	0.00 min	0.00 min
	10:00 - 11:00		1.0 Hours	14.11 min	3.45 min	0.00 min	0.00 min	0.00 min
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	28.16 min	0.00 min	4.56 min	0.00 min	0.00 min
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	21.90 min	0.00 min	21.86 min	4.71 min	6.04 min
	13:00 - 14:00		1.0 Hours	0.00 min	0.00 min	10.75 min	5.00 min	9.51 min
	14:00 - 15:00		1.0 Hours	18.00 min	0.00 min	21.66 min	12.90 min	4.06 min
	15:00 - 16:00		1.0 Hours	60.00 min	5.34 min	4.16 min	0.00 min	5.68 min
	16:00 - 16:35		0.58 Hours	36.00 min	0.00 min	0.00 min	0.00 min	0.00 min
Thursday	7:00 - 8:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	4.32 min
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	0.00 min	0.00 min	0.00 min	0.00 min	14.20 min
	9:00 - 10:00		1.0 Hours	0.00 min	0.00 min	21.37 min	10.41 min	11.99 min
	10:00 - 11:00		1.0 Hours	10.00 min	3.00 min	0.00 min	0.00 min	17.48 min
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	35.70 min	0.00 min	0.00 min	0.00 min	0.00 min
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	0.00 min	0.00 min	0.00 min	0.00 min	12.33 min
	13:00 - 14:00		1.0 Hours	5.00 min	0.00 min	0.00 min	14.85 min	10.04 min
	14:00 - 15:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	1.37 min
	15:00 - 16:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	8.09 min
	16:00 - 16:35		0.58 Hours	0.00 min	0.00 min	0.00 min	0.00 min	17.26 min
Friday	7:00 - 8:00		1.0 Hours	0.00 min	2.00 min	0.00 min	0.00 min	7.75 min
	8:00 - 9:00	8:24 - 8:39	0.75 Hours	5.75 min	0.00 min	0.00 min	8.26 min	0.91 min
	9:00 - 10:00		1.0 Hours	0.00 min	0.00 min	0.00 min	11.01 min	2.83 min
	10:00 - 11:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	11:00 - 12:00	11:45 - 12:00	0.75 Hours	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	12:00 - 13:00	12:00 - 12:20	0.67 Hours	7.66 min	0.00 min	0.00 min	0.00 min	11.70 min
	13:00 - 14:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	14:00 - 15:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	1.31 min
		15:00 - 15:35		0.58 Hours	0.00 min	0.00 min	0.00 min	0.00 min

Table 3.1 (Younger Cell: Production Numbers)

Day	Time	Break / Lunch	Available Time	Dozens	Standard Allowed Minutes (SAM)	Hours Produced (HP)	Hours Worked (HW)	Efficiency
Monday	7:00 - 8:00		1.0 Hours	28	19,5576	9.13	10.00	91.27%
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	24	19,5576	7.82	7.50	104.31%
	9:00 - 10:00		1.0 Hours	32	19,5576	10.43	10.00	104.31%
	10:00 - 11:00		1.0 Hours	28	19,5576	9.13	10.00	91.27%
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	8	19,5576	2.61	4.17	62.58%
	12:00 - 13:00		1.00 Hours	16	19,5576	5.22	10.00	52.15%
	13:00 - 14:00		1.0 Hours	24	19,5576	7.82	10.00	78.23%
	14:00 - 15:00		1.0 Hours	32	19,5576	10.43	10.00	104.31%
Tuesday	15:00 - 16:00		1.0 Hours	32	19,5576	10.43	10.00	104.31%
	16:00 - 16:35		0.58 Hours	20	19,5576	6.52	5.83	111.76%
	7:00 - 8:00		1.0 Hours	24	19,5576	7.82	10.00	78.23%
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	24	19,5576	7.82	7.50	104.31%
	9:00 - 10:00		1.0 Hours	32	19,5576	10.43	10.00	104.31%
	10:00 - 11:00		1.0 Hours	28	19,5576	9.13	10.00	91.27%
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	16	19,5576	5.22	4.17	125.17%
	12:00 - 13:00		1.00 Hours	32	19,5576	10.43	10.00	104.31%
Wednesday	13:00 - 14:00		1.0 Hours	24	19,5576	7.82	10.00	78.23%
	14:00 - 15:00		1.0 Hours	24	19,5576	7.82	10.00	78.23%
	15:00 - 16:00		1.0 Hours	20	19,5576	6.52	10.00	65.19%
	16:00 - 16:35		0.58 Hours	16	19,5576	5.22	5.83	89.41%
	7:00 - 8:00		1.0 Hours	28	19,5576	9.13	10.00	91.27%
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	20	19,5576	6.52	7.50	86.92%
	9:00 - 10:00		1.0 Hours	24	19,5576	7.82	10.00	78.23%
	10:00 - 11:00		1.0 Hours	32	19,5576	10.43	10.00	104.31%
Thursday	11:00 - 12:00	11:10 - 11:45	0.42 Hours	16	19,5576	5.22	4.17	125.17%
	12:00 - 13:00		1.00 Hours	36	19,5576	11.73	10.00	117.35%
	13:00 - 14:00		1.0 Hours	28	19,5576	9.13	10.00	91.27%
	14:00 - 15:00		1.0 Hours	36	19,5576	11.73	10.00	117.35%
	15:00 - 16:00		1.0 Hours	32	19,5576	10.43	10.00	104.31%
	16:00 - 16:35		0.58 Hours	16	19,5576	5.22	5.83	89.41%
	7:00 - 8:00		1.0 Hours	24	19,5576	7.82	10.00	78.23%
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	28	19,5576	9.13	7.50	121.69%
Friday	9:00 - 10:00		1.0 Hours	28	19,5576	9.13	10.00	91.27%
	10:00 - 11:00		1.0 Hours	32	19,5576	10.43	10.00	104.31%
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	8	19,5576	2.61	4.17	62.58%
	12:00 - 13:00		1.00 Hours	20	19,5576	6.52	10.00	65.19%
	13:00 - 14:00		1.0 Hours	16	19,5576	5.22	10.00	52.15%
	14:00 - 15:00		1.0 Hours	28	19,5576	9.13	10.00	91.27%
	15:00 - 16:00		1.0 Hours	32	19,5576	10.43	10.00	104.31%
	16:00 - 16:35		0.58 Hours	8	19,5576	2.61	5.83	44.70%
Saturday	7:00 - 8:00		1.0 Hours	40	19,5576	13.04	10.00	130.38%
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	32	19,5576	10.43	7.50	139.08%
	9:00 - 10:00		1.0 Hours	30	19,5576	9.78	10.00	97.79%
	10:00 - 11:00		1.0 Hours	32	19,5576	10.43	10.00	104.31%
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	16	19,5576	5.22	4.17	125.17%
	12:00 - 13:00		1.00 Hours	32	19,5576	10.43	10.00	104.31%
	13:00 - 14:00		1.0 Hours	20	19,5576	6.52	10.00	65.19%
	14:00 - 15:00		1.0 Hours	18	19,5576	5.87	10.00	58.67%
15:00 - 15:35		0.58 Hours	16	19,5576	5.22	5.83	89.41%	

Table 3.2 (Younger Cell: Personal Delays)

YOUNGER CELL										
Day	Time	Break / Lunch	Available Time	Personal Delays						
				Bathroom Breaks	Drink Water	Throw Trash	Clinic Visits	Asking Questions	Receiving Instructions	Bring Materials
Monday	7:00 - 8:00		1.0 Hours	4.88 min	0.00 min	3.79 min	0.00 min	0.00 min	1.55 min	5.72 min
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	21.85 min	3.49 min	0.00 min	0.00 min	0.00 min	0.00 min	1.40 min
	9:00 - 10:00		1.0 Hours	0.00 min	0.58 min	0.00 min	0.00 min	0.00 min	0.00 min	4.20 min
	10:00 - 11:00		1.0 Hours	3.66 min	1.25 min	6.14 min	0.00 min	0.00 min	0.00 min	3.48 min
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	10.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	12:00 - 13:00		1.0 Hours	21.46 min	0.00 min	5.04 min	0.00 min	0.00 min	0.00 min	2.08 min
	13:00 - 14:00		1.0 Hours	8.77 min	3.75 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	14:00 - 15:00		1.0 Hours	9.16 min	4.60 min	0.00 min	0.00 min	0.00 min	2.00 min	3.10 min
	15:00 - 16:00		1.0 Hours	5.13 min	1.08 min	0.00 min	0.00 min	0.00 min	0.00 min	3.50 min
	16:00 - 16:35		0.58 Hours	13.62 min	1.08 min	6.53 min	0.00 min	0.00 min	0.00 min	0.00 min
Tuesday	7:00 - 8:00		1.0 Hours	6.42 min	6.60 min	5.04 min	0.00 min	0.00 min	2.71 min	18.98 min
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	20.11 min	5.85 min	0.00 min	0.00 min	0.00 min	0.00 min	4.29 min
	9:00 - 10:00		1.0 Hours	2.61 min	0.90 min	0.00 min	0.00 min	0.00 min	0.00 min	2.48 min
	10:00 - 11:00		1.0 Hours	21.17 min	1.88 min	2.01 min	0.00 min	0.00 min	0.00 min	3.71 min
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	9.75 min	0.50 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	12:00 - 13:00		1.0 Hours	4.00 min	2.56 min	0.00 min	0.00 min	0.00 min	1.33 min	0.50 min
	13:00 - 14:00		1.0 Hours	17.16 min	1.69 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	14:00 - 15:00		1.0 Hours	13.86 min	5.33 min	4.49 min	0.00 min	0.00 min	0.00 min	1.45 min
	15:00 - 16:00		1.0 Hours	4.78 min	1.58 min	0.00 min	0.00 min	0.00 min	0.00 min	3.13 min
	16:00 - 16:35		0.58 Hours	5.15 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.86 min
Wednesday	7:00 - 8:00		1.0 Hours	0.00 min	3.09 min	3.88 min	0.00 min	0.00 min	0.00 min	4.23 min
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	17.87 min	5.62 min	0.00 min	0.00 min	0.00 min	0.00 min	1.01 min
	9:00 - 10:00		1.0 Hours	0.00 min	0.70 min	0.00 min	0.00 min	0.00 min	0.00 min	4.10 min
	10:00 - 11:00		1.0 Hours	22.92 min	1.39 min	2.08 min	0.00 min	0.00 min	1.28 min	4.10 min
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	12:00 - 13:00		1.0 Hours	8.07 min	0.30 min	0.00 min	0.00 min	4.36 min	0.00 min	0.00 min
	13:00 - 14:00		1.0 Hours	14.67 min	2.50 min	0.00 min	0.00 min	0.00 min	0.00 min	4.77 min
	14:00 - 15:00		1.0 Hours	12.46 min	2.92 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	15:00 - 16:00		1.0 Hours	9.89 min	0.50 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	16:00 - 16:35		0.58 Hours	15.30 min	0.00 min	6.98 min	0.00 min	0.00 min	0.00 min	0.00 min
Thursday	7:00 - 8:00		1.0 Hours	0.00 min	0.85 min	0.00 min	0.00 min	0.00 min	2.00 min	6.12 min
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	17.00 min	3.12 min	0.00 min	0.00 min	0.00 min	1.50 min	7.59 min
	9:00 - 10:00		1.0 Hours	0.00 min	0.40 min	1.86 min	0.00 min	0.00 min	6.69 min	1.21 min
	10:00 - 11:00		1.0 Hours	5.54 min	1.11 min	0.00 min	0.00 min	0.00 min	0.00 min	3.08 min
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	11.38 min	0.00 min	0.75 min	0.00 min	0.00 min	0.00 min	0.00 min
	12:00 - 13:00		1.0 Hours	0.00 min	0.81 min	0.00 min	0.00 min	0.00 min	0.00 min	7.07 min
	13:00 - 14:00		1.0 Hours	21.09 min	1.98 min	0.00 min	0.00 min	0.00 min	0.00 min	11.88 min
	14:00 - 15:00		1.0 Hours	5.00 min	0.00 min	2.00 min	0.00 min	4.15 min	0.00 min	2.25 min
	15:00 - 16:00		1.0 Hours	4.93 min	2.20 min	0.00 min	0.00 min	0.00 min	0.00 min	5.80 min
	16:00 - 16:35		0.58 Hours	15.98 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	1.45 min
Friday	7:00 - 8:00		1.0 Hours	0.00 min	0.30 min	0.00 min	0.00 min	1.75 min	0.00 min	2.00 min
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	20.71 min	3.08 min	0.00 min	0.00 min	0.00 min	0.00 min	4.55 min
	9:00 - 10:00		1.0 Hours	0.00 min	0.75 min	4.61 min	0.00 min	0.00 min	1.55 min	1.15 min
	10:00 - 11:00		1.0 Hours	11.03 min	2.88 min	5.92 min	0.00 min	0.00 min	1.35 min	3.06 min
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min
	12:00 - 13:00		1.0 Hours	6.41 min	1.50 min	0.00 min	0.00 min	0.00 min	4.81 min	0.50 min
	13:00 - 14:00		1.0 Hours	25.86 min	0.00 min	0.00 min	5.48 min	0.00 min	0.00 min	0.00 min
	14:00 - 15:00		1.0 Hours	3.16 min	1.00 min	4.92 min	0.00 min	0.00 min	0.00 min	5.75 min
15:00 - 15:35		0.58 Hours	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	0.00 min	5.02 min	

Table 3.3 (Younger Cell: Work Delays)

YOUNGER CELL								
Day	Time	Break / Lunch	Available Time	Work Delays				
				Machine Down	Lack of Supplies	Change of batch	Rejected Garments	Repairs
Monday	7:00 - 8:00		1.0 Hours	92.65 min	0.00 min	0.00 min	0.00 min	4.49 min
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	0.00 min	1.23 min	5.68 min	0.00 min	17.71 min
	9:00 - 10:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	5.98 min
	10:00 - 11:00		1.0 Hours	0.00 min	11.45 min	31.61 min	11.33 min	14.85 min
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	0.00 min	0.00 min	0.00 min	7.97 min	9.55 min
	12:00 - 13:00		1.00 Hours	60.00 min	0.00 min	0.00 min	0.00 min	13.35 min
	13:00 - 14:00		1.0 Hours	60.00 min	0.00 min	0.00 min	0.00 min	6.21 min
	14:00 - 15:00		1.0 Hours	10.36 min	0.00 min	0.00 min	0.00 min	7.34 min
Tuesday	15:00 - 16:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	16.36 min
	16:00 - 16:35		0.58 Hours	0.00 min	0.00 min	0.00 min	0.00 min	12.13 min
	7:00 - 8:00		1.0 Hours	54.90 min	0.00 min	0.00 min	0.00 min	11.79 min
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	30.00 min	0.00 min	0.00 min	3.43 min	10.57 min
	9:00 - 10:00		1.0 Hours	20.00 min	0.00 min	0.00 min	4.04 min	14.82 min
	10:00 - 11:00		1.0 Hours	60.00 min	0.00 min	0.00 min	11.03 min	10.18 min
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	45.00 min	0.00 min	0.00 min	0.00 min	11.07 min
	12:00 - 13:00		1.00 Hours	0.00 min	0.51 min	0.00 min	0.00 min	2.45 min
Wednesday	13:00 - 14:00		1.0 Hours	68.27 min	2.50 min	0.00 min	8.11 min	5.47 min
	14:00 - 15:00		1.0 Hours	60.00 min	0.00 min	0.00 min	8.17 min	9.18 min
	15:00 - 16:00		1.0 Hours	60.00 min	0.00 min	0.00 min	4.48 min	26.18 min
	16:00 - 16:35		0.58 Hours	35.00 min	0.00 min	0.00 min	0.00 min	7.90 min
	7:00 - 8:00		1.0 Hours	60.00 min	3.08 min	0.00 min	0.00 min	9.59 min
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	60.00 min	0.00 min	0.00 min	2.58 min	12.96 min
	9:00 - 10:00		1.0 Hours	35.00 min	0.00 min	5.61 min	7.38 min	19.65 min
	10:00 - 11:00		1.0 Hours	0.00 min	0.00 min	0.00 min	5.63 min	2.84 min
Thursday	11:00 - 12:00	11:10 - 11:45	0.42 Hours	0.00 min	0.00 min	0.00 min	0.00 min	12.24 min
	12:00 - 13:00		1.00 Hours	0.00 min	0.00 min	0.00 min	0.00 min	3.26 min
	13:00 - 14:00		1.0 Hours	35.00 min	0.00 min	0.00 min	5.75 min	28.54 min
	14:00 - 15:00		1.0 Hours	0.00 min	1.30 min	0.00 min	7.75 min	5.32 min
	15:00 - 16:00		1.0 Hours	0.00 min	0.00 min	0.00 min	13.66 min	4.29 min
	16:00 - 16:35		0.58 Hours	0.00 min	0.00 min	3.58 min	0.00 min	7.94 min
	7:00 - 8:00		1.0 Hours	82.99 min	0.00 min	23.03 min	0.00 min	2.58 min
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	43.57 min	0.00 min	0.00 min	5.06 min	4.26 min
Friday	9:00 - 10:00		1.0 Hours	0.00 min	0.00 min	0.00 min	3.21 min	14.15 min
	10:00 - 11:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	27.17 min
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	15.00 min	0.00 min	0.00 min	5.08 min	14.36 min
	12:00 - 13:00		1.00 Hours	35.00 min	0.00 min	0.00 min	2.68 min	1.06 min
	13:00 - 14:00		1.0 Hours	28.73 min	0.00 min	0.00 min	2.56 min	9.08 min
	14:00 - 15:00		1.0 Hours	0.00 min	0.00 min	0.00 min	17.87 min	5.16 min
	15:00 - 16:00		1.0 Hours	0.00 min	0.00 min	0.00 min	0.00 min	10.23 min
	16:00 - 16:35		0.58 Hours	0.00 min	0.00 min	0.00 min	0.00 min	10.31 min
Saturday	7:00 - 8:00		1.0 Hours	0.00 min	0.00 min	0.00 min	6.31 min	0.00 min
	8:00 - 9:00	8:10 - 8:25	0.75 Hours	0.00 min	4.25 min	0.00 min	9.36 min	12.64 min
	9:00 - 10:00		1.0 Hours	0.00 min	0.00 min	0.00 min	17.37 min	4.22 min
	10:00 - 11:00		1.0 Hours	0.00 min	0.00 min	0.00 min	6.43 min	17.41 min
	11:00 - 12:00	11:10 - 11:45	0.42 Hours	4.36 min	7.33 min	2.45 min	0.00 min	0.00 min
	12:00 - 13:00		1.00 Hours	20.37 min	0.00 min	0.00 min	5.06 min	11.72 min
	13:00 - 14:00		1.0 Hours	0.00 min	4.50 min	34.67 min	0.00 min	18.54 min
	14:00 - 15:00		1.0 Hours	48.40 min	0.00 min	23.65 min	0.00 min	37.66 min
15:00 - 15:35		0.58 Hours	0.00 min	0.00 min	0.00 min	0.00 min	5.08 min	

Table 4.1 (Experienced Cell: Fatigue Survey)

EXPERIENCED CELL											
QUESTION: How tired do you feel at this hour on a scale from 1-10.											
	Fatigue Question	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 16:35
M O N D A Y	Employee 1	2	2	3	5	4	3	3	4	6	5
	Employee 2	1	2	3	4	5	3	3	4	6	6
	Employee 3	3	3	4	3	4	3	4	5	6	7
	Employee 4	3	2	3	4	3	3	4	5	5	7
	Employee 5	2	2	3	3	4	3	4	5	6	8
	Employee 6	3	2	3	3	5	4	4	4	7	7
	Employee 7	4	3	5	5	6	6	5	6	5	6
	Employee 8	3	3	4	4	4	3	5	6	6	6
	Employee 9	4	4	5	3	3	2	3	3	7	7
	Employee 10	4	4	3	3	3	3	4	4	7	8
			2.90	2.70	3.60	3.70	4.10	3.30	3.90	4.60	6.10
T U E S D A Y	Employee 1	2	2	2	3	3	2	3	5	5	6
	Employee 2	3	3	2	3	4	3	3	5	5	6
	Employee 3	1	2	2	3	4	4	4	7	7	7
	Employee 4	1	2	1	2	3	3	4	5	5	6
	Employee 5	2	3	3	3	3	3	4	4	4	5
	Employee 6	3	4	2	3	4	3	5	5	5	6
	Employee 7	2	2	1	2	3	2	4	6	8	8
	Employee 8	3	4	3	4	3	2	3	7	7	7
	Employee 9	2	3	2	2	3	3	4	6	6	7
	Employee 10	1	2	2	3	3	3	5	6	7	9
			2	2.7	2	2.8	3.3	2.8	3.9	5.6	5.9
W E D N E S D A Y	Employee 1	1	2	1	4	3	3	4	6	7	8
	Employee 2	2	3	2	5	5	4	6	6	6	7
	Employee 3	2	3	3	5	5	5	6	7	6	7
	Employee 4	1	2	2	5	6	5	7	8	6	8
	Employee 5	3	4	3	5	5	4	6	8	7	8
	Employee 6	2	3	3	6	5	6	7	7	6	6
	Employee 7	2	3	3	4	4	2	5	7	7	8
	Employee 8	2	4	3	5	6	4	7	9	7	7
	Employee 9	3	4	5	6	5	3	5	6	6	7
	Employee 10	3	3	3	3	6	4	6	7	7	8
			2.1	3.1	2.8	4.8	5	4	5.9	7.1	6.5
T H U R S D A Y	Employee 1	1	2	2	3	4	3	4	5	4	5
	Employee 2	2	2	2	3	5	4	6	6	4	6
	Employee 3	1	2	1	2	5	4	4	4	5	8
	Employee 4	2	2	1	2	4	4	5	6	7	8
	Employee 5	1	2	1	3	5	2	3	4	5	8
	Employee 6	2	3	2	4	6	4	6	5	6	7
	Employee 7	1	2	3	4	5	3	3	4	5	7
	Employee 8	2	2	2	2	4	2	3	3	3	8
	Employee 9	2	3	4	5	6	4	3	3	4	6
	Employee 10	2	2	2	3	4	5	7	8	8	9
			1.6	2.2	2	3.1	4.8	3.5	4.4	4.8	5.1
F R I D A Y	Employee 1	3	3	3	4	6	4	5	5	6	
	Employee 2	2	2	1	3	5	3	4	6	7	
	Employee 3	2	3	2	3	5	2	3	5	8	
	Employee 4	2	3	3	4	5	3	3	3	5	
	Employee 5	3	3	2	4	4	4	5	6	6	
	Employee 6	1	1	2	3	4	4	4	5	6	
	Employee 7	1	2	3	4	5	3	6	6	6	
	Employee 8	3	3	3	5	5	4	6	6	7	
	Employee 9	2	2	4	5	3	4	4	5	6	
	Employee 10	1	2	1	3	5	5	5	5	7	
			2	2.4	2.4	3.8	4.7	3.6	4.5	5.2	6.4

Table 4.2 (Younger Cell: Fatigue Survey)

YOUNGER CELL										
Fatigue Question	7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	12:00 - 13:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 16:35
M O N D A Y	Employee 1	2	3	4	4	5	4	5	8	7
	Employee 2	1	3	3	5	7	5	5	5	6
	Employee 3	3	1	5	6	5	5	5	6	6
	Employee 4	4	3	3	6	6	4	5	5	6
	Employee 5	6	4	4	7	6	6	7	7	8
	Employee 6	4	3	3	5	5	6	8	9	10
	Employee 7	2	3	6	5	7	7	8	9	10
	Employee 8	1	3	6	4	7	7	6	8	10
	Employee 9	4	4	5	5	7	6	7	8	9
	Employee 10	5	4	4	4	8	5	6	7	8
	3.20	3.10	4.30	5.10	6.30	5.50	6.20	7.20	7.90	8.40
T U E S D A Y	Employee 1	2	3	5	4	3	3	4	5	7
	Employee 2	3	5	6	4	4	4	4	6	7
	Employee 3	1	5	4	5	5	5	5	8	8
	Employee 4	3	3	4	6	3	5	4	8	9
	Employee 5	2	4	3	6	4	4	5	7	10
	Employee 6	3	3	2	8	2	4	6	7	9
	Employee 7	4	4	3	5	2	3	5	6	7
	Employee 8	5	4	3	4	1	5	4	8	8
	Employee 9	2	5	4	3	1	3	4	6	8
	Employee 10	3	4	4	4	3	3	5	7	9
	2.80	4.00	3.70	4.90	2.80	3.90	4.60	6.80	8.20	8.30
W E D N E S D A Y	Employee 1	2	4	5	5	4	2	3	3	4
	Employee 2	3	5	6	6	5	4	4	4	6
	Employee 3	4	5	5	4	6	3	2	4	4
	Employee 4	3	5	5	4	5	4	5	5	3
	Employee 5	1	7	6	5	4	4	4	5	5
	Employee 6	2	8	7	6	3	3	4	4	5
	Employee 7	1	5	6	5	4	2	3	5	7
	Employee 8	3	3	4	5	4	4	5	6	8
	Employee 9	6	4	6	7	6	3	4	4	6
	Employee 10	5	7	7	7	5	3	3	5	5
	3.00	5.30	5.70	5.40	4.60	3.20	3.70	4.50	5.30	7.20
T H U R S D A Y	Employee 1	2	2	1	2	4	6	6	7	8
	Employee 2	2	3	3	4	5	4	5	6	8
	Employee 3	2	1	2	4	4	5	5	4	5
	Employee 4	1	2	4	4	5	4	4	4	5
	Employee 5	3	2	3	3	3	4	3	4	6
	Employee 6	3	3	2	4	5	6	5	5	7
	Employee 7	2	3	3	5	5	5	5	7	8
	Employee 8	1	2	2	4	5	5	6	8	8
	Employee 9	2	2	2	3	4	3	4	5	6
	Employee 10	2	1	2	4	3	4	4	3	5
	2.00	2.10	2.40	3.70	4.30	4.60	4.70	5.30	6.40	8.00
F R I D A Y	Employee 1	1	2	2	4	5	5	7	7	7
	Employee 2	3	3	2	4	5	4	5	5	8
	Employee 3	1	3	2	4	6	5	6	9	10
	Employee 4	2	3	3	5	5	5	6	8	9
	Employee 5	3	5	4	5	6	5	7	7	8
	Employee 6	2	3	4	4	5	6	8	8	9
	Employee 7	1	2	2	3	6	5	5	8	10
	Employee 8	2	3	2	4	5	5	6	9	10
	Employee 9	3	3	3	5	6	4	7	8	10
	Employee 10	2	2	2	4	5	4	5	7	8
	2.00	2.90	2.60	4.20	5.40	4.80	6.20	7.60	8.90	

Table 5.1 (Regression: Efficiency/Delays)

SUMMARY OUTPUT

<i>Regression Statistics</i>	
Multiple R	0.541105525
R Square	0.292795189
Adjusted R Square	0.183346826
Standard Error	21.06282478
Observations	98

ANOVA					
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>
Regression	13	15428.76793	1186.828302	2.675190198	0.00345853
Residual	84	37265.97738	443.6425879		
Total	97	52694.74531			

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Intercept	128.7273499	8.315156573	15.48104943	2.49936E-26	112.1917492	145.2629507	112.1917492	145.2629507
Fatigue Survey	-5.007528988	1.322689906	-3.785867698	0.000286611	-7.637842921	-2.377215055	-7.637842921	-2.377215055
Asking questions	-0.864850829	2.016109487	-0.428970169	0.669043092	-4.874105645	3.144403988	-4.874105645	3.144403988
Bathroom Breaks	-0.005413569	0.305575603	-0.017715972	0.985907451	-0.613084166	0.602257028	-0.613084166	0.602257028
Drink Water	1.001833623	1.318706432	0.759709363	0.449555221	-1.620558736	3.624225982	-1.620558736	3.624225982
Throw Trash	0.835339965	1.256287047	0.664927627	0.507918249	-1.662924601	3.333604531	-1.662924601	3.333604531
Clinic Visits	-0.21435305	1.689452225	-0.126877249	0.899340776	-3.574014076	3.145307976	-3.574014076	3.145307976
Receiving Instructions	-0.636301627	1.576904148	-0.403513192	0.687596072	-3.772148459	2.499545206	-3.772148459	2.499545206
Machine Down	-0.364360997	0.098061669	-3.715631186	0.000364242	-0.559367381	-0.169354613	-0.559367381	-0.169354613
Bring Materials	-0.607998116	0.596504532	-1.019268226	0.311002342	-1.794212795	0.578216563	-1.794212795	0.578216563
Lack of Supplies	-0.472852416	1.154669833	-0.409513094	0.683205557	-2.769040008	1.823335176	-2.769040008	1.823335176
Change of Batch	0.023058656	0.262388722	0.087879752	0.930181417	-0.498730094	0.544847406	-0.498730094	0.544847406
Rejected Garments	0.066331653	0.457113078	0.145109943	0.884971692	-0.842687834	0.97535114	-0.842687834	0.97535114
Repairs	-0.223126163	0.298960064	-0.746341032	0.45754516	-0.817641037	0.371388711	-0.817641037	0.371388711

Table 6.1 (Hourly Efficiency)

HOURLY EFFICIENCY		
Average Mon-Fri	Efficiency - 4495-1B (Experienced Cell)	Efficiency - 4450-0A (Younger Cell)
7:00 - 8:00	106.91%	93.88%
8:00 - 9:00	124.30%	111.26%
9:00 - 10:00	98.44%	95.18%
10:00 - 11:00	102.35%	99.09%
11:00 - 12:00	97.35%	100.13%
12:00 - 13:00	119.30%	88.66%
13:00 - 14:00	103.66%	73.02%
14:00 - 15:00	100.40%	89.96%
15:00 - 16:00	91.64%	93.50%
16:00 - 16:35	89.41%	83.82%

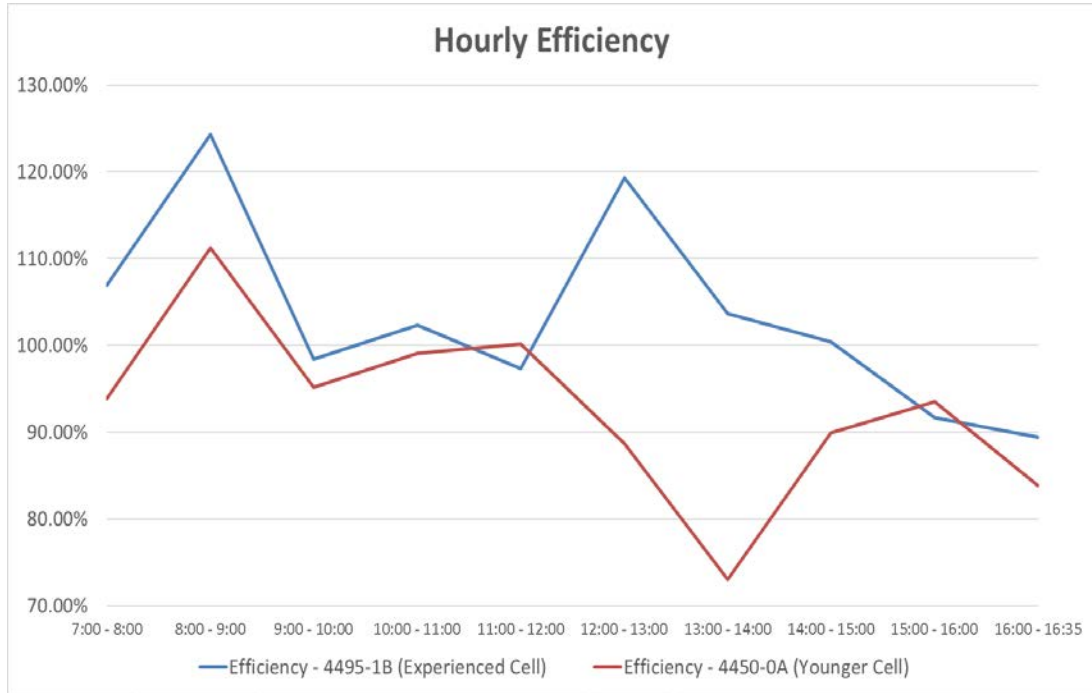


Table 6.2 (Daily Efficiency)

Daily Efficiency		
Day	Efficiency - 4495-1B (Experienced Cell)	Efficiency - 4450-0A (Younger Cell)
Monday	107.16%	90.45%
Tuesday	112.05%	91.86%
Wednesday	88.47%	100.56%
Thursday	109.99%	81.57%
Friday	100.29%	101.59%

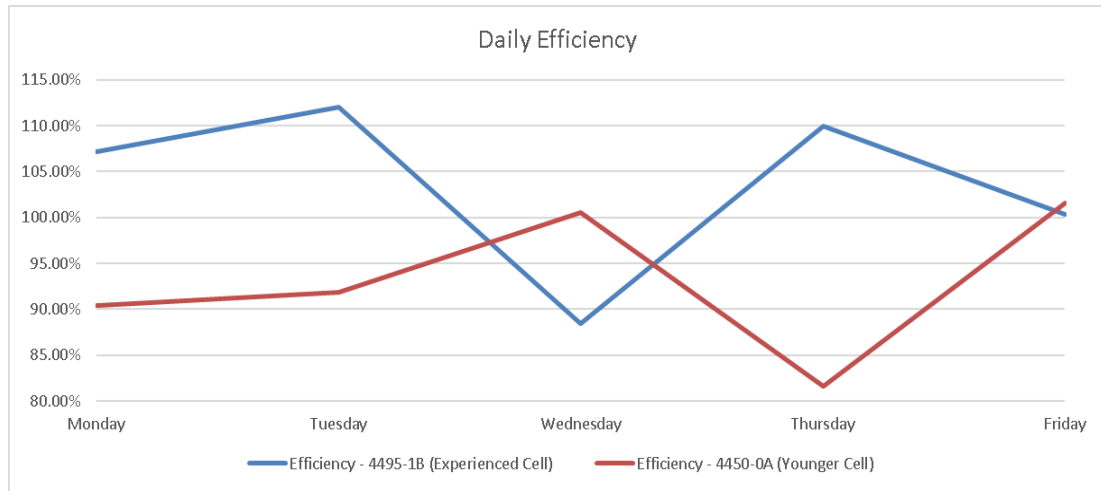


Table 7.1 (Current Weekly Schedule for Both Cells)

Current Weekly Schedule for Both Cells			
Day of Week	Start of Shift	End of Shift	Total Hours Worked
Monday	7:00 AM	4:35 PM	9 Hours
Tuesday	7:00 AM	4:35 PM	9 Hours
Wednesday	7:00 AM	4:35 PM	9 Hours
Thursday	7:00 AM	4:35 PM	9 Hours
Friday	7:00 AM	3:35 PM	8 Hours
Saturday	N/A	N/A	0 Hours
TOTAL			44 Hours

Table 7.2 (Proposed Weekly Schedule for Both Cells)

Proposed Schedule for Experienced Cell			
Day of Week	Start of Shift	End of Shift	Total Hours Worked
Monday	8:00 AM	6:00 PM	9 Hours
Tuesday	8:00 AM	6:00 PM	9 Hours
Wednesday	8:00 AM	5:00 PM	8 Hours
Thursday	8:00 AM	6:00 PM	9 Hours
Friday	8:00 AM	6:00 PM	9 Hours
Saturday	N/A	N/A	0 Hours
TOTAL			44 Hours
Proposed Schedule for Younger Cell			
Day of Week	Start of Shift	End of Shift	Total Hours Worked
Monday	8:00 AM	6:00 PM	9 Hours
Tuesday	8:00 AM	6:00 PM	9 Hours
Wednesday	8:00 AM	6:00 PM	9 Hours
Thursday	8:00 AM	5:00 PM	8 Hours
Friday	8:00 AM	6:00 PM	9 Hours
Saturday	N/A	N/A	0 Hours
TOTAL			44 Hours

Table 8.1 (Current Break Time – Experienced and Younger Cells)

Current Break Time Experienced Cell			
Break Type	Start of Break 1	End of Break 1	Total Minutes
Break 1	8:24 AM	8:39 AM	15 Minutes
Lunch	11:45 AM	12:20 AM	35 Minutes
TOTAL			50 Minutes
Current Break Times - Younger Cell			
Break Type	Start of Break 1	End of Break 1	Total Minutes
Break 1	8:10 AM	8:25 AM	15 Minutes
Lunch	11:10 AM	11:45 AM	35 Minutes
TOTAL			50 Minutes

Table 8.2 (Proposed Break Time – Experienced and Younger Cell)

Proposed Break Times - Experienced Cell			
Break Type	Start of Break	End of Break	Total Minutes
Break 1	8:24 AM	8:39 AM	15 Minutes
Break 2	2:30 PM	2:45 PM	15 Minutes
Lunch	11:10 AM	11:45 AM	35 Minutes
TOTAL			65 Minutes
Proposed Break Times - Younger Cell			
Break Type	Start of Break	End of Break	Total Minutes
Break 1	8:10 AM	8:25 AM	15 Minutes
Break 2	1:30 PM	1:45 PM	15 Minutes
Lunch	10:35 AM	11:10 AM	35 Minutes
TOTAL			65 Minutes