Production Scheduling in Reducing Overtime and Overtime Expense at Pamutongan Box Manufacturer

Stephen Lloyd Malacat Altamarino[1], John Niño Pitogo Gomez[2], Gwyneth Carao Indangan[3], Arameah Reyes Narvasa[4], Nico Lex Gerodias Racaza[5]

[1,2,3,4,5]Student, Bachelor of Science in Industrial Engineering, Cebu Technological University-Danao Campus

ABSTRACT
Many manufacturing businesses face high labor costs due to overtime, especially when meeting production quotas. Pamutongan Box Manufacturer a corrugated box producer located in Pamutongan, Jubay, Liloan, Cebu, encountered similar challenges in its Corrugator, Converting, and Extra Process Sections. This study aimed to develop a production scheduling strategy to minimize overtime and associated expenses. Data on production flow, standard task times, workforce distribution, and overtime hours were collected. Lucidchart was used to map workflows, while Microsoft Excel analyzed labor costs and production trends. The study focused on overtime during weekdays and Sundays, employing a quantitative research design. Findings showed the company's standard work time of 532.68 minutes exceeded the 450-minute workday, causing frequent overtime. The production department logged 7,471 overtime hours, involving an average of 19 workers daily, resulting in ₱552,323.40 in expenses. The average daily output was 12.5 tons, straining workforce capacity. To address this, the study proposed acquiring additional machines and optimizing manpower. A revised production schedule was developed, and a cost-benefit analysis demonstrated significant reductions in overtime and related costs.

Keywords: Overtime, Overtime Expense, Production Scheduling, Additional Machine, Cost Benefit Analysis

Chapter 1
THE PROBLEM AND ITS SCOPE
INTRODUCTION
Rationale

Pamutongan Box Manufacturer was a company that produced corrugated boxes in Pamutongan, Jubay, Liloan, Cebu. According to Mrs. Jhie, the company was owned by Ernesto Dakay Jr., and the manufacturing plant belonged to the Dakay Group of Companies. The main office operated as Miesto International Food Corporation in Mandaue City, Cebu, formerly known as Shemberg. The company's primary customers included large organizations such as Monde Nissin, Profoods, Angels Pizza, Titay's, Virginia Food Corp., and others. Mrs. Jhie shared that Pamutongan Box Manufacturer began its operations around 2019, marking five years of business. The company played a vital role in supporting other businesses by providing high-quality packaging solutions, contributing to the success of local enterprises one box at a time.

At Pamutongan Box Manufacturer, labor costs caused by overtime due to meeting production quotas had become a significant concern. In the competitive business environment, relying on overtime to meet production quotas had considerable financial implications, primarily escalating labor expenses due to higher pay rates mandated by overtime regulations (Golberg & Gage, 2022). The dependency on overtime, particularly in the Corrugator Section, Converting Section, and Extra Process Section, significantly affected operational costs and efficiency. This practice often resulted in budget overruns and reduced profit margins, especially when overtime became a routine operational method rather than a temporary solution (Tongol et al, 2023). While overtime could assist companies in achieving short-term production goals, it ultimately strained financial resources, emphasizing the need for organizations to implement strategies that balanced workforce utilization with cost control (Praveen K., 2020). At Pamutongan Box Manufacturer, the persistent reliance on overtime to fulfill production quotas had led to increasing labor costs, posing a challenge to the company's financial stability. Research suggested that effective scheduling was a crucial strategy for minimizing overtime in various industries. By aligning labor allocation with fluctuating operational demands, organizations could reduce the dependence on extended hours to meet production targets (Kaushik, 2023). Improved shift scheduling was shown to enhance operational efficiency by optimizing workforce deployment and reducing inefficiencies (Prohance, 2024).

The purpose of the study was to proposed a production scheduling for Pamutongan Box Manufacturer, aimed at reducing overtime and overtime expense. By analyzing overtime data, the study sought to develop a sustainable scheduling approach that minimizes labor costs and improve operational efficiency.

Theoretical Background

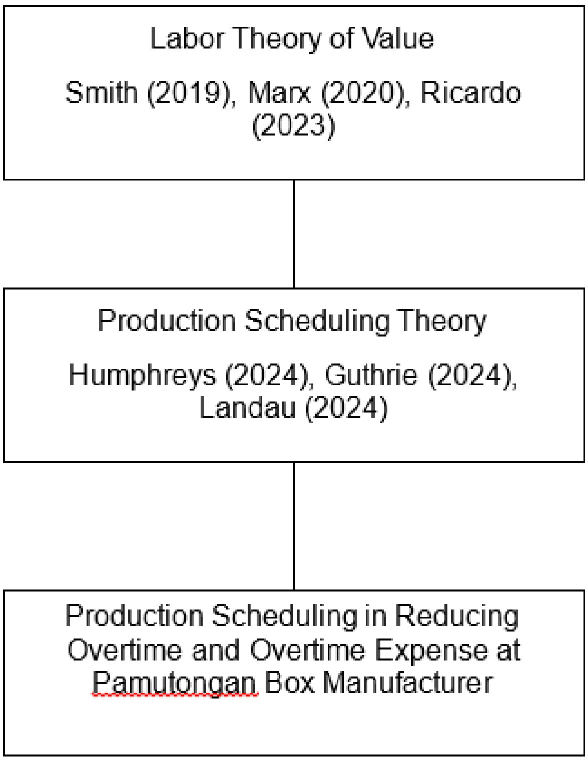

Figure 1. Theoretical Background of the Study

Figure 1 presented the theoretical background of the study, asserting that a good's value was based on the labor required to produce it. The division of labor increased productivity through specialization, while value was distinguished between exchange value, tied to trade, and use value, tied to utility. It also acknowledged the role of other inputs, like land and capital, in value creation, emphasizing labor's central role in economic growth and progress (Smith, 2019). Overtime, as an extension of labor beyond regular working hours, directly connected to the emphasis on productivity and division of labor. While additional labor hours could have increased output, prolonged reliance on overtime likely disrupted the efficiency gained through specialization, leading to diminishing productivity over time. Commodity production involved creating goods for market exchange, requiring a market and a social division of labor. Commodities had both use-value and exchange-value. In capitalism, the process involved advancing capital by investing money to increase commodity value for profit (Marx, 2020). Overtime increased the total labor input into production, which could have enhanced commodity value and profits. However, it likely also highlighted the dynamic of labor exploitation, as additional working hours often failed to result in proportional increases in compensation, benefiting capital accumulation at the expense of worker welfare. The labor theory of value posited that a good's value was based on the labor required to produce it, focusing on total production time rather than labor compensation, as seen in the example where a table requiring two hours of labor was equal in value to two chairs, each requiring one hour of labor (Ricardo, 2023). Overtime aligned with this framework by increasing the total production time of a good, thereby adding to its value. However, it raised questions about whether the cost of additional labor was accurately reflected in the pricing of goods, particularly if workers were underpaid for their extended hours.

Production scheduling focused on short-term decisions aimed at optimizing efficiency, reducing costs, and maintaining a smooth workflow in the production process. It involved creating detailed timelines, assigning tasks to workstations or production lines, and considering factors such as equipment availability, setup times, and task dependencies. Effective production scheduling helped reduce overtime by ensuring tasks were completed within regular working hours through proper planning and task allocation, minimizing the likelihood of delays or last-minute adjustments that required extended labor hours (Humphreys, 2024). Resource allocation was key, determining the optimal distribution of labor, equipment, and other resources for production tasks, with the goal of balancing workloads, and minimizing delays and bottlenecks. By efficiently distributing resources, production schedules prevented resource shortages or overuse that could have led to overtime expenses. The theory behind production scheduling described each product, its production steps, and their timing, considering logistics and raw materials. It included procedures that allowed managers to identify and address issues like bottlenecks before they escalated, which prevented situations requiring additional labor hours to compensate for lost time. The schedule required frequent updates, facilitating communication between the production and sales teams, so that sales could communicate demand levels and manufacturers could notify sales when products were ready (Guthrie, 2024). This collaboration avoided overproduction or misaligned timelines that could have created the need for overtime. Production scheduling was a key component of the broader supply chain, addressing labor, raw material acquisition, transportation, costs, and production schedules. Manufacturers addressed production scheduling before starting the manufacturing process, as it influenced labor and production-related expenses. By carefully planning and allocating funds for each stage of the production cycle, manufacturers minimized the risk of overtime costs due to unanticipated delays or inefficiencies (Landau, 2024).

Production scheduling at Pamutongan Box Manufacturer helped address overtime and its expenses by organizing workflows and allocating resources effectively. By carefully planning tasks and balancing workloads, overtime and overtime expense are minimized, allowing production to be completed within regular working hours. This approach ensures that the labor at the company is utilized appropriately, reducing the reliance on extended work hours that drive up costs. It aligns the efforts of workers with production goals, preventing unnecessary expenditures while maintaining consistent output.

Review of Related Literature

The process flow within manufacturing companies was emphasized as a key strategy for streamlining operations, enhancing productivity, and reducing inefficiencies. Tools like flow charts were recognized as effective in analyzing and improving production efficiency (Pydimarry, 2023). For Pamutongan Box Manufacturer, the process flow served as a valuable approach for improving operational performance, reducing waste, and increasing overall productivity in its manufacturing processes. The importance of determining standard times was highlighted as a means to optimize efficiency, reduce operational delays, and enhance productivity. By analyzing workflows and identifying the time required for each process, the study provided a framework for achieving consistent output and maintaining quality standards. This approach allowed organizations to balance workforce allocation and streamline production schedules effectively. The findings supported the objective of evaluating and implementing standard times for each process at Pamutongan Box Manufacturer to improve operational efficiency and address labor cost management challenges (Saliba, 2019). A comprehensive framework showed how standardized processes could enhance coordination, ensure compliance with regulations, and streamline operational efficiency by optimizing processing times. By discussing these approaches, organizations could achieve more consistent output, improve overall productivity, and drive continuous performance improvements in their operations (Münstermann, et al., 2021).

Overtime referred to documenting the additional hours an workers worked beyond their product's standard schedule. This process ensured accurate calculation of overtime pay and could be performed manually or automatically. According to Bonifacio (2024), time tracking was essential for maintaining a clean, legal record of how much workers worked per day, week, or month. The primary objective was to reliably monitor workers hours to determine eligibility for overtime compensation. For Pamutongan Box Manufacturer, tracking overtime hours was crucial for ensuring compliance with labor laws by accurately recording extra hours worked, thus preventing legal issues and penalties related to improper overtime pay (Bonifacio, 2024). Hours beyond regular working hours were tracked, as noted by Stojanovic (2022). The tracking of overtime hours at Pamutongan Box Manufacturer included hours worked by workers during weekends, holidays, or outside of their scheduled shifts (Kenai Gonzales, 2024).

Additionally, the tracking of overtime hours was systematically organized per department or section within the company. The systematic monitoring of overtime hours across departments was essential for improving productivity, ensuring equitable compensation, maintaining compliance with labor regulations, and optimizing operational efficiency. According to Exaktime (2024), analyzing overtime trends and using detailed departmental or role-specific reports enabled managers at Pamutongan Box Manufacturer to identify areas of overutilization and set targets for optimal overtime use, ultimately improving productivity. A recent study by Tarika (2024) emphasized the value of workers formation reports for tracking workforce metrics. These reports, which included data on workers headcount and overtime hours, helped the company identify workload issues, turnover trends, and staffing needs.

In the modern economic environment, where businesses continually strive to improve competitiveness and profitability, effectively understanding and managing labor costs had become a crucial component of financial management (Duy Nguyen, 2023). Labor costs at Pamutongan Box Manufacturer could increase due to inefficiencies, overtime work, and high turnover (theintactone, 2024). Under Wage Order No. ROVII-24, the minimum wage in Region VII for Class A areas increased from PHP 435 to PHP 468. Overtime pay was calculated by multiplying the worker's hourly wage by a percentage and the number of overtime hours, as outlined in The Labor Code of the Philippines. Furthermore, Vega (2024) stated that overtime pay increased by 125% on regular days, 130% on rest days, 150% on non-working holidays, and 200% on regular holidays. For Pamutongan Box Manufacturer, accurate overtime tracking was critical to ensure that the company adhered to these regulations and maintained fair compensation for its workforce. The relationship between overtime work and weekly output in manufacturing environments is complex. While overtime can initially increase production capacity, a study by Sean (2024) indicated that its effectiveness diminishes over time. Output increases proportionately up to about 48 hours per week, but rises at a slower rate thereafter. Notably, working 70 hours yields nearly the same output as working 56 hours, suggesting that excessive overtime does not significantly enhance productivity and could lead to inefficiencies and burnout among workers. This indicates that companies, including Pamutongan Box Manufacturer, should carefully consider their overtime policies to avoid counterproductive outcomes. A study highlighted by Celayix (2020) revealed that excessive overtime could significantly decrease workers output, with a 10% increase in overtime leading to a 24% decrease in output per hour. This finding is highly relevant to Pamutongan Box Manufacturer, as it underscores the importance of balancing workloads to maintain productivity. In a manufacturing setting, where efficiency and output are critical, relying too heavily on overtime may lead to diminishing returns, ultimately affecting both production quality and speed. Therefore, the company should adopt strategies to balance regular working hours with overtime to optimize productivity and prevent worker burnout.

Creating clear overtime policies is essential for managing labor costs and ensuring a fair distribution of work among workers. These policies should outline the maximum allowable overtime hours and specify which workers are eligible for overtime. By capping overtime at reasonable levels, companies, including Pamutongan Box Manufacturer, can prevent burnout and improve worker engagement (Icehrm, 2023). When combined with optimized shift schedules, which balance workloads more effectively across shifts, companies can further minimize the need for extended hours. Techniques such as flexible schedules, staggered start times, and rotating shifts can help achieve this, making work more evenly distributed and reducing overtime reliance (Jun, S., 2021).

In practice, production scheduling patterns may result in extended work periods but with scheduled days off. These patterns can help manage peak workloads, but they also require careful planning to avoid overburdening workers (Samel, M., 2020). A significant factor in managing overtime is maintaining appropriate staffing levels. Understaffing leads to excessive overtime because companies may only schedule enough workers to meet the bare minimum demands, leaving no buffer for surges in work. Conducting a workforce analysis to determine the optimal number of workers for each shift can help reduce the need for overtime (Circadian, 2024).

Incorporating demand-based staffing and advanced scheduling tools can further optimize workforce planning. By adjusting schedules based on real-time demand, businesses can align workers availability with operational needs. This approach helps prevent excessive overtime, which not only increases labor costs but also leads to worker fatigue (Kanwal, M., 2024). Together, these strategies provide a comprehensive approach to reducing overtime hours, cutting overtime expenses, and increasing overall efficiency, which would be beneficial for Pamutongan Box Manufacturer in optimizing their workforce and controlling labor costs.

THE PROBLEM

Statement of the Problem

The purpose of the study was to proposed a production scheduling for Pamutongan Box Manufacturer, aimed at reducing overtime and overtime expense. By analyzing overtime data, the study sought to develop a sustainable scheduling approach that minimizes labor costs and improve operational efficiency.
Specifically, the study sought to answer the following questions:

1. What is the process flow of the production department at Pamutongan Box Manufacturer?
2. What is the standard time for each process of the production department at Pamutongan Box Manufacturer?
3. What are the weekly overtime hours recorded for each section at Pamutongan Box Manufacturer during regular working days Sunday working days?

3.1 Corrugator Section:
3.1.1 Regular Working Days?
3.1.2 Sunday Working Days?
3.2 Converting Section:
3.2.1 Regular Working Days?
3.2.2 Sunday Working Days?
3.3 Extra Process Section:
3.3.1 Regular Working Days?
3.3.2 Sunday Working Days?

4. What is the daily average total number of workers working overtime per week for each section at Pamutongan Box Manufacturer?

4.1 Corrugator Section?
4.2 Converting Section?
4.3 Extra Process Section?

5. What is the estimated expense associated with the weekly overtime hours for each department at Pamutongan Box Manufacturer during regular working days Sunday working days?

5.1 Corrugator Section:
5.1.1 Regular Working Days?
5.1.2 Sunday Working Days?
5.2 Converting Section:
5.2.1 Regular Working Days?
5.2.2 Sunday Working Days?
5.3 Extra Process Section:
5.3.1 Regular Working Days?
5.3.2 Sunday Working Days?

6. What is the current number of workers for each process of the production department at Pamutongan Box Manufacturer?

7. What is the daily average output produced per week by Pamutongan Box Manufacturer?
8. Based on findings, what is the possible recommendation to reduce overtime and overtime expense in Pamutongan Box Manufacturer?

Significance of the Study

The significance of the research was that it provided information for improvement that was useful to the individuals involved in the study. The following were the beneficiaries of this study:

Pamutongan Box Manufacturer Management: The study allowed the company to implement a more efficient scheduling, reducing overtime costs, enhancing productivity, and meeting production targets without overburdening the workforce. This contributed to improved operational efficiency, financial performance, and long-term sustainability.

Industry Stakeholders: The findings of the study served as a model for other businesses facing similar challenges with overtime and workforce management, offering a practical framework minimizing overtime and overtime expense through production scheduling.

Workers: The study highlighted the benefits of a well-balanced scheduling with adequate staffing, which helped reduce overtime, prevent burnout, and improve job satisfaction. The hiring of additional workers for a second shift ensured that workers were not overworked, promoting better retention and morale.

Future Researchers: The study provided a foundation for further exploration into the effectiveness of production scheduling and strategic hiring in manufacturing settings, contributing to the understanding of labor cost reduction and workforce optimization strategies.

Scope and Limitation

The scope of the study was to propose a production scheduling approach aimed at reducing overtime and overtime expenses at Pamutongan Box Manufacturer. The study collected input from key stakeholders, including production managers and the HR manager, to better understand the challenges related to overtime and overtime expenses, as well as preferences regarding scheduling, such as the process flow, the standard time for each process flow, and the required number of workers for each process. The research was based on data from Pamutongan Box Manufacturer and covered four months of historical overtime data.

The limitations of the study included several key constraints. First, the researchers did not address issues such as employee absenteeism, tardiness, or undertime, as the primary focus was on proposing production scheduling to reduce overtime and overtime expenses. The study also did not involve conducting a time study or utilizing system dynamics to simulate the impact of the proposed scheduling model. The research relied on a limited four-month period of historical data, which may not have accounted for long-term fluctuations in overtime patterns or external disruptions. Finally, the study depended on the accuracy and completeness of the existing data provided by the company, which may have been inconsistent and could have affected the reliability of the findings. Despite these limitations, the study aimed to propose a production scheduling approach and provide practical recommendations.

RESEARCH METHODOLOGY

Research Design

This study employed a quantitative research design to propose a production scheduling at Pamutongan Box Manufacturer. The researchers collected and analyzed data on the company's process flow, overtime hours, estimated expenses, workforce distribution, and production outputs.

Research Process and Flow

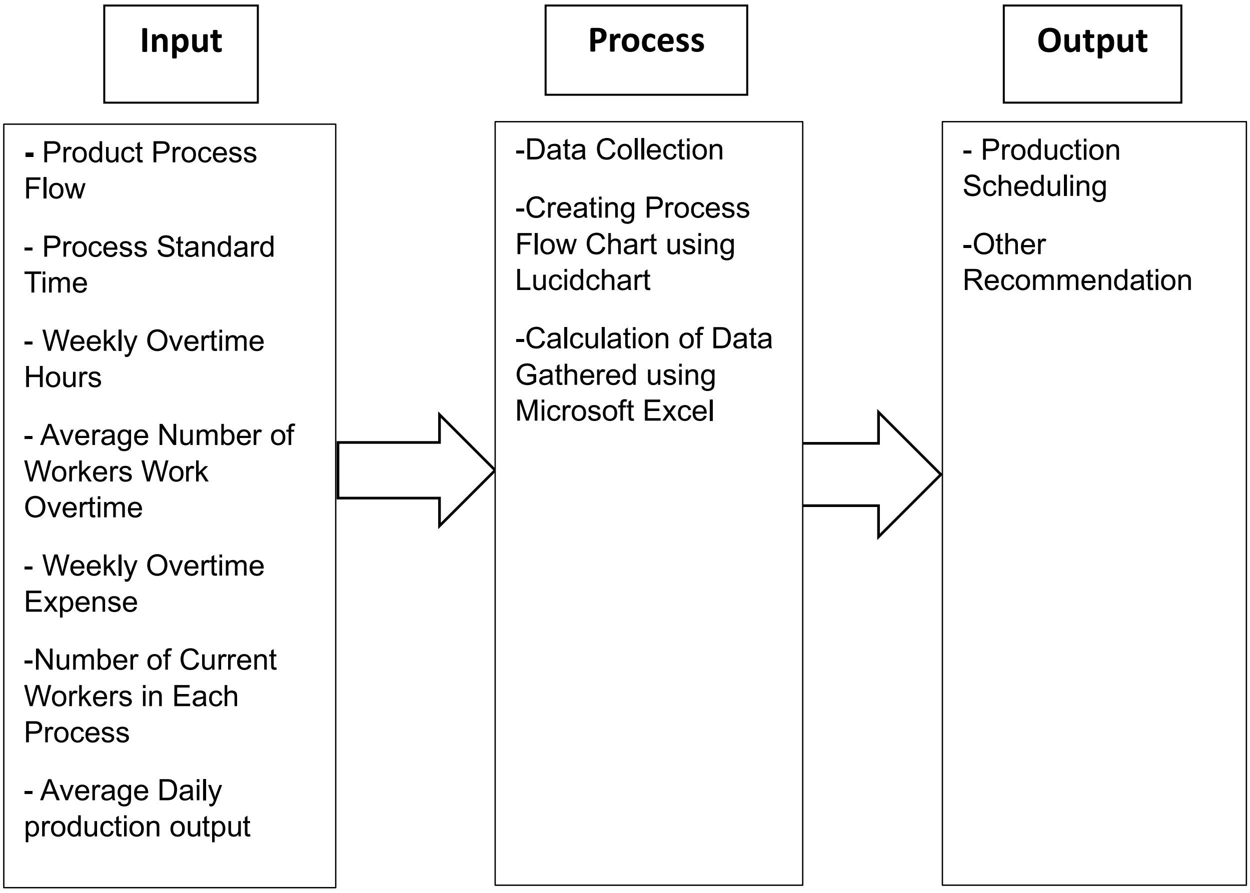

Figure 2. Flow of the Study

Figure 2 presented the research process flow of the study, where the researchers gathered important data, including the product process flow, process standard time, weekly overtime hours, the average number of workers performing overtime, estimated weekly overtime expenses, the number of required workers in each process, and the average daily production output per week. This information helped to form the basis for further analysis.

The gathered data were carefully examined to ensure accurate and reliable information was obtained. First, data collection was conducted to ensure the information was reliable. This was followed by the creation of a process flow chart using Lucidchart to visually represent the company's current production flow. The calculation and analysis of the collected data followed, which helped identify the relationships between overtime, overtime expense, and production output by adding the daily total overtime hours, daily number of workers working overtime, estimated daily overtime expense, and daily production output using Microsoft Excel.

The study concludes with the proposed production scheduling that aimed to minimize overtime and overtime expense at Pamutongan Box Manufacturer. Other recommendations are developed that improve the scheduling process, optimize labor use, and minimize unnecessary overtime expense.

Research Environment

Figure 3 Vicinity Location of Pamutongan Box Manufacturer

Figure 4. Vicinity Map of Pamutongan Box Manufacturer

Figure 3 showed Pamutongan Box Manufacturer, located in Pamutongan, Jubay, Liloan, Cebu. Jubay was a barangay situated between barangays Cotcot and Poblacion in the municipality of Liloan. The study site was located at a latitude of 10.4202°N and a longitude of 123.9924°E. From the Central Nautical Highway Fatima Road, the distance to was 1.3 km. Figure 4 showed the neighboring companies of Pamutongan Box Manufacturer, with Ceed Forming Corporation on the left side, Roy & Wilma Store and Nelzy Store at the front, Global Farmers Agricultural Supply as the nearest landmark on the right, and Gold Coast Oil and Environment and Hawood Compound behind the company.

Research Instrument

The research instruments utilized in the study were Microsoft Excel and Lucidchart, selected for their ability to effectively collect, analyze, and visualize data related to labor cost management and overtime reduction. Microsoft Excel was employed to gather and organize quantitative data, including weekly overtime hours, number of workers work overtime, overtime expense, and production output. The software facilitated the calculation of total labor and overtime expenses through the use of built-in formulas and functions. Lucidchart was used to develop detailed process flowcharts that mapped the company's production workflows.

Procedures of Data Gathering

The researchers began by identifying key areas for data collection with the assistance of Pamutongan Box Manufacturer's HR manager and production manager. These areas included the company's process flow, standard time, overtime hours, number of workers involved in overtime, overtime expenses, number of required workers for each process, and weekly production output. They first gathered the process flow from the company, which allowed them to visualize the workflows within the production departments. Subsequently, they collected data on the standard time allocated for each task and the required number of workers for each process. The researchers then analyzed overtime records to track the total overtime hours worked in each department and the number of workers involved. Overtime expenses were estimated based on the minimum wage and applicable overtime laws. Additionally, they gathered data on the company's weekly production output to complete their analysis.

Treatment of Data

In problem 1, the data related to the production process at Pamutongan Box Manufacturer was visualized by creating a process flow chart using Lucidchart. The process flow was developed by gathering detailed information from the company's production manager. The gathered data was then used to map out each step of the production process.

In problem 2, the standard time were inputted into Microsoft Excel for compilation of each production process, ensuring that the data was neatly organized for easy reference and comparison.

In problem 3, the data related to weekly overtime hours for each section at Pamutongan Box Manufacturer, categorized into regular working days and Sundays, were analyzed by adding up the daily recorded overtime hours for each section. Data for the Corrugator Section, Converting Section, and Extra Process Section were segregated into two categories: regular working days and Sunday working days. The daily overtime hours for each category were recorded and compiled into Microsoft Excel for accurate computation. Weekly overtime hours were calculated by adding up the daily values for each category within the specified timeframes. Separate totals were determined for regular working days and Sundays to provide a clear comparison of overtime hours.

In problem 4, the researchers calculated the total number of workers working overtime for each section at Pamutongan Box Manufacturer by summing the daily number of workers working overtime in each section. Data were collected for the Corrugator Section, Converting Section, and Extra Process Section, with the daily overtime work hours for each worker recorded. The researchers added up the number of workers working overtime each day across all days for each section and average it to determine the total number of workers working overtime using Microsoft Excel and calculate the daily average workers working overtime.

In problem 5, the researchers calculated the estimated expense associated with the weekly overtime hours for each department at Pamutongan Box Manufacturer by using Microsoft Excel. The weekly overtime hours for each section, including the Corrugator Section, Converting Section, and Extra Process Section, were multiplied by the applicable minimum wage per hour and the overtime rates.

In problem 6, the current number workers in each process were inputted and calculated into Microsoft Excel for the compilation of how many workers are required in each production process, ensuring that the data was neatly organized for easy reference and comparison. The researchers calculated the total number of current workers by adding all the workers per process.

In problem 7, the researchers determined the average daily output produced by Pamutongan Box Manufacturer per week by adding the daily production outputs generated by workers working beyond their regular shifts. Data on the daily output quantities were collected from production logs and categorized based on the work completed during overtime hours. To calculate the average output, the weekly totals were divided by 7 days per week, and the average output per day was determined. The researchers then totaled all the calculated daily averages and found the overall daily average output per week.

DEFINITION OF TERMS

Converting Section: This is the department where the raw corrugated sheets are transformed into finished products like boxes or other types of packaging at Pamutongan Box Manufacturer. It involves processes like cutting, printing, and assembling the materials to create the final product ready for shipment.

Corrugator Section: The department where corrugated cardboard sheets are produced at Pamutongan Box Manufacturer. This involves taking layers of paperboard and bonding them together using heat and adhesives to create a strong, flexible material used in packaging.

Extra Process Section: The area responsible for any additional or special tasks that go beyond regular production steps at Pamutongan Box Manufacturer.

Overtime Expense: The additional labor costs incurred by Pamutongan Box Manufacturer due to workers working beyond their regular scheduled hours. These included wages paid at an overtime rate, as mandated by labor regulations, and represented a significant financial impact on the company's operational budge

Chapter 2

PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

This chapter included the presentation of results, analysis, and interpretation of data gathered in the study. It showed the findings from the data provided by Pamutongan Box Manufacturer regarding overtime, with a focus on reducing overtime and overtime expenses by proposing a production scheduling.

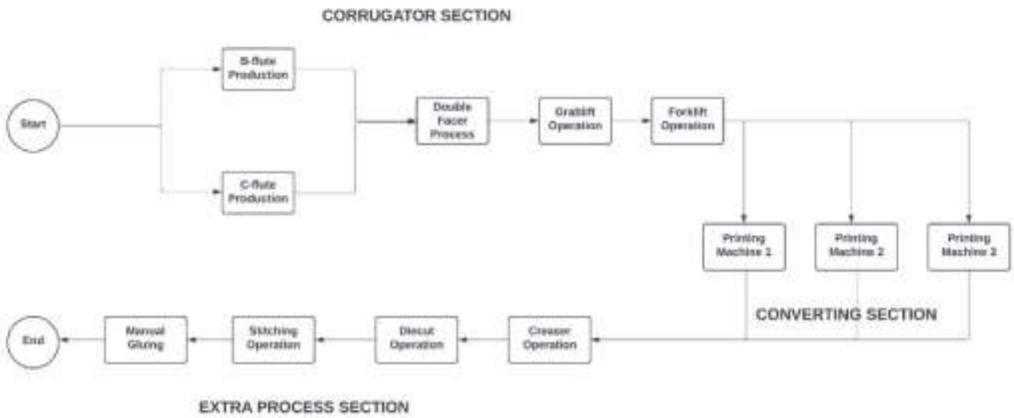

Figure 5. Process Flow Chart

Figure 5 illustrates the production flow at Pamutongan Box Manufacturer, showcasing three major sections: the Corrugator Section, Converting Section, and Extra Process Section. The process begins with B-flute and C-flute materials, essential for producing corrugated boards with varied flute types. These flutes determine the strength and cushioning properties of the final product, which are critical for packaging durability. The Double Facer Process then binds the corrugated medium to the linerboards, adding structural integrity to the material. Material handling operations, such as the Grab lift and Forklift Operations, follow, ensuring efficient movement of heavy rolls and goods within the production area. The flow then progresses to the Converting Section, where Printing Machines 1, 2, and 3 perform critical branding, labeling, and design tasks. Finally, the Extra Process Section refines the corrugated products. The Die Cut Operation shapes the materials into its customized design, while Creaser Operation creates creases to facilitate folding, while the Stitching Operation and Manual Gluing address assembly tasks requiring precision.

Different flute types, such as B-flute and C-flute, directly influence the mechanical properties of corrugated packaging, including its strength and shock absorption, as seen in the Corrugator Section, where these materials are produced to meet durability requirements (Glittenberg, 2021). Efficient material handling systems, such as forklifts and grab lifts, help minimize production delays and improve workflow efficiency, which is reflected in the Grab lift Operation and Forklift Operation, ensuring smooth transitions between stages (Taher et al., 2024). High-quality printing, represented by the three Printing Machines in the Converting Section, significantly impacts the competitiveness of manufacturers by enabling branding and customized packaging designs (Szopa et al., 2024). Finally, the Die-cut Operation in the Extra Process Section is critical for creating flexible and customized packaging designs, allowing manufacturers to adapt products to various shapes and sizes, meeting diverse customer needs (Forestpackage, 2023).

Table 1. Process Standard Time

Section	Process	Standard time (minutes)
Corrugator	B-flute and C-flute Production Double Facer	40
	Grab lift Operation	14.40
	Forklift Operation	17.28
Converting	Printing Machine 1 Printing Machine 2 Printing Machine 3	35
Extra Processes	Die cut Operation	131
	Creaser Operation	82
	Stitching Operation	77
	Manual Gluing	136
Total Standard Time		**532.68**

Table 1 presented the standard time for various processes in the production department at Pamutongan Box Manufacturer, which were essential for ensuring smooth and efficient operations across the different stages of production. The B-flute, C-flute, and double facer processes, operating as a single-line workflow, were allocated a standard time of 40 minutes, reflecting their streamlined yet essential role in forming the base structure of the boxes. Supporting operations, such as the grab lift operation (14.40 minutes) and forklift operation (17.28 minutes), provided the necessary material handling capabilities, ensuring a smooth transition of materials within the production line. In the converting section, the standard times for printing machines and post-processing tasks like die-cutting (131 minutes), creasing (82 minutes), stitching (77 minutes), and manual gluing (136 minutes) revealed the complexity and labor-intensive nature of these downstream activities. These processes required careful coordination to meet quality standards while maintaining efficiency. The total standard time of 532.68 minutes illustrated the cumulative effort needed to produce 1.06 metric tons of corrugated boxes. It reflected a balance between the speed of initial processes and the precision of finishing operations, a critical consideration for any startup aiming to establish a foothold in the market. These benchmarks not only provided a clear understanding of time allocation but also emphasized the importance of optimizing workflows to reduce potential bottlenecks. As a starting point for a new business, this data underscored the value of establishing well-defined processes to ensure consistent output while allowing room for future improvements as the business scaled and demand grew.

The standard processes outlined were vital benchmarks for maintaining operational efficiency in the production of corrugated boxes at Pamutongan Box Manufacturer (Luther, 2024). The B-flute, C-flute, and double facer processes showcased the importance of single-line workflows in ensuring consistency and reliability in production (Mahalik, 2021). Supporting tasks such as the grab lift and forklift operations played a crucial role in streamlining material handling and preventing delays within the production flow (Taher et al. (2024). Downstream activities like die-cutting, creasing, stitching, and manual gluing highlighted the labor-intensive nature of finishing operations, emphasizing the need for precision to meet quality standards (Behrens, 2020). Overall, these processes balanced efficiency and accuracy, serving as a foundation for startups to achieve consistent output while preparing for future growth and scalability (Fitas, 2023).

Table 2. Total Weekly Overtime Hours at Production Department

Date (2024)	**Regular Working Days Overtime Hours (Corrugator Section)**	**Sunday Working Days Overtime Hours (Corrugator Section)**	**Regular Working Days Overtime Hours (Converting Section)**	**Sunday Working Days Overtime Hours (Converting Section)**	**Regular Working Days Overtime Hours (Extra Process Section)**	**Sunday Working Days Overtime Hours (Extra Process Section)**	**Total Overtime Hours**
June 01-June 07	**132.5**	**41**	**92**	**32.5**	**115.5**	**43**	**456.5**
June 08-June 14	**150.5**	**38.5**	**132.5**	**27.5**	**143.5**	**34**	**526.5**

June 15-June 21	119.5	31.5	87.5	32.5	96.5	32	399.5
June 22-June 28	122.5	42	102	35	109.5	40	451
June 29-July 05	127.5	56	86.5	34	81	44	429
July 06-July 12	113	53	68.5	32	95.5	27	389
July 13-July 19	152	51.5	116.5	43	137	43	543
July 20-July 26	102	39	79.5	29.5	90	40	380
July 27-Aug 02	134.5	42	104	24	112	24	440.5
Aug 03-Aug 9	104.5	42	74	33.5	90.5	41	385.5
Aug 10-Aug 16	118	49	84.5	31.5	84.5	35	402.5
Aug 17-Aug 23	115	63	78.5	36	97.5	40	430
Aug 24-Augt 30	103	36	98	30	92	42	401

Aug 31-Sept 06	**127**	**37**	**81.5**	**27**	**83**	**31.5**	**387**
Sept 07-Sept 13	**98**	**55.5**	**50.5**	**51.5**	**79**	**52**	**386.5**
Sept 14-Sept 20	**147**	**62**	**108**	**51**	**130**	**50**	**548**
Sept 21-Sept 27	**153**	**56.5**	**110**	**42**	**107**	**47**	**515.5**
Total							**7471**

Table 2 presented the total overtime hours accrued by the production department at Pamutongan Box Manufacturer from June 1 to September 27, 2024. In the first week of June (June 1–June 7), total overtime hours amounted to 456.5 hours, with significant overtime in the Corrugator Section (132.5 hours for regular working days) and the Converting Section (92 hours for regular working days). The Extra Process Section also contributed with 115.5 regular overtime hours. This pattern of overtime increased in the following week, June 8–June 14, with a rise in total overtime to 526.5 hours, driven mainly by Converting Section overtime (132.5 hours for regular working days) and Extra Process Section overtime (143.5 hours for regular working days). The data showed fluctuations across the summer months, with July 13–July 19 recording the highest total overtime of 543 hours. This surge was driven by overtime in all sections, particularly the Converting Section (116.5 hours for regular working days) and the Extra Process Section (137 hours for regular working days), indicating a peak in production demands or staffing shortages during this period. In contrast, the lowest total overtime was observed during July 20–July 26, with 380 hours. This week experienced lower overtime across all sections, particularly in the Converting and Extra Process Sections. As the months progressed into August and September, overtime hours remained relatively high, with September 14–September 20 peaking at 548 total overtime hours, the highest recorded in the latter half of the year. This surge could be attributed to sustained overtime in both the Corrugator (147 hours) and Converting Sections (108 hours). Conversely, the week of September 7–September 13 had a total of 386.5 overtime hours, showing a slight dip compared to the other weeks. The overall total overtime for the period from June 1 to September 27 amounted to 7,471 hours, indicating a persistent reliance on overtime to meet production targets.

The total overtime hours data from June 1 to September 27, 2024, revealed a consistent pattern of reliance on overtime across all sections of the production department at Pamutongan Box Manufacturer. The overall trend indicated that overtime was a recurring necessity, likely driven by fluctuating production demands, staffing levels, and operational challenges. The data suggested that the production process was not entirely aligned with regular working hours, necessitating the extension of workdays to meet production targets. Despite the variability in the weekly totals, the continuous use of overtime pointed to an underlying issue of either increased demand for products or insufficient labor during standard hours. The surge of overtime during peak periods, such as the week of July 13 to July 19, which recorded the highest overtime hours (543 hours), may have been driven by unanticipated demand or supply chain disruptions, exacerbating labor costs and worker fatigue (Askarov, 2024). Conversely, weeks with lower overtime hours, like June 15 to June 21, demonstrated the benefits of improved scheduling practices, which have been shown to enhance worker well-being and reduce labor costs (Ranta et al., 2019). Despite these fluctuations, sustained reliance on overtime, particularly on Sundays, aligned with findings by Heizer et al. (2019), who identified weekend shifts as essential but potentially detrimental to worker health if overused. Furthermore, studies by Masa (2023) and Howe (2023) emphasized the need for alternative strategies, such as better resource allocation and shift optimization, to reduce inefficiencies and avoid overburdening workers. The data also suggested that excessive overtime, while sometimes necessary, increased operational costs and could diminish long-term productivity if not managed effectively, as noted by Huang et al. (2020). In conclusion, while overtime remained a key strategy for meeting production targets, the data supported the need for improved scheduling and resource planning to optimize workforce efficiency and reduce the adverse effects on both costs and employee well-being.

Table 3. Total Daily Average Number of Workers Work Overtime per Week

Date (2024)	**Average Number of Workers Working Overtime (Corrugator Section)**	**Average Number of Workers Working Overtime (Converting Section)**	**Average Number of Workers Working Overtime (Extra Process Section)**	**Total Number of Workers Working Overtime**
June 01-June 07	8	5	7	20
June 08-June 14	8	7	8	23
June 15-June 21	7	5	6	18
June 22-June 28	6	5	5	17
June 29-July 05	7	6	6	19
July 06-July 12	6	5	5	17
July 13-July 19	7	6	6	19
July 20-July 26	6	5	5	17
July 27-Aug 02	6	5	5	17

Aug 03-Aug 9	8	6	6	20
Aug 10-Aug 16	6	5	5	17
Aug 17-Aug 23	8	6	6	21
Aug 24-Augt 30	6	5	5	17
Aug 31-Sept 06	7	6	6	20
Sept 07-Sept 13	7	6	6	20
Sept 14-Sept 20	8	7	7	22
Sept 21-Sept 27	8	6	6	20
Average				**19**

Table 3 showed the number of workers working overtime across three sections—Corrugator, Converting, and Extra Process—over a period from June to September 2024. In the first week, June 01–June 07, a total of 20 workers worked overtime, with 8 from the Corrugator section, 5 from Converting, and 7 from Extra Process. The following week, June 08–June 14, saw an increase in overtime, with 23 total workers, driven by higher numbers in both the Converting and Extra Process sections, which reached 7 and 8 workers, respectively. During the weeks of June 15–June 21 and June 22–June 28, the total number of workers dropped to 18 and 17, respectively, reflecting reduced overtime demands. In July 06–July 12, the total again reached 17, with consistent numbers across all sections. The week of August 17–August 23 showed another peak with 21 total workers, as overtime remained high in the Converting and Extra Process sections, each having 6 workers. The trend of fluctuating overtime continued, with lower totals of 17 in several weeks, such as July 20–July 26 and August 24–August 30, before rising again to 22 in September 14–September 20. Throughout the period, the average number of workers working overtime remained consistent at 19, indicating ongoing demands for overtime with occasional spikes based on production needs.

The fluctuations in overtime across the different weeks emphasize the complex nature of production schedules and the ways in which different sections react to varying demands (Tina, 2024). The importance of the Corrugator Section in maintaining overall workflow, with its high overtime numbers reflecting its pivotal role in the production process. Spikes in overtime, such as those seen in early June, are often driven by external factors like client demand, making overtime a necessary strategy to meet tight deadlines (Circadian, 2024). Effective resource allocation and forecasting can prevent unnecessary overtime, which is especially relevant in periods like late July when the scheduling approach seemed to help stabilize overtime hours (Bari et al., 2024). The correlation between localized overtime surges and production bottlenecks, particularly in the Corrugator Section during certain weeks, further highlights how specific areas of production can influence overall overtime levels (Dash, 2024). Strategic workforce management during low-demand periods can avoid unnecessary strain on workers, as seen in the drop of overtime in late August (Krauß A., 2023). Finally, fluctuations in overtime, like those in early September, reflect the cyclical nature of demand that can be expected as part of regular production cycles (Tina, 2024).

Table 4. Estimated Total Overtime Expense

Date (2024)	Regular Working Days Overtime Expense (Corrugator Section)	Sunday Working Days Overtime Expense (Corrugator Section)	Regular Working Days Overtime Expense (Converting Section)	Sunday Working Days Overtime Expense (Converting Section)	Regular Working Days Overtime Expense (Extra Process Section)	Sunday Working Days Overtime Expense (Extra Process Section)	Total Overtime Expense
June 01- June 07	₱9,689.1	₱3,118.1	₱6,727.5	₱2,471.6	₱8,445.9	₱3,270.2	₱33,722.3
June 08- June 14	₱11,005.3	₱2,927.9	₱9,689.1	₱2,091.4	₱10,493.4	₱2,585.7	₱38,792.8
June 15- June 21	₱8,738.4	₱2,395.6	₱6,398.4	₱2,471.6	₱7,056.6	₱2,433.6	₱29,494.2
June 22- June 28	₱8,957.8	₱3,194.1	₱7,458.8	₱2,661.8	₱8,007.2	₱3,042.0	₱33,321.6
June 29- July 05	₱9,323.4	₱4,258.8	₱6,325.3	₱2,585.7	₱5,923.1	₱3,346.2	₱31,762.6
July 06- July 12	₱8,263.1	₱4,030.7	₱5,009.1	₱2,433.6	₱6,983.4	₱2,053.4	₱28,773.2
July 13- July 19	₱11,115.0	₱3,916.6	₱8,519.1	₱3,270.2	₱10,018.1	₱3,270.2	₱40,109.1

July 20-July 26	₱7,458.8	₱2,966.0	₱5,813.4	₱2,243.5	₱6,581.3	₱3,042.0	₱28,104.9
July 27-Aug 02	₱9,835.3	₱3,194.1	₱7,605.0	₱1,825.2	₱8,190.0	₱1,825.2	₱32,474.8
Aug 03-Aug 9	₱7,641.6	₱3,194.1	₱5,411.3	₱2,547.7	₱6,617.8	₱3,118.1	₱28,530.5
Aug 10-Aug 16	₱8,628.8	₱3,726.5	₱6,179.1	₱2,395.6	₱6,179.1	₱2,661.8	₱29,770.7
Aug 17-Aug 23	₱8,409.4	₱4,791.2	₱5,740.3	₱2,737.8	₱7,129.7	₱3,042.0	₱31,850.3
Aug 24-Augt 30	₱7,531.9	₱2,737.8	₱7,166.3	₱2,281.5	₱6,727.5	₱3,194.1	₱29,639.0
Aug 31-Sept 06	₱9,286.9	₱2,813.9	₱5,959.7	₱2,053.4	₱6,069.4	₱2,395.6	₱28,578.7
Sept 07-Sept 13	₱7,166.3	₱4,220.8	₱3,692.8	₱3,916.6	₱5,776.9	₱3,954.6	₱28,727.9
Sept 14-Sept 20	₱10,749.4	₱4,715.1	₱7,897.5	₱3,878.6	₱9,506.3	₱3,802.5	₱40,549.3
Sept 21-Sept 27	₱11,188.1	₱4,296.8	₱8,043.8	₱3,194.1	₱7,824.4	₱3,574.4	₱38,121.5
Total							**₱552,323.4**

Table 4 showed the overtime expense data for the Corrugator, Converting, and Extra Process sections from June to September 2024 highlighted key trends in labor cost management at Pamutongan Box Manufacturer. The overtime expenses from June 1 to September 27, 2024, exhibit noticeable variations week by week. In the first week (June 1-June 7), the total overtime expense was ₱33,722.3, driven by significant costs in the Corrugator and Extra Process sections. The following week (June 8-June 14) saw an increase to ₱38,792.8, with the Corrugator Section's regular overtime expenses rising substantially. From June 15 to June 21, the total overtime expense decreased to ₱29,494.2, mainly due to lower expenses in the Converting Section. The week of June 22-June 28 witnessed a slight rise to ₱33,321.6, driven by an increase in the Corrugator Section's Sunday overtime. By June 29-July 5, the total dropped to ₱31,762.6, as Sunday overtime in the Corrugator Section surged. In the week of July 6-12, overtime expenses decreased to ₱28,773.2, with significant reductions across all sections. The following week (July 13-19) experienced a sharp spike to ₱40,109.1, driven by increased overtime in all sections, particularly the Extra Process section. The week of July 20-26 saw a decline to ₱28,104.9, largely due to lower expenses in the Converting and Extra Process sections. From July 27-August 2, the total was ₱32,474.8, reflecting increased overtime in the Corrugator Section. The week of August 3-9 saw a drop to ₱28,530.5, with a notable decrease in overtime in the Extra Process section. From August 10-16, the total increased to ₱29,770.7 due to higher Sunday overtime expenses. The week of August 17-23 witnessed another increase to ₱31,850.3, with substantial overtime in the Corrugator Section. The following week (August 24-30) saw a decrease to ₱29,639.0, primarily due to lower costs in the Extra Process Section. The week of August 31-September 6 dropped to ₱28,578.7, driven by lower expenses across all sections. The week of September 7-13 saw a slight increase to ₱28,727.9, with higher overtime costs in the Corrugator Section. In the week of September 14-20, total expenses spiked to ₱40,549.3, driven by increased overtime across all sections. Finally, the week of September 21-27 saw a decrease to ₱38,121.5, due to reduced overtime costs in the Converting Section. Overall, the total overtime expense for the period amounted to ₱552,323.4, reflecting the variations of production demands and overtime requirements week by week.

Understanding the fluctuations in overtime expenses at Pamutongan Box Manufacturer provided valuable insights into labor cost management. The overtime expense data presented from June to September 2024 revealed significant variations across different production sections, driven by operational demands and the need to meet production quotas. For instance, specialized sections like Extra Process tended to incur higher overtime due to their role in completing precise tasks, often requiring extra hours (Shepard, 2024). Bottlenecks in primary production sections led to disproportionate overtime reliance, especially when sudden demand surges occurred (Samani, 2020). Redistributing the workload could lead to temporary reductions in overtime expenses by avoiding weekend work (Poonja, 2024). Sunday overtime typically incurred premium pay, which could reflect poor weekday scheduling (Replicon, 2022). Fluctuations in overtime expenses often arose from attempts to recover production delays, necessitating weekend work (Truein, 2024). Reducing downtime could significantly lower overtime costs, a perspective echoed in the declining overtime expenses during the second week of July (Circadian, 2024). Sustained weekend overtime often indicated poor task prioritization during the workweek. Equipment-dependent sections experienced higher overtime costs due to unplanned downtime (Samani, 2020), and improved production efficiency resulted from the application of lean manufacturing practices. Finally, efficient task scheduling played a key role in alleviating the need for weekend premium pay, and overtime expenses typically rose when production backlogs occurred. High overtime expenses could lead to worker burnout, further exacerbating inefficiencies (Garcia et al., 2022).

Table 5. Current Worker for Each Process

Section	Process	Required Worker
Corrugator	B-flute Production	4
	C-flute Production	4
	Double Facer	4
	Grab lift Operation	1
	Forklift Operation	1
Converting	Printing Machine 1	4
	Printing Machine 2	4
	Printing Machine 3	4
Extra Processes	Die cut Operation	2
	Creaser Operation	5
	Stitching Operation	1
	Manual Gluing	1
Total		**35**

Table 5 presented the current number of workers for each process at Pamutongan Box Manufacturer, segmented into the Corrugator, Converting, and Extra Processes sections. The total number of workers needed across all sections is 35, with the majority assigned to the Converting and Corrugator sections. In the Corrugator section, processes such as B-flute Production and C-flute Production each required 4 workers, reflecting the complexity of producing different flute types necessary for corrugated board. These flute types are integral in determining the strength and cushioning properties of the final product. Similarly, the Double Facer operation, which bonds the corrugated medium to linerboards, also required 4 workers to ensure proper alignment and consistency. More straightforward tasks such as Grablift Operation and Forklift Operation each required only 1 worker, as these operations focused on material handling and did not demand as much direct intervention. In the Converting Section, processes such as Printing Machine 1, Printing Machine 2, and Printing Machine 3 each required 4 workers. The need for four workers per machine was due to the precision and attention required for ensuring consistent print quality. The Extra Processes Section involved a mix of labor requirements for tasks like Die cut Operation (2 workers), Creaser Operation (5 workers), Stitching Operation (1 worker), and Manual Gluing (1 worker). The Die cut Operation required only 1 worker, as it primarily involved machine handling and material cutting. However, tasks like Creaser Operation, which requires precise scoring to facilitate easy folding, necessitated 2 workers to ensure accuracy. Tasks like Stitching Operation and Manual Gluing required fewer workers, as these operations were relatively simple but labor-intensive.

Worker allocation aligns with common practices in manufacturing environments where more complex processes demand additional labor to manage machinery, maintain production efficiency, and meet quality standards (Häberer and Arlinghaus, 2020). More intricate processes such as printing and creasing often require multiple workers to operate machinery and ensure consistent output. Simpler, more routine operations like material handling or die cutting typically require fewer workers, as these processes are more straightforward and automated. The distribution of workers also follows the strategic workforce planning principles highlighted by Humphreys (2024). The research emphasized that efficient labor allocation, ensuring neither understaffing nor overstaffing at any stage, is crucial for maintaining smooth production flows and avoiding bottlenecks. By ensuring that more precise operations, such as Creaser Operation, have the appropriate number of workers, the company minimizes the risk of errors and improves operational efficiency. Effective worker distribution is critical in complex manufacturing environments, where processes with higher levels of precision, such as printing and creasing, require more operators to ensure consistent output quality. This supports the decision to allocate multiple workers to the printing machines and creasing operation, where attention to detail and machine management are crucial for maintaining production standards (Mourtzis, 2022).

Table 6 Average Daily Output Produced per Week

Date (2024)	Output Produced (Metric Tons)
June 01-June 07	12.9
June 08-June 14	12.7
June 15-June 21	12.9
June 22-June 28	12.4
June 29-July 05	12.9
July 06-July 12	12.1
July 13-July 19	12.7
July 20-July 26	12.1
July 27-Aug 02	12.4
Aug 03-Aug 9	12.4
Aug 10-Aug 16	12.2
Aug 17-Aug 23	12.5
Aug 24-Augt 30	12.0
Aug 31-Sept 06	12.6
Sept 07-Sept 13	12.1
Sept 14-Sept 20	12.4
Sept 21-Sept 27	12.4
Average	12.5

Table 6 outlines weekly overtime output in metric tons from June to September 2024, highlighting production trends and fluctuations. Over the 17 weeks, output ranged from a low of 12.0 metric tons (August 24–30) to a high of 12.9 metric tons, achieved in June during three separate weeks, with an average of 12.5 metric tons. The high-output weeks in June suggest strong performance driven by strategic planning or workforce efficiency, while dips such as June 22–28 (12.4 metric tons) and a decline to 12.1 metric tons in early July indicate potential inefficiencies or challenges like workforce fatigue or bottlenecks. A period of fluctuation was observed from July to August, with outputs ranging from 12.0 to 12.7 metric tons, potentially due to operational disruptions or seasonal factors. Recovery began in early September, with outputs increasing to 12.6 metric tons, followed by stabilization around 12.4 metric tons in the last few weeks. This stabilization reflects effective management practices, such as improved scheduling and resource allocation. Overall, the data demonstrates a generally stable output but highlights areas for improvement in sustaining peak performance and addressing mid-cycle dips to enhance consistency.

Early-month goal-setting effectively motivated the workforce, as shown by the strong performance in early June, where strategic planning and clear objectives led to peak outputs of 12.9 metric tons (Vorecol, 2022). Prolonged overtime, however, resulted in fatigue, causing mid-cycle productivity declines and underscoring the need to manage sustained workloads to maintain efficiency (Circadian, 2024). Mid-cycle interventions, such as task redistribution and breaks, proved valuable in restoring productivity, as seen in early September when workflow adjustments stabilized outputs (Moriano et al., 2022). Deadline-driven urgency further enhanced performance, driving employees to meet critical targets efficiently during peak periods (Traqq, 2024). These insights emphasized the importance of balanced workloads, goal-setting, and strategic interventions for sustained productivity. Overall, consistent performance throughout the cycle reflected effective management practices, including optimized scheduling, resource allocation, and workforce management strategies (Choudhury et al., 2021)

Chapter 3
SUMMARY OF FINDINGS, CONCLUSION, AND RECOMMENDATIONS

This chapter presented the summary of findings, conclusion, recommendations, and the proposal of production scheduling at Pamutongan Box Manufacturer.

Summary of Findings

Understanding the findings of the study as shown in Figure 5, and Table 1 to Table 6, reveals opportunity to reduce overtime hours and overtime expense by proposing production scheduling. The data reveals the current process flow of the production department of Pamutongan Box Manufacturer, as shown in Figure 5, that serves as crucial tool in proposing production scheduling by providing a clear, structured overview of the sequence of operations required to manufacture the product. Table 1 showed the standard time of the company that serves as a benchmark in production scheduling by providing an established, consistent measure of how long a specific task or process should take under normal working conditions. However, the current standard time exceeds the regular working hours of 450 minutes, indicating that certain processes may require additional time beyond the typical shift to meet production demands.

Table 2 highlights the total overtime hours of each section in production department that serves as an important indicator in production scheduling by helping to assess the gap between planned production capacity and actual output. Overtime peaks, especially in mid-July, indicate that production targets often exceed regular working hours, pointing to inefficiencies in scheduling and resource management. While Table 3 shows the total numbers of workers who work overtime that serves as a key metric in production scheduling by providing insights into workforce utilization and potential labor shortages. Total overtime expense serves as a critical indicator in production scheduling by highlighting the financial cost of overtime work as shown in Table 4. Overtime contributes significantly to production costs, often due to bottlenecks and fluctuating demand, underlining the need for better scheduling.

Table 5 showed the required number of workers for each process that serves as a fundamental guideline for efficient production scheduling. It helps determine the optimal workforce needed for each operation to ensure that production flows smoothly and that no stage is understaffed or overstaffed. This distribution ensures quality and efficiency. Additionally, the total output produced serves as an indicator of production capacity generated by the workforce beyond regular working hours. It helps assess the efficiency and effectiveness of overtime work in meeting production targets or deadlines shown in Table 6.

Conclusion

The main objective of the study was to propose a production scheduling at Pamutongan Box Manufacturer focusing on reducing overtime and overtime expense.

In conclusion, the findings of this study highlighted the significant potential for reducing overtime hours and associated expenses through improved production scheduling at Pamutongan Box Manufacturer. By analyzing current production processes and identifying areas where overtime was most prevalent, the company implemented targeted changes, such as the addition of specialized machines and optimized manpower allocation, to streamline operations. The introduction of machines for die-cutting, creasing, stitching, and manual gluing helped eliminate bottlenecks, reduce processing time, and enhance overall efficiency, thus minimizing the need for overtime work. Moreover, adjustments to workforce distribution across key production stages ensured that labor was utilized more effectively. Through these improvements, the company not only met production demands more efficiently but also achieved better cost control, higher productivity, and sustainable growth. Under the proposed production schedule, the company efficiently produced 17.36 tons of output daily with a workforce of 34 workers, all within the regular working hours. This schedule ensured that resources were effectively allocated and eliminated the need for overtime, aligning production capacity with the company's operational goals. Implementing these changes enabled Pamutongan Box Manufacturer to sustain production efficiency while achieving significant cost savings, fostering long-term operational and financial sustainability.

Recommendations

Based on the analysis and conclusion drawn from the study at Pamutongan Box Manufacturer’s overtime and overtime expense the recommendations are as follows:

Image	Name of Machine	Price (PHP)	Quantity	Machine Life (years)
	Corrugated cardboard auto feeding rotary die cutting machine	449995.88	1	25
	VV Industry corrugated box creasing machine	151701.17	1	15
	Foot operated binding corrugated box stitching sealing machine	10950.59	2	10

Table 7. Proposed Additional Machines Per Process

Table 7 showed the proposed additional machinery for the corrugated box production process. No additional machines were recommended for the corrugator section (B flute, C flute, and double facer production), the grab lift, or forklift operations. Similarly, the converting section did not require any additional machinery.

Within the extra process section, one additional die-cutting machine was proposed, with an average cost of 449,995.88 pesos and a machine life of 25 years. One additional creaser machine was also recommended, with an average cost of 151,701.17 pesos and a machine life of 15 years. For the stitching operation, two additional machines were proposed, at an average cost of 5,475.30 pesos each (10,950.59 pesos total) and a machine life of 10 years.

Average machine costs were determined using price data from three different suppliers. The average cost for each machine type was calculated by summing the costs from the three suppliers and dividing by three. The total cost of the four proposed machines was 612,647.64 pesos. Compared to the total estimated overtime expense of 552,323.40 pesos over four months, the return on investment for the machines was projected to be achieved within 4.5 months which is calculated by dividing the total overtime expense by four months which is equal to 138080.85 pesos and using the quotient as the divisor for the total proposed machine expense.

Table 8. Improved Standard Time Based on Proposed Additional Machines

Section	Process	Standard time (minutes)
Corrugator	B-flute and C-flute Production Double Facer	40
	Grab lift Operation	14.40
	Forklift Operation	17.28
Converting	Printing Machine 1 Printing Machine 2 Printing Machine 3	35
Extra Processes	Die cut Operation 1 Die cut Operation 2	66
	Creaser Operation 1 Creaser Operation 2	82
	Stitching Operation 1 Stitching Operation 2 Stitching Operation 3	26
	Manual Gluing 1 Manual Gluing 2 Manual Gluing 3	45
Total Standard Time		325.68

Table 8 highlighted the significant improvements in standard time achieved through the addition of specialized machines, such as die-cutting, creasing, stitching, and manual gluing machines. These upgrades are specifically targeted at reducing overtime and overtime expenses by streamlining the production line, eliminating bottlenecks, and improving overall efficiency. By adding these machines, the company will be able to produce up to 1.6 tons of corrugated boxes more efficiently, thus reducing the need for extended working hours and minimizing additional labor costs associated with overtime.

The optimized production process, facilitated by the new machines, will expedite critical tasks such as shaping, folding, and assembly while maintaining product quality. This reduction in processing time directly impacts overtime, helping the company meet demand without requiring excessive working hours. The efficiency gains from these machines will lower operational costs and reduce overtime expenses in the long run. Furthermore, better workforce planning will enable employees to focus on more complex tasks, improving overall productivity and supporting sustainable growth while ensuring that overtime is minimized and costs are kept under control.

Table 9. Proposed Man Power Allocation

Man Power Allocation									
Processes	B-flute and C-flute Production	Double Facer	Grab lift Operation	Forklift Operation	Printing Machine 1, 2 and 3	Die cut Operation 1 and 2	Creaser Operation 1 and 2	Stitching Operation 1, 2 and 3	Manual Gluing 1, 2, and 3
Number of Workers	4	2	1	1	6	4	4	6	6

Table 9 showed the proposed man power allocation, the table outlines the proposed distribution of workers across various production processes, designed to ensure efficiency at each stage. However, optimizing this scheduling could significantly reduce overtime and the associated expenses. The B-flute and C-flute Production process is staffed with 4 workers, responsible for producing the flute materials, while the Double Facer process is handled by 2 workers to bind the corrugated material. Grab lift and Forklift Operations each have 1 worker, facilitating the movement of materials. The Printing Machines 1, 2, and 3 are operated by 6 workers to handle branding and labeling tasks. Die cut Operation 1 and 2 and Creaser Operation 1 and 2 are each assigned 4 workers, while the Stitching Operation 1, 2, and 3 and Manual Gluing 1, 2, and 3 are each managed by 6 workers.

By strategically adding machines and optimizing the manpower allocation, such as increasing the number of machines in key stages or adjusting the worker distribution, production efficiency could be enhanced, reducing the need for overtime. With more efficient processes, workers can complete tasks within standard working hours, minimizing delays and reducing the reliance on overtime, which in turn will lower overtime expenses. Implementing these changes will not only streamline the workflow but also improve the overall productivity of the production line, helping the company achieve better cost control and higher output without compromising product quality

Table 10. Proposed Production Scheduling

Monthly			
	Time	Number of Workers	Total Output (Metric Ton)
Monday	7:00-4:00	34	17.36
Tuesday	7:00-4:00	34	17.36
Wednesday	7:00-4:00	34	17.36
Thursday	7:00-4:00	34	17.36
Friday	7:00-4:00	34	17.36
Saturday	7:00-4:00	34	17.36
Sunday			
Total Monthly Output			416.64

Table 10 presented the proposed monthly schedule based on the new standard time for producing corrugated boxes. Under this schedule, the company required 34 workers daily from Monday to Saturday. No workers were needed on Sundays, as the company met its regular production quota without requiring overtime. With the updated production standard time set at 323.28 minutes, the company achieved an increase in daily output. This improvement resulted in an hourly production rate of 2.31 tons during a total production time of 7.5 hours. Consequently, the company's average daily output increased from 12.5 tons to approximately 17.36 tons per day, which amounted to 416.64 tons per month.

Table 11. Cost Benefit Analysis

Benefit Category	Monthly Savings (PHP)	Monthly Additional Sales	Cost Savings
Reduction in overtime expenses	₱138,080.85	₱10,108,800.00	₱2,090,036,593.40
Net savings after machine cost	N/A		₱2,089,423,946

Table 11 presented the cost-benefit analysis, which demonstrated the significant financial and operational advantages of investing in the proposed additional machinery for corrugated box production. The reduction in monthly overtime expenses, estimated at PHP 138,080.85, was calculated by dividing the total estimated four-month overtime expense of PHP 552,323.40 by four. Throughout the machines' average lifespan of approximately 17 years, equivalent to 204 months, the company was projected to gain additional savings. These savings were determined by dividing the daily estimated sales by the current production per ton, then multiplying the result by the proposed daily production of 17.36 tons and further multiplying by 26 days, resulting in a monthly additional sales figure of PHP 10,108,800. By summing the monthly savings and additional sales, the cumulative savings from reduced overtime expenses amounted to PHP 2,090,363,693.40. Over the long term, after deducting the machine costs, the company achieved net savings of PHP 2,089,751,045.76, highlighting the substantial financial benefits.

In addition to these tangible savings, the proposed machinery will enhance production efficiency, improve product quality, and reduce manual labor, providing additional intangible benefits. The short payback period and significant long-term financial gains clearly indicate that this investment is cost-effective and operationally advantageous. The machines will not only improve profitability but also contribute to a more sustainable and efficient production process, reinforcing the company's competitiveness in the industry.

Other Recommendation:

Pamutongan Box Manufacturer must optimize their facility layout. A well-designed layout can significantly improve the flow of materials and workers, reducing delays and inefficiencies that contribute to the need for overtime

BIBLIOGRAPHY

1. Askarov. (2024). *How overworking affects productivity*. Monitask.
2. https://www.monitask.com/en/blog/how-overworking-affects-productivity
3. Bari, M., et al. (2024). *Predictive analytics for strategic workforce planning: A cross-*
4. *industry perspective from energy and telecommunications*.
5. Behrens. (2020). *Precision manufacturing*. ScienceDirect.
6. https://www.sciencedirect.com/topics/engineering/precision-manufacturing
7. Bonifacio. (2024). *Effective overtime tracking: What every business should know*.
8. Circadian. (2024a). *Excessive overtime: Understanding its impact on your*
9. *workforce and business*. https://blog.circadian.com/excessive-overtime

10. Circadian. (2024b). *How to reduce overtime: Strategies for a healthier, more*
11. *productive workforce*.https://blog.circadian.com/reduce-overtime
12. Dash, R. (2024). *What is overtime management and how to reduce it*. Empmonitor.
13. https://empmonitor.com/blog/overtime-management-plan/
14. Exaktime. (2024). *Tracking overtime accurately increases benefits and*
15. *performance*. https://exaktime.com/blog/tracking-overtime/
16. Fitas. (2023). *A review of optimization for corrugated boards*. Sustainability, 15(21),
17. 15588. https://www.mdpi.com/2071-1050/15/21/15588
18. Forestpackage. (2023). *The role of die cutting in the packaging industry*.
19. https://forestpackage.com/the-role-of-die-cutting-in-the-packaging-industry
20. Goldberg & Gage. (2022). *Law targeting unreasonable production quotas takes effect*.https://www.goldbergandgage.com/blog/2022/01/law-targeting-unreasonable-production-quotas-takes-effect/
21. Heizer, J., Render, B., & Munson, C. (2019). *Operations management:*
22. *Sustainability and supply chain* (12th ed.).
23. Howe. (2023). *Manufacturing workforce management: The complete guide*. LandrumHR.https://www.landrumhr.com/blog/march-2023/manufacturing-workforce-management
24. Humphreys, J. (2024, August 6). *Production planning and scheduling for manufacturing*. Katana MRP. https://katanamrp.com/blog/production-planning-scheduling/
25. IceHRM. (2023). *Strategies for overtime management in the workplace*. https://icehrm.com/blog/strategies-for-overtime-management-in-the-workplace/
26. Jamestown Container. (2020). *Corrugated box design: What makes them so*
27. *strong*.https://www.jamestowncontainer.com/resources/blog/corrugated-box-design-what-makes-them-so-strong/
28. Jun, S. (2021). *Two-time system, three patterns of working hours*. JSTOR.
29. https://www.jstor.org/stable/25791256
30. Kanwal, M. (2024). *7 proven ways to reduce your employee's overtime*.
31. Connecteam. https://connecteam.com/e-how-to-reduce-overtime/
32. Karl Marx. (2020, December 21). *Stanford Encyclopedia of Philosophy*.
33. https://plato.stanford.edu/entries/marx/
34. Kaushik, S. (2023). *Strategies for minimizing overtime and optimizing shift scheduling in dispatch operations*. https://www.linkedin.com/pulse/strategies- minimizing-overtime-optimizing-shift-dispatch-kaushik/
35. Kenai, G. (2024). *Tracking overtime: How to do it accurately & be compliant*.
36. Landau, P. (2024, October 4). *Production scheduling basics: Creating a production schedule*.https://www.projectmanager.com/blog/production-scheduling
37. Luther. (2024). *Manufacturing benchmarking guide: Benefits, types, and guidance*. NetSuite.https://www.netsuite.com/portal/resource/articles/erp/benchmark-manufacturing.shtml
38. Mahalik. (2021). *Advances in packaging methods, processes and systems*. ResearchGate.https://www.researchgate.net/publication/307710104_Advances_in_Packaging_Methods_Processes_and_Systems
39. Masa. (2023). *Managing overtime in the manufacturing industry during year-end surges*.https://measuredability.com/overtime-management-in-peak-manufacturing-season/

40. Melanie. (2021). *Hours vs. output*. BeyondManaging.
41. http://beyondmanaging.com/2016/01/hours-vs-output/
42. Münstermann, B., et al. (2021). *What is process standardization?*
43. https://core.ac.uk/download/pdf/301346409.pdf
44. Needy, K. L., & Ragsdale, S. K. (2021). *Production and operations management*.
45. Wiley.
46. Nguyen, D. (2023). *Understanding labor cost and its implications for businesses*.
47. Le Tran Law. https://letranlaw.com/insights/understanding-labor-cost-and-its-implications-for-businesses/
48. Praveen, K. (2020). *Analyzing overtime costs: A strategic step for HR*. LinkedIn. https://www.linkedin.com/pulse/analyzing-overtime-costs-strategic-step-hr-kulkarni-he-him-his-/
49. PROHANCE. (2024). *What is overtime management and how to reduce overtime*. https://www.prohance.net/blog/what-is-overtime-management-and-how-to-reduce-overtime/
50. Pydimarry. (2023). *Enhancing productivity using flow process charts and value*
51. *stream mapping*.
52. Ranta, M., et al. (2019). *Workload balancing in the manufacturing environment: A*
53. *multicriteria trade-off analysis*.
54. Saliba, J. (2019). *Standardization of a production process*.
55. https://mdh.diva-portal.org/smash/get/diva2:1219490/FULLTEXT01.pdf
56. Samel, M. (2020). *16-hour shifts explained: Jobs, schedules, pros & cons &*
57. *practical tips*. Parim. https://parim.co/blog/16-hour-shift
58. Sean. (2024). *3 effects of overtime on productivity*. WorkPlays.
59. https://workplays.ph/blog/effects-of-overtime-on-productivity/
60. Stevenson, W. J. (2019). *Operations management* (13th ed.). McGraw-Hill
61. Education.
62. Stojanovic, M. (2022). *Why you should keep track of work hours (both as an*
63. *employer and an employee)*. Clockify.
64. Szopa, A., et al. (2024). *Advanced packaging techniques—A mini-review of 3D*
65. *printing potential*
66. Taher, M., et al. (2024). *Enhancing efficiency of material handling equipment in*
67. *engineering sectors*
68. Tarika. (2024). *Top 5 employee information reports every organization should*
69. *track*. Zoho People.https://www.zoho.com/people/hrknowledgehive/Top-5-employee-information-reports-every-organization-should-track.html
70. Team, I. (2023, September 1). *Who is David Ricardo and what is he famous for?*
71. Investopedia. https://www.investopedia.com/terms/d/david-ricardo.asp
72. TheIntactOne. (2024). *Treatment and control of labor turnover, idle time, and overtime*. https://theintactone.com/2019/10/27/cma-u2-topic-3-treatment-and-control-of-labor-turnover-idle-time-overtime/
73. Tina. (2024). *Bottlenecks in manufacturing—How to solve them in 2024*.
74. ThroughPut. https://throughput.world/blog/bottlenecks-in-manufacturing/
75. Tongol, A., et al. (2023). *Investigation on the factors influencing time and cost*
76. *overrun in vertical construction in Pampanga*. s

77. Vargas, M., et al. (2019). *Implementation of production process standardization— A case study of a publishing company from the SMEs sector*. Processes, 7(10), 646. https://www.mdpi.com/2227-9717/7/10/646
78. Vega, J. (2024). *New wage order takes effect today in Region VII*. Cebu Daily News.https://cebudailynews.inquirer.net/598278/new-wage-order-takes-effect-today-in-region-vii