Proceedings of the International Conference on Industrial Engineering and Operations Management

Publisher: IEOM Society International, USA DOI: 10.46254/AP07.20260280
Published: March 25, 2026

Optimizing Manpower Allocation by Developing Integer Linear Programming-Based System at JacksonVille Creative Concept Mfg. Inc., in Alaminos City, Laguna

Melan Dyrene N. Almendras, John Lloyd R. Platon, Angel Kate A. Tolentino and Pia Althea B. Villanueva
Industrial Engineering Department, First Asia Institute of Technology and Humanities, Pres JP. Laurel Highway, Tanauan, 4232 Batangas melanalmendras28@gmail.com, lloydplaton29@gmail.com, nglkttolentino@gmail.com
piaaltheavillanueva@gmail.com

Abstract

This study aims to develop a decision-support system using Integer Linear Programming (ILP) to optimize workforce allocation in the sewing department of Jacksonville Creative Concept Mfg. Inc., located in Alaminos. The company currently faces recurring issues of overstaffing and understaffing due to the absence of a structured manpower planning system and the unpredictability of employee attendance, which is heavily influenced by the piece-rate compensation structure. A mixed-methods approach was employed, combining quantitative data from company records and surveys with qualitative insights from interviews and observations. A total of 43 piece-rate sewers participated in the study. Survey results also indicated that employees were open to the use of computerized scheduling tools. The study concludes that the proposed LP-based system can significantly improve operational efficiency and fairness in manpower distribution. Recommendations for future adoption include system training, real-time data integration, and expansion to other departments.

Keywords
Integer Linear Programming (LP), Assignment Model, Constraints, System Development and Manpower Allocation.

1. Introduction
Efficient manpower allocation is essential in manufacturing environments, where proper workforce distribution supports smooth operations and consistent production output. In labor-intensive departments such as sewing, manpower planning becomes more complex due to varying production demands, worker availability, and differences in product requirements. Poor manpower allocation can lead to delays in production, idle workers, and increased operational costs.

Manufacturing companies that produce multiple product types often face challenges in balancing available workers with changing workloads. As production demand shifts across different items, workforce planning becomes more important to ensure that the right number of employees are assigned where they are most needed. Inefficient manpower allocation may result in overstaffing, understaffing, uneven workload distribution, and reduced productivity.

At Jacksonville Creative Concept Mfg. Inc. (JCCMI), manpower allocation in the sewing department is still based on manual decision-making. The department has 43 sewing employees assigned to products such as bags, pouches, pants, shorts, and T-shirts. Because worker assignments relies on estimation rather than a structured analytical method, the company may experience inefficient workforce distribution depending on production workload. To address this issue, the study applies Integer Linear Programming (ILP) to develop a decision-support model for improving manpower allocation and enhancing production efficiency.

1.1 Objectives

The main objective of this study is to develop a Linear Programming system to optimize workforce allocation at Jacksonville Creative Concept Mfg. Inc. to address overstaffing and understaffing.

1. To assess the current workforce situation of Jacksonville Creative Concept Mfg. Inc. in terms of:

1.1 Manpower

1.1.1. Worker Assignment

1.1.2. Availability

1.1.3. Efficiency

1.1.4. Worker Attendance Behavior and Influencing Factors

1.2. Operations

1.2.1. Employee Allocation

1.2.2. Operations Schedule

1.2.3. Budget Allocation

2. To conduct a time study in order to determine the productivity levels of workers across different products and operations.

3. To apply the assignment model as a decision-support tool for aligning workers with specific products based on productivity, attendance, and order requirements.

4. To formulate an Integer Linear Programming model based on the assignment model to ensure efficient allocation and utilization of manpower resources.

5. To design a workforce scheduling system that integrates the developed Linear Programming model as a decision-support tool in terms of;

5.1 User Interface

5.2 Key Features of the System

5.3 System Validation

6. To develop the actual system prototype that will improve the company's manpower scheduling for daily operations.

7. To implement and evaluate the developed manpower scheduling system in terms of;

7.1 Manpower Efficiency

7.2 Cost Efficiency

7.3 System Accuracy

7.4 User Acceptance

8. To propose recommendations to further improve workforce allocation and manpower scheduling at Jacksonville Creative Concept Mfg. Inc. based on the insights and outcomes derived from the developed system.

2. Literature Review

Integer Linear Programming (ILP) and related optimization techniques have been widely applied in workforce planning, production scheduling, and constrained resource allocation. In labor-intensive industries such as garment manufacturing, these models are valuable because they provide structured methods for assigning limited manpower while considering operational constraints such as labor availability, skills, wages, production demand, and scheduling efficiency. Your thesis shows that recent foreign studies consistently position Linear Programming and ILP as practical decision-support tools for improving labor utilization and production outcomes in manufacturing settings.

Foreign literature highlights how optimization models support manpower and production decisions in apparel and manufacturing environments. Suariya and Hasan (2023) developed a deterministic Linear Programming model for made-to-order garment factories in Bangladesh, focusing on minimizing cost while maximizing profit and labor utilization. Their study demonstrated Nguyen et al. (2023) further extended this direction by incorporating labor skills, wage rates, and workload balancing into task allocation for small and medium-sized apparel businesses, proving that Linear Programming can adapt to skill-based and cost-sensitive production environments. More recent studies also show the growing flexibility of ILP in handling dynamic and multi-constraint production systems. Gulia et al. (2025) used Integer Programming to improve responsiveness to real-time demand changes, allowing adjustments in labor and production resources that led to better profit margins and scheduling performance.

Kong, Ning, and Kong (2025) combined Mixed-Integer Linear Programming with lean methodology and line balancing, achieving more than 50% reduction in labor cost while optimizing production capacity. These studies indicate that modern ILP-based approaches are no longer limited to static allocation problems, but are increasingly designed for adaptive, integrated, and efficiency-oriented industrial systems.

The literature also supports the use of assignment-based and workforce-specific optimization models. Febianti and Hasbiyati (2024) applied an Assignment Model within a MILP framework to improve allocation decisions, while Khadivi et al. (2024) formulated a model for worker shift and machine assignment under real production constraints.

İşeri et al. (2025) proposed a workforce scheduling model that considered worker skills and preferences, showing that ILP can support both cost-efficiency and better manpower-task matching. Clautiaux et al. (2025) likewise emphasized the continued progress of ILP in solving large-scale discrete optimization problems, reinforcing its suitability for manpower allocation where decisions must be integer-based. Together, these studies strengthen the view that ILP is appropriate for solving workforce scheduling and assignment problems in complex production systems.

Local literature also demonstrates the relevance of optimization models in Philippine settings. Coronado-Hernández et al. (2021) developed a Linear Programming model for minimizing production cost in a rice crop protection firm and reported an 11% reduction in total production costs, showing that optimization can address operational and budget constraints in local production contexts. Soriano et al. (2020) created a hybrid AHP-MILP framework for labor scheduling under fluctuating demand and worker preferences, illustrating how local decision environments can benefit from mathematical scheduling models.

Torres and Gavina (2021) used an Integer Programming-based Assignment Model for faculty-course allocation, which, although developed in education, reflects the same core problem of matching limited human resources to tasks under constraints.

Galindo et al. (2021) also applied ILP to procurement, production, and distribution decisions in a Philippine plastic manufacturing firm and achieved a 7.09% reduction in total planning cost. These local studies confirm that optimization-based methods are applicable across Philippine sectors and can improve efficiency, cost control, and resource allocation.

Overall, the reviewed literature shows that ILP is effective for solving constrained allocation and scheduling problems, especially in environments where manpower, production targets, and operational limitations must be balanced simultaneously. However, your thesis also points out a key gap: many Linear Programming studies determine workforce size or optimize schedules, but fewer directly integrate manpower sizing with detailed worker-to-task assignment in a single framework. This gap supports the need for your study, which applies an ILP-based manpower scheduling system to address overstaffing, understaffing, and unequal workload or income distribution in an actual manufacturing setting.

3. Methods

This study used applied research to address the manpower allocation problem in the sewing department of Jacksonville Creative Concept Mfg. Inc. The participants included 43 sewing workers, one production supervisor, and the researcher. Data were gathered through observation, interviews, surveys, and document analysis of worker assignments, attendance records, production schedules, and labor allocation practices.

The study developed an optimization-based manpower allocation framework supported by time study and Integer Linear Programming (ILP). A time study was conducted to measure worker productivity across product categories such as bags, pouches, pants, shorts, and T-shirts. The observed task times were used to compute standard time and productivity rates, which served as input parameters for the optimization model. An assignment model and an ILP model were then formulated to determine the optimal worker distribution while considering production demand, workforce availability, and labor cost.

For evaluation, the developed system was tested using actual company production data and compared with the existing manual allocation process. The study assessed improvements in manpower efficiency, cost efficiency, system accuracy, and user acceptance to determine the effectiveness of the proposed workforce allocation system.

4. Data Collection

Interviews, survey questionnaires, and on-site observations with supervisors and management will be conducted to gather insights on current worker assignment practices, operational challenges, and decision-making processes. The information obtained through the data collection will be evaluated through both qualitative and quantitative methods in order to find viable solutions to improve workforce distribution and production efficiency throughout the manufacturing facility. Prior to any analysis of the collected data, the first step in the research process is to conduct a workforce and production evaluation by evaluating the utilization, availability, attendance behaviors, and current manual allocation practices of the hourly employees in the organization. Additionally, current production schedules, working hours, and costs of labor will be reviewed in order to incorporate these parameters into the Linear Programming Model.

The collected data will be analyzed using percentage analysis, thematic analysis, and weighted means. Percentage analysis will provide percentage totals of the factors that contribute to inefficiencies, while thematic analysis will display the patterns identified through the combination of interview responses and observations from the workers pertaining to their behaviors and the manual allocation practices used by the company's management.

Time Study Sheets will be utilized to record actual processing times and compute worker productivity for each product type, serving as essential inputs for the assignment model and Integer Linear Programming (ILP). The Assignment Model Matrix will be developed to map workers to products based on productivity and capacity, forming the structural basis for the ILP model. Technology tools, including Python, Notepad++, FPDF, ConfigParser, PyInstaller, and Cryptography, will support system development, data processing, report generation, packaging, and data security. Microsoft Excel will be used extensively for organizing raw data, performing productivity and cost calculations, and conducting comparative analysis between manual and system-generated results. The ILP model was then developed and validated using historical production process data. Model effectiveness was assessed through a comparison of the system-generated workforce allocation vs. manual workforce allocation by means of both Mean Absolute Deviation (MAD), and Mean Absolute Percentage Error (MAPE).

The system was validated by experts in both Operations Research and Information Technology for model accuracy, system functionality and usability. The prototype system was then presented to the company as a trial for assessing various performance measures including staff accuracy, labor cost savings and on-time order delivery, to evaluate the system's usability in practice.

5. Results and Discussion

5.1 Current Worker Assignment

The distribution of sewing employees among different products is a reflection of the firm's typical labor setup: 8 employees working on bags, 15 on pouches, 8 on pants, 8 on shorts, and 4 on t-shirts. The division of labor shows that pouch production requires the maximum number of workers due to its increased order frequency, and higher workload volume, while T-shirt production has the minimum number of workers assigned. Concentrating on these 43 workers means that the system is founded on the organization’s existing capacity and operational structure, which allows for realistic modeling, implementation, and analysis (Table 1).

Table 1. Worker Assignment

Worker Assignment	
Product	**No. of workers**
Bags	8
Pouch	15
Pants	8
Shorts	8
T-shirts	4
TOTAL	43

5.2. Influencing Factors

Table 2. Percentage Distribution of Factors Contributing to Overstaffing and Understaffing

Influencing Factors	
Order-based Attendance Behavior	40%
Lack of Structured Assignment System	33.20%
Ineffective Manpower Planning	26.80%
Total	**100%**

The findings indicate that Order-Based Attendance Behavior is the leading factor for the overstaffing and understaffing issues experienced, making up 40%. This suggests workers' attendance is driven by either the availability of production orders that pay well or not. Orders at higher pay rates lead to overstaffing as more workers report to work, while orders at lower per-piece rates lead to understaffing due to low attendance. Such behavior has a direct impact on the company's ability to have reliable labor (Table 2).

5.3. Time Study Results

Table 3. Time Study Summary

Product	**Standard Time (minutes)**	**Worker Capacity (units/day)**
Bags	29	14
Pants	52	8
Pouches	14	27
Shorts	37	11
T-shirts	23	17

The results indicate that **pants require the longest production time (52 minutes per unit)**, resulting in the lowest worker capacity of **8 units per day**. Conversely, **pouches require the shortest production time (14 minutes)**, enabling workers to produce **27 units per day**, which is the highest production capacity among all products. These productivity values were incorporated into the Integer Linear Programming model to determine the optimal number of workers assigned to each product category while minimizing labor cost and ensuring that production demand is satisfied (Table 3).

5.4 Assignment Model Matrix

Based on the table, each row reflects an individual worker while each column represents the five products—bags, pants, t-shirts, shorts, and pouches—viewed in this study. The value for each column represents the standard time, which is constant for each product type across workers. While the last column represents productivity of each worker (in terms of time) for each product, which was initially measured through the time study. The researchers established the assignment model in a way that included time-based and capacity-based parameters for a fair, data-based distribution of workers. By including standard time per product and the worker capacity, the model ensures each worker is assigned only to tasks within their achievable workload level (Figure 1- Figure 6).

WORKER	BAGS	PANTS	T-SHIRT	SHORTS	POUCH	CAPABILITY (IN MINS)
1	29					348
2	29					435
3	29					377
4	29					290
5	29					493
6	29					377
7	29					348
8	29					435
9		52				312
10		52				416
11		52				468
12		52				364
13		52				364
14		52				416
15		52				468
16		52				312
17			23			368
18			23			437
19			23			391
20			23			345
21				37		444
22				37		370
23				37		296
24				37		333
25				37		407
26				37		481
27				37		370
28				37		444
29					14	378
30					14	392
31					14	392
32					14	336
33					14	406
34					14	420
35					14	448
36					14	392
37					14	350
38					14	336
39					14	350
40					14	378
41					14	420
42					14	378
43					14	308
OCTOBER	29000	93 600	46 000	55 500	35 000	

Figure 1. Assignment Model Table

5.5 Formulation of Integer Linear Programming Model

In order to complete Objective 4 of the study, an Integer Linear Programming (ILP) model was developed from the structure and findings of the Assignment Model. The goal of this step was to mathematically describe the labor allocation problem of JCCMI by formulating a structured optimization model from actual conditions of operation including labor productivity, product requirements, labor capacity, and labor allocation constraints. The ILP model was an important step in being able to optimize worker assignments to product lines in a feasible way that minimized the overall labor costs while satisfying production needs. By using integer decision variables, the model ensured realistic outputs to the assignments of whole workers instead of fractions. This model constituted the main analytical component of the system, and used a data-driven approach to identify inefficiencies and help guide labor utilization in the sewing processes (Table 4).

Table 4. Mathematical Formulation of the Integer Linear Programming Model for Workforce Allocation

Objective Function	**Actual Objective Function**
$Minimize\ Z = \Sigma(x_i \times c_i$ where; Xi = workers Ci = cost per product	$Minimize\ Z = 22.12A_{1} + 22.12A_{6} + 22.12A_{11} + 22.12A_{16} + 22.12A_{21} + 22.12A_{26} + 22.12A_{31} + 22.12A_{36} + 68B_{42} + 68B_{47} + 68B_{52} + 68B_{57} + 68B_{62} + 68B_{67} + 68B_{72} + 68B_{77} + 35C_{83} + 35C_{88}\ 35C_{93} + 35C_{98} + 45D_{104} + 45D_{109} + 45D_{114} + 45D_{119} + 45D_{124} + 45D_{129} + 45D_{134} + 45D_{139} + 14.13E_{145}$
	$+ 14.13E_{150} + 14.13E_{155} + 14.13E_{160}\ 14.13E_{165} + 14.13E_{170}$ $+ 14.13E_{175} + 14.13E_{180} + 14.13E_{185}\ 14.13E_{190} + 14.13E_{195}$ $+ 14.13E_{200} + 14.13E_{205}\ 14.13E_{210} + 14.13E_{215}$ Production Feasibility Constraints $Ti \le P$ where: Ti = time (mins.) P = Productivity (in min.) 29A ≤ 348, 29A ≤ 435, 29A ≤ 377, 29A ≤ 290, 29A ≤ 493, 29A ≤ 377, 29A ≤ 348, 29A ≤ 435, 52B ≤ 312, 52B ≤ 416, 52B ≤ 468, 52B ≤ 364, 52B ≤ 364 52B ≤ 416, 52B ≤ 468, 52B ≤ 312, 23C ≤ 368, 23C ≤ 437, 23C ≤ 391, 23C ≤ 345 37D ≤ 444, 37D ≤ 370, 37D ≤ 296, 37D ≤ 333, 37D ≤ 407, 37D ≤ 481, 37D ≤ 370, 37D ≤ 444, 14E ≤ 378, 14E ≤ 392, 14E ≤ 392, 14E ≤ 336, 14E ≤ 406 14E ≤ 420, 14E ≤ 448, 14E ≤ 392, 14E ≤ 350, 14E ≤ 336, 14E ≤ 350, 14E ≤ 378 14E ≤ 420, 14E ≤ 378, 14E ≤ 308 Demand Constraints Bags $29A_{1} + 29A_{6} + 29A_{11} + 29A_{16} + 29A_{21} + 29A_{26} + 29A_{31} + 29A_{36} = 29,000$ Pants $52B_{42} + 52B_{47} + 52B_{52} + 52B_{57} + 52B_{62} + 52B_{67}\ 52B_{72} + 52B_{77} = 93,600$ $\Sigma(T_i \times X_i) = D$ T-Shirts $23C_{88} + 23C_{93} + 23C_{98} + 23C_{103} = 46,000$ where: Ti = Time (mins) Shorts $37D + 37D + 37D + 37D + 37D + 37D$

	104	109 114 119 124 129
	$37D$	$+ 37D$ $= 55,500$
	Xi = workers	
	D = Demand	134 139
	Pouches	$14E$ $+ 14E$ $+ 14E$ $+ 14E$ $+ 14E$ $+ 14E$ $14E$ $+ 14E$ $+$
	145	150 155 160 165 170 175 180
	$14E$	$+ 14E$ $+ 14E$ $+ 14E$ $14E$ $+ 14E$ $+ 14E$ $= 35,000$
		185 190 195 200 205 210 215
	Budget Constraints	$Q \times Ci = B$
	where:	Q = Order quantity
	Ci = Cost per product	
	B = Labor budget	
	Non-negativity Constraints	$x \geq 0$ *and Integers*

5.6. Design and Development of Workforce Allocation System

The fifth objective is to design a workforce scheduling system that integrates the developed Linear Programming model as a decision-support tool. The system was designed and developed in order to support the reallocation of workers to daily production orders so the organization could maximize percent of man-hours worked, and the percent of labor costs continued to be relatively constant. At the heart of the system is the ILP model developed, which determines how many workers may be needed for each product when evaluating based on productivity, attendance behavior, and order requirements. Through the development of a user interface, the ILP model development is observable, data driven, and complies with operational constraints when re-assigning workers.

Figure 2. System Logo

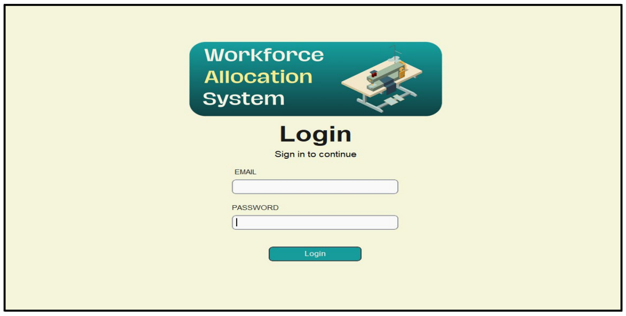

Figure 3. User Authentication and Access Control

Figure 4. JCCMI Workforce Allocation System Dashboar

The ISO 25010 Software Quality Model was utilized to evaluate the developed Linear Programming-Based Workforce Allocation System by both end-users and IT Professionals regarding the system's functionality, efficiency and usability as well as the overall software quality.

As for the end-user evaluation, the system received an average composite score of Very Functional (3.67), Very Efficient (3.33) and Very Usable (3.17). These results indicate that JCCMI-WorkPro possesses all required features and produces accurate results in scheduling manpower, can process workforce allocation job orders quickly while using resources efficiently. This indicates that the system can be easily used, learned and accessed by individuals involved in manpower planning at production facilities.

As for the IT professional evaluation, the system receives a composite mean of Very Functional (3.67), Very Efficient (3.17), Compatible (2.75), Very Usable (3.08), Reliable (2.88), Secure (2.80), Very Maintainable (3.10), and Very Portable (3.00)The assessment of the system indicates that it is effective in meeting its intended goals and optimizing tasks. Overall, it exhibited superior performance, acceptable interoperability, user-friendly features, easy to learn how to use by end-users, trustworthy results and safety through adequate data protection. Furthermore, its maintainable and portable design facilitates updating, improving and installing the software on varying computer environments. In summary, all results support the conclusion that this system is appropriate for practical applications in workforce allocation and operational support.

5.7. Comparison of Manual and Developed System

To better illustrate the differences between the current manpower allocation and the optimized allocation generated by the Integer Linear Programming model, graphical analysis was performed. The graphical results show that the current manual allocation method often leads to uneven distribution of workers across product lines. Some production areas experience excess labor while others experience insufficient manpower, resulting in production delays and idle time.

Figure 2 illustrates the comparison between the existing manpower allocation used by the company and the optimized allocation generated by the Integer Linear Programming model. The graphical results reveal that the current manual allocation tends to concentrate workers in certain product categories without fully considering productivity differences. In particular, the existing system allocates a higher number of workers to the production of pouches, resulting in potential inefficiencies in labor utilization. The optimized allocation generated by the ILP model redistributes workers more effectively across product categories by aligning manpower assignments with productivity levels and production demand. This adjustment results in a more balanced workforce distribution, ensuring that labor resources are utilized more efficiently while maintaining production requirements.

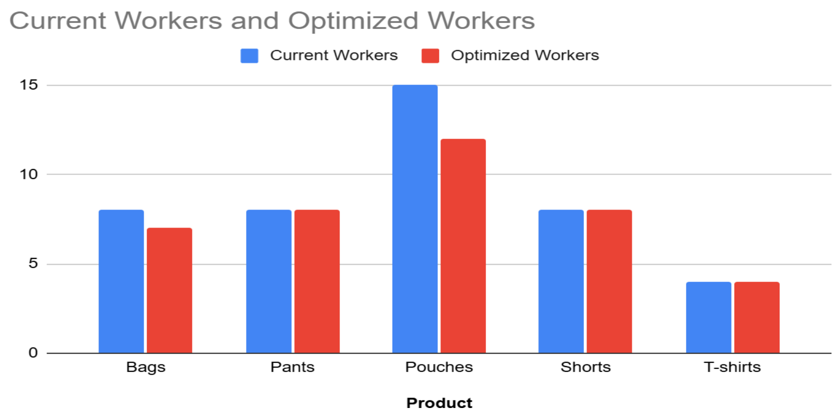

Figure 5. Current vs Optimized Worker Allocation

Figure 3 presents the manpower efficiency levels achieved after implementing the optimized workforce allocation generated by the Integer Linear Programming model. The graphical results indicate that most product categories achieved full manpower efficiency, particularly in the production of pants, shorts, and T-shirts, where the efficiency ratio reached 1.000. This suggests that the number of workers assigned to these product categories is optimally aligned with their production requirements. Meanwhile, the efficiency values for bags and pouches remain slightly lower, indicating minor adjustments in worker allocation to avoid overstaffing. Overall, the results demonstrate that the proposed optimization model significantly improves manpower utilization by reducing allocation inefficiencies and ensuring that labor resources are distributed according to production capacity and demand.

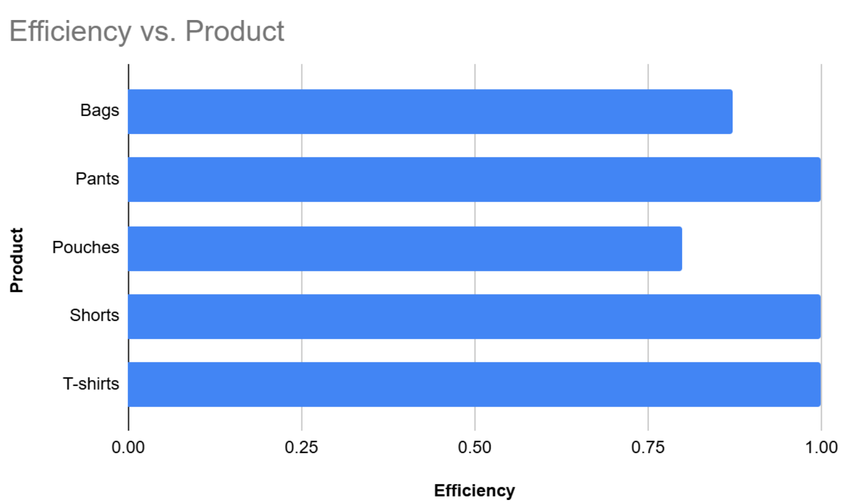

Figure 6. Manpower Efficiency Comparison

5. Conclusion

- The manual system that is currently in use to manage manpower allocation at JCCMI is not enough to ensure smooth operations. Its dependence on the subjective decisions and the unreliability of the workers attendance has created inefficiencies in the production scheduling and hence the need to employ an analytical and systematic allocation methodology.
- A time-study implementation also played a significant role in identifying the differences in the productivity of the workers. It made it easier to set uniform performance standards across its operations, which is invaluable to the process of developing data-driven workforce decisions.
- The assignment model effectively addressed the parity concern in the distribution of workers with an optimized methodology of pairing workers to orders and also on the data of performance, as well as operational needs. This framework provides congruity of work distribution, and avoids unnecessary surplus or deficiency of labor.
- The LP model created provided a useful mathematical representation of JCCMI's workforce optimization problem by minimizing total labor cost while also satisfying demand and capacity constraints. The LP model provided a framework for automating manpower scheduling.
- The workforce scheduling system successfully provided a decision-support platform by applying optimization modeling into an applied framework. Its design allows data to be input easily, content to be computed quickly, and results to be visualized correctly, which provides a useful tool for managers.
- The completed prototype showed that applying operations research methods with a computerized interface improves accuracy, speed, and consistency in manpower planning, which offers specificity in the small-batch production environment for optimization models.
- The developed and studied system showed a very significant increase in manpower efficiency for JCCMI and lowered labor costs, with good acceptance by users and evaluators. The results provided confirmation that a workforce allocation system using LP can increase productivity, fairness and decision-making transparency within the garment industry.

References

Clautiaux, F., & Ljubić, I. Last fifty years of integer linear programming: A focus on recent practical advances. *European Journal of Operational Research*, 324(3), 707–731. 2024.

Coronado-Hernández et al. Linear programming model for production cost minimization at a rice crop products manufacturer. *Communications in Computer and Information Science*, pp. 335–346. 2021.

Febianti, F., & Hasbiyati, I. Optimal inventory policy using assignment model as mixed integer linear programming problem. *Deleted Journal*, 1(1), 17–24. 2024. https://doi.org/10.31258/jomso.1.1.17-24

Galindo et al. Cost optimization for the allocation, production, and distribution of a plastic manufacturing company using integer linear programming. *2021 IEEE 13th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM)*, pp. 1–6. 2021.

Gulia et al. Multi-objective optimization with integer linear programming: A case study of garment industry. *AIP Conference Proceedings*, 3185, 020071. 2025.

İşeri, A., Güner, H., & Güner, A. R. Pareto-optimal workforce scheduling with worker skills and preferences. *Operational Research*, 25(2). 2025.

Khadivi, M., Abbasi, M., Charter, T., & Najjaran, H. A mathematical model for simultaneous personnel shift planning and unrelated parallel machine scheduling. *arXiv*. 2024.

Kong et al. Mixed-integer linear programming (MILP) for garment line balancing. *International Journal of Scientific Research and Modern Technology*, 4(2), 64–77. 2025.

Nguyen et al. Binary integer formulations for task allocation and optimal labor cost in small and medium apparel manufacturing. *Designs*, 7(4), 84. 2023.

Soriano et al. Integrated employee scheduling with known employee demand, including breaks, overtime, and employee preferences. *Journal of Industrial Engineering and Management*, 13(3), 451. 2020.

Suariya, S., & Hasan, M. B. Approaching a linear programming model for production planning of a ready-made garments industry. *Journal of Applied Mathematics & Informatics*, 41. 2023.

Torres, and Gavina. Solving faculty-course allocation problem using integer programming model. *The Philippine Journal of Science*, 150(4). 2021.

Biographies

John Lloyd R. Platon is a fourth-year Bachelor of Science in Industrial Engineering student at First Asia Institute of Technology and Humanities, expected to graduate in 2026. His research focuses on optimization models and production planning in manufacturing systems. His undergraduate thesis, *"Optimizing Manpower Allocation by Developing an Integer Linear Programming-Based System at Jacksonville Creative Concept Mfg. Inc., in Alaminos City, Laguna,"* investigates the application of mathematical optimization to improve workforce allocation in manufacturing operations. His interests include industrial systems optimization, manufacturing efficiency, and the use of data analytics for operational decision-making.

Angel Kate A. Tolentino is a fourth-year Bachelor of Science in Industrial Engineering student from First Asia Institute of Technology and Humanities in Tanauan City, Batangas, Philippines- expected to graduate in 2026. Her academic interests focus on main fields such as Operations Research, Optimization, Data Analytics, and Innovation etc.. During her undergraduate studies, they conducted research titled "Optimizing Manpower Allocation by Developing an Integer Linear Programming-Based System at Jacksonville Creative Concept Mfg. Inc., in Alaminos City, Laguna", which focused on applying Integer Linear Programming models to optimize workforce allocation in a garment manufacturing environment. She is currently gaining practical experience through an On-the-Job Training (OJT) program, where she worked on projects related to warehouse operations, space optimization, inventory monitoring, and process improvement.

Pia Althea B. Villanueva is a fourth-year Bachelor of Science in Industrial Engineering student at First Asia Institute of Technology and Humanities, expected to graduate in 2026. Her academic background reflects a strong interest in operations optimization, production management, and process improvement in manufacturing systems. She is particularly interested in applying analytical methods and quantitative techniques to address operational challenges and improve workplace efficiency. Her undergraduate thesis, "Optimizing Manpower Allocation by Developing an Integer Linear Programming-Based System at Jacksonville Creative Concept Mfg. Inc., in Alaminos City, Laguna," focuses on the development of an optimization-based system designed to improve workforce assignment and enhance productivity in manufacturing operations. Through this study, she demonstrates an interest in creating practical and data-driven solutions to support better decision-making in industrial environments.

Melan Dyrene N. Almendras is an Industrial Engineering professional, educator, and researcher dedicated to advancing engineering education, research, and industry collaboration. She currently serves as the Industrial Engineering Coordinator in the Industrial Engineering Department in FAITH Colleges in Tanauan City, Batangas, Philippines where she plays a vital role in overseeing academic programs, student research initiatives, and departmental development. She holds a master's degree in engineering with a specialization in Industrial Engineering and is actively involved in teaching core Industrial Engineering subjects, mentoring students, and facilitating research projects. In her role as coordinator, she manages research supervision, student programs, external affiliations, and curriculum development while ensuring that the department complies with academic and accreditation standards. She is committed to preparing future engineers by integrating real-world applications into the learning process and promoting collaboration with industry partners for internships, research, and professional development opportunities. Her research interests include production systems optimization, production scheduling, quality management, and the integration of Industry 4.0 technologies in manufacturing environments. She is a recognized Associate ASEAN Engineer, demonstrating her commitment to professional excellence and adherence to regional engineering standards. Through research, professional engagement, and academic leadership, she aims to contribute to the advancement of Industrial Engineering practice and strengthen the connection between academia and industry in the ASEAN region.