7th European Conference on Industrial Engineering and Operations Management
Augsburg, Germany, July 16-18, 2024
Publisher: IEOM Society International, USA DOI: 10.46254/EU07.20240178
Published: July 16, 2024

Process Enhancement using Promodel Simulation: A Case Study of a Third-Party Logistic Service Company in the Philippines

Mark Jherald Acilo, Trishia Anne Marie Cobalida, Rhiza Anne Barbara Lopez, Jake Quijano, Nikko Luis Tabasa and Maricar M. Navarro
Industrial Engineering
Technological Institute of the Philippines
Quezon City, MNL 1109, Philippines
qmjacilo@tip.edu.ph, qtamcombalida@tip.edu.ph, qrablopez@tip.edu.ph, jjquijano@tip.edu.ph, qnltabasa@tip.edu.ph, mnavarro.ie@tip.edu.ph

Abstract

This study focuses on the process flow of the third-party logistic (3PL) company. It aims to analyze the operation management and processing system using Promodel software, a computer-aided drafting software utilized to simulate the operational models of a company. Process enhancement brings about the study's key objective since it is the most accessible and requires less intervention in the working environment. While the manpower and material are insufficient, the study aims to mitigate the problems by providing suggestions regarding the company's process. This paper found operational inefficiencies resulting from poor operation management using the Ishikawa diagram and considered the need for change by accounting for the company's current resources. By using Promodel, process observation, and time-and-motion study, this paper identified the blocked, operational, and moving rate of the company. The assembly line proved to be inefficient with the company's current resources in which the study simulated and proposed a synchronous process model. By implementing a fitting manufacturing model for the company, the ability to be productive will be easily achieved. In light of this, the study aims to contribute to the effectiveness of the synchronous process model for companies that find limitations in their manpower and locations.

Keywords

Computer-aided drafting, Third-Party Logistics, Production Management, Promodel, Synchronized process

1. Introduction

Planning and coordination include a production management system and control of all aspects of the process in production, from the processing of raw materials to testing the finished products. To produce goods in an efficient and timely manner, production and operations management ensures the completion of activities to streamline the production process of the company. The role of production management is to ensure that the production process runs smoothly and efficiently, with the least possible bottlenecks. Through the collaborative efforts of the various sectors in the logistics and supply chain industry of the Philippines, the country's economy has remained robust because of its location in the region and of course the major international trade routes. This industry includes transactional and physical activities that include transportation, warehousing, distributing, inventory management, and procurement. The study focuses on the company's weaknesses in the distribution of the received packages and how well the company can release these packages.

This study identified that there was a need to assess and analyze the current operation management and process system of a Third-party logistic service (3PL) company. The study found that inefficiencies of methods implemented in

package processing and storage area congestion due to inefficient operations were some of the main problems a 3PL service may experience. The 3PL service company currently uses a progressive assembly for processing their goods. The current application of the method used to process the packages results to bottlenecking under the current condition of the system hence the study aimed to propose a fitting method for the company.

The study's findings are significant because they will help improve the efficiency of 3PL service company production management systems. The study tries to highlight the significance of the findings and who will benefit from the study (Hiebert et al., 2023). Additionally, the organization will receive knowledge into elements that improve work capability and production (Birt, 2023). Finally, the study's techniques will be used as a reference for future Industrial Engineering researchers, helping them comprehend the value of method analysis in the workplace.

1.1. Objectives

This study aimed to improve the package release of a 3PL service company by understanding how they implement their operations first. The general objective is to increase the overall efficiency and effectiveness of each process, ensuring they can utilize their resources. To achieve this goal, this study set specific objectives to increase productivity in the workplace. The aim of the study was the following:

- Understand and analyze the current model of a 3PL service company;
- Develop a model that satisfies the current resources of the company and analyze its effectiveness; and
- Compare and contrast the current model of the company and the proposed model.

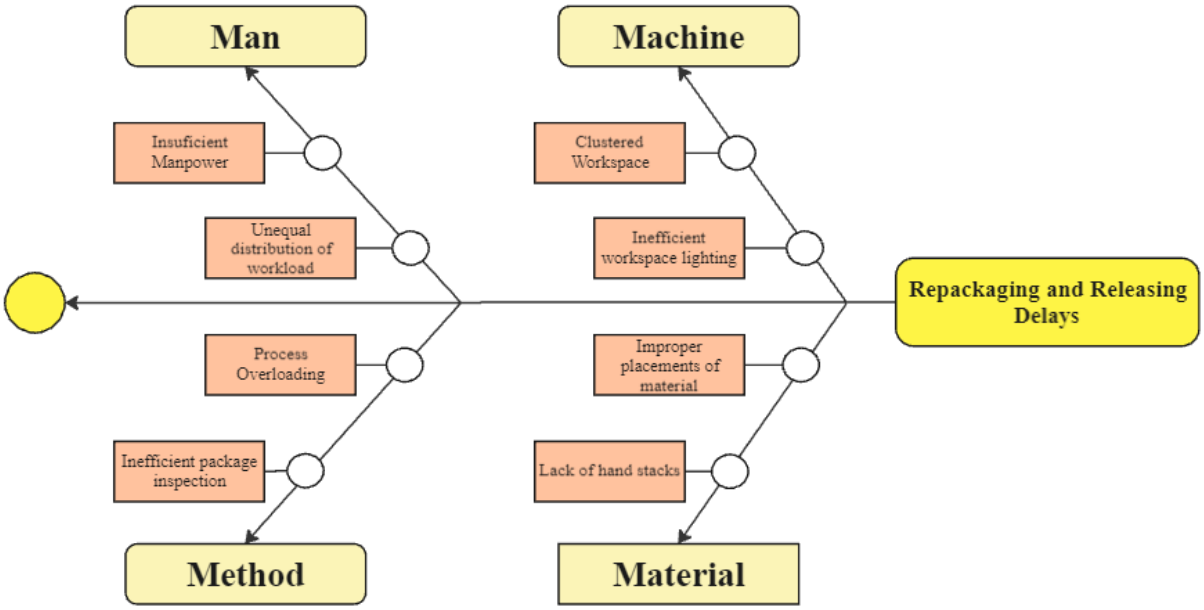

Figure 1. Ishikawa diagram of the Third-party logistic service company.

Figure 1 shows the identified problems of the company and their corresponding sub-causes. The study aims to research and address the problems through the use of a simulation model while taking into account the limitations faced by the company.

2. Literature Review

Lean and agile principles continue to guide efforts to improve production efficiency and responsiveness (Christopher and Towill 2019). Gunasekaran et al. (2017) highlight the application of lean techniques such as Just-in-Time (JIT) and Total Quality Management (TQM), as well as agile methodologies like Kanban and Scrum, to minimize waste, shorten lead times, and adapt to changing customer demands. Improving efficiencies and responsiveness can be applied to the company by determining whether the company's production management is efficient. Although,

according to Carrasquiera (2013), the application of the Lean principle does not simply entail a reduction of costs, for logistic services, there is a need to consider how many available resources they have, and from that, the company may draw conclusions and recommendations on how they should run the business (Carrasquiera, 2013). This would mean that the application of the Lean principle to 3PL services should not just cut their costs by reducing their manpower or the process but would also rely on how effective they were utilizing the processes, however, 3PL service that currently has limitations to their manpower and materials may find it hard to achieve the lean technique.

The production management system is the gateway to logistics and it does this by acting as a regulator thus streamlining the operations, optimizing the resources, and enhancing efficiency at the supply chain level. Effective management of production processes lets this kind of system ship a product on time, keep it in stock, prevent stock-outs, minimize inventory holding costs, and to top it all – satisfy customers. What Heizer and Render (2019) suggest is that productive management would allow the delivery of goods at the right time when needed by customers hence reducing unnecessary stock storage and incurring storage costs. Additionally, Prananingtyas and Zulaekhah (2021) stated that there was a need for logistic services to utilize their storage effectively. In a sense, for 3PL, there was a need to attend to all the goods they were receiving whilst minimizing the inventory holding cost. When the goods are kept in stock in the system for a longer time, inefficiencies become visible to the company therefore the need for understanding how inventory holding affects the company becomes apparent. Therefore, for a 3PL service to prosper in its operations, efficient use of storage would be important to a 3PL service provider and the assumptions of the effectiveness of production processes for companies that focus on repacking may still be considered too unclear. As such, 3PL that process the same-day arrival of packages may find it difficult to determine the appropriate amount of receiving goods or improve their current production model as a dilemma for good storage arises.

A Progressive assembly manufacturing model is associated with the mixture of human and machine tasks, enabling the modeling of the variable work tasks and the variability of process data using a runtime-decision model (Lindorfer et al. 2018), for a 3PL service that adopted the kind of manufacturing model, the company may experience inefficiencies due to variability of its model since some companies work through manpower. The model under consideration is geared towards augmenting the efficiency and the quality of the assembling process. Besides, the application of progressive dies in the industry makes it possible to carry out several operations in one stroke which, in turn, boosts the production rates and cuts the costs in the mechanical, defense, and automotive sectors (Ahmad et al. 2018). According to Longo and Mirabelli (2017), the assembly line should be implemented with effective designs and only partially entails smooth operations. 3PL were also included when it came to the assumption of when to use progressive assembly. By taking into consideration what are the current resources the 3PL have, they will be able to determine the effective design of assembly lines. In simpler terms, progressive assembly cannot be used just because they are the norm in the industry but some considerations need to be accounted for before implementing the manufacturing model into logistic services. For a 3PL service provider who follows progressive assembly, the ability of its employees to process shortly in their respective processes would be beneficial, however, this case may prove to be challenging if the progressive assembly has an increasing amount of time processing. Lack of consideration for the process flow may result in ineffective use of the progressive assembly manufacturing model.

According to Kuhlang et. al. (2011), value stream mapping can be implemented in logistic services since there were operational inefficiencies. For a 3PL service that primarily works around packing and repacking, the application of value stream mapping may be overkill for some companies that were found to have limited resources. In an article published by Camacho (2011), warehouse and logistics work hand in hand, and storage use typically affects the operations of a logistics company. The application of internal distribution optimization to improve the operations of a logistic service may prove sufficient for some companies that have a lot of limitations to their resources, especially in manpower. Internal distribution optimization may be implemented for a 3PL service that finds the company to have limited manpower, although internal distribution optimization can be used to determine the applicability of the manufacturing model a logistic service company currently has. On the other hand, a lack of study about logistic services that are delivered within the same day may cause the implementation of value stream mapping and internal distribution optimization to be unfitting for companies who find that manpower and materials are limited in their system. Simply adding units from the identified categories of the Ishikawa diagram' wouldn't be satisfactory since space allocation becomes another key consideration.

An article published by Chen (2016) had tackled a logistic process improvement by utilizing the queuing model. With the application of the queueing model, the study was able to achieve better understanding of resource allocation in its services. The application of suppliers requesting the service of a 3PL can be implemented in to the current study but

poses a weak correlation to the operations of the logistic service itself. Oršič et. al. (2020), provided a key performance indicator in improving the sustainability of 3PL services which may be used as a guide for studies conducting multiple company reviews.

In summary, numerous research had already been conducted to improve the efficiency of the process itself but the study noticed that there is a lack of research on the conceptual use of the production line in different areas of industry such as operations and processing of 3PL providers. As industry steadily inclines to the use of machines, several working capabilities are being overlooked especially to services that are heavily reliant on manpower rather than machinery. Additionally, lack of recent in-depth research about improving the individual operations of 3PL services due to the increasing amount of 3PL process improvement generalization becomes a research obstacle especially to newly built 3PL companies.

Current studies improve the efficiency of the flow between the processes such that it becomes more exponentially effective for services that undergo numerous processing before producing certain types of goods since it effectively shows how to eliminate downtime. However, there were cases of services that only had a few processes in which the downtime that process have between each other is only minimal. This would mean that the impact of reviewing and eliminating minor efficiencies would only contribute little to the overall efficiency of the system and the most likely scenario to address would refer back to the Ishikawa model. Hence it would lead to the need to explore areas that would involve the recalibrations of the whole operation and process management. With the application of process recalibration, generalized studies regarding the 3PL operational improvement may impact the recalibration but also lacks the weight to provide new perspectives in conducting 3PL operations.

3. Methods

The study used process observation to visualize the current assembly line of a 3PL company and used the Promodel software to simulate the company's current model. With the application of the Time-and-Motion Study (TMS), this study was able to time the average time of each process and the gathered data would serve as the time to be used for filling out each process in Promodel software. With the limited manpower the company has and the space allocated for each process, this study will provide a model that would work with the current limitations of the company. The research paper outlines the background of simulation in manufacturing engineering and gives an overview of simulation software tools used for Computer-Aided Production Engineering (Klingstam & Gullander, 1999)

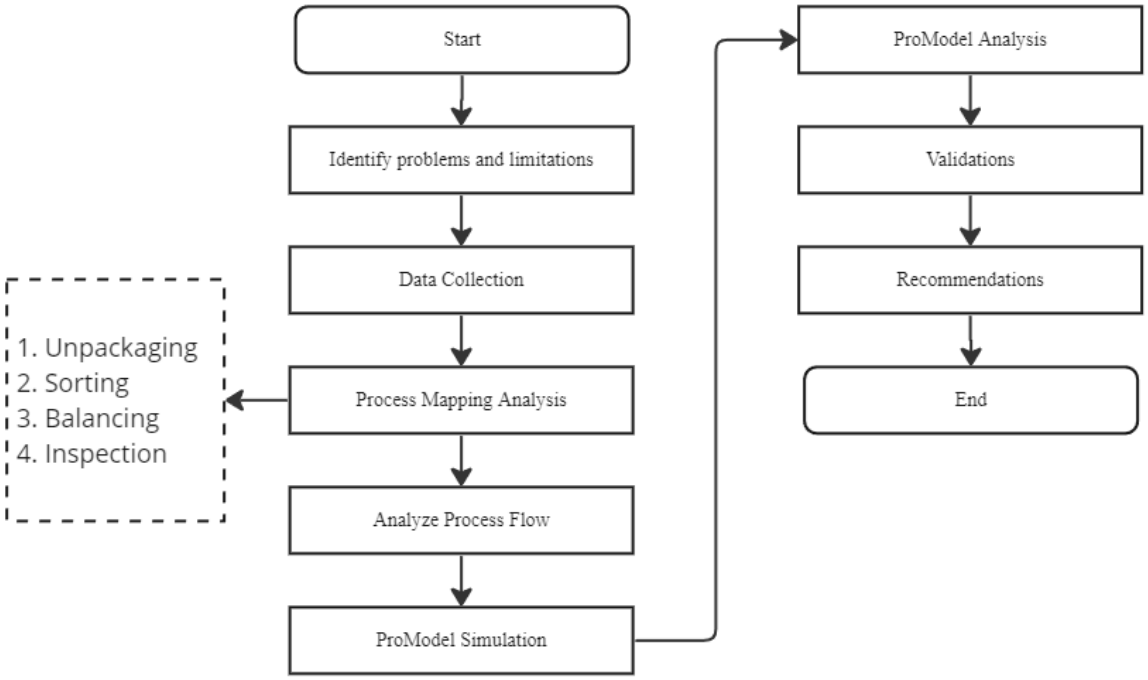

Figure 2. Case methodology for the simulation of a third-party logistic service

Figure 2 determined by the study was divided into several parts to achieve a meaningful study A similar style of a study published by Abad et. al. (2023) became a basis of the study for following key figures in conducting effective methodologies. The steps followed by the study are as follows:

1. *Identify problem, scope and limitations of the study* - the study defines the problem, the scope, and the limitations of the study focusing on operational inefficiencies through process observation.
2. *Data Collection* - the study gathers substantial data to analyze and serves as a basic foundation for variable identification.
3. *Process mapping analysis* - process flow of the third-party logistic service
4. *Analyze Process Flow* - analysis of the process serves as the identification phase for operational inefficiencies.
5. *ProModel simulation* - simulate the current model of a third-party logistic company and develop a proposed model for the third-party logistic service provider.
6. *ProModel analysis* - analyze both the current model and the proposed model of the study to determine the effectiveness of the simulation in replicating the scenarios in the real world. The study includes the performance metrics and scoreboard result analysis.
7. *Validations* - Validate the gathered data from the ProModel simulation to the real world and determine whether the restrictions identified by this study were carefully considered in the simulation.
8. *Recommendations* - recommends a proposed model to the company based on the scoreboard result analysis of the simulation.

In this study, the observed process of shipping goods. There are currently 5 locations present in the company and for every location, two assigned workers are dealing with the particular process. It gives a recognized standard, a set of guidelines, or specifications about a certain system, which are often recorded to denote trustworthy standards, procedures, processes, and procedures. The implementation of a single quality assurance method, and the elimination of duplicate or redundant quality systems (Trotman, 2018). This study employed industry standards for the acknowledgment of the company's compliance with the law and established general ethical guidelines.

4. Data Collection

The study identified the current process the 3PL service company currently uses. Figure 3 currently has one input, one output, three processes, and one inspection for a 3PL service. The process flow of the 3PL service follows a simple process in which for every process, corresponding workers were designated to each task.

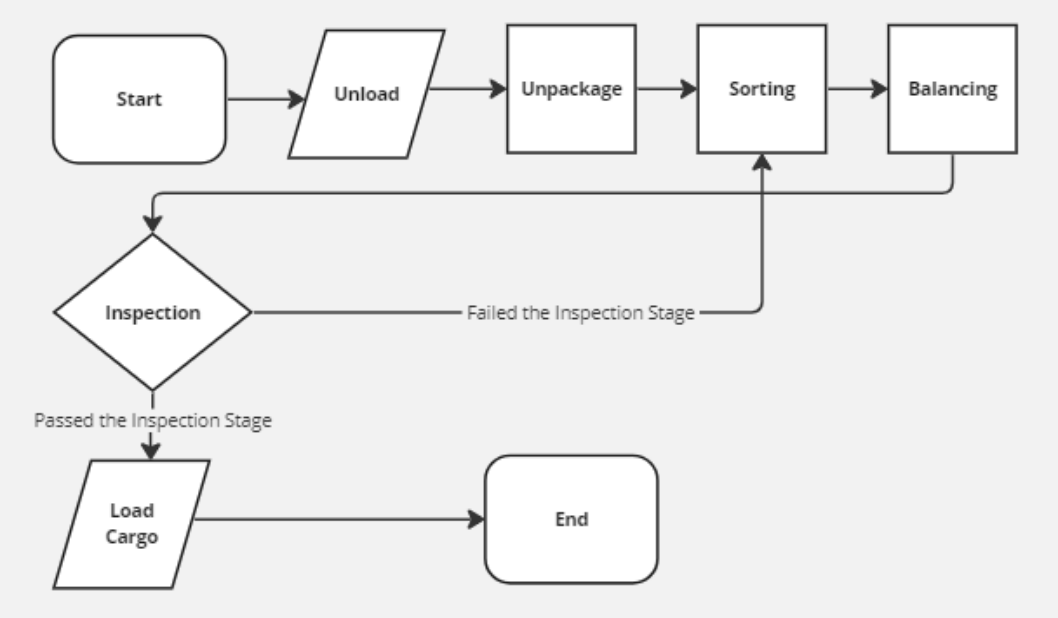

Figure 3. Process Flow of a Third-party Logistic Service

Table 1. Observed time from the Third-party logistic service

Element	Observed Time	Half Range	Location Unit
Arrival	118 mins	3 mins	1
Unpackage	4.02 mins	1 min	1
Sorting	9.87 mins	2 mins	1
Balancing	5.3 mins	1 min	1
Inspection	19.42 mins	2 mins	2

The package that arrives at the company at a uniform interval of two hours contains 24 packages. The packages that arrived were being processed by the locations facilitated by two employees each. The location unit explains how many tables a process needs to accommodate the packages.

5. Results and Discussion

5.1. Result of the Third-party Logistic Service Model

Figure 4 shows the visualized model the 3PL service currently uses. It allowed the study to analyze where the packages flow and how it was being processed in a given location. In the identified model of the company, the packages flow directly to the sorting and balancing before going to the temporary which would lead to buildup and

delays when the following process is full. The study determined that the huge area allotted for the unloading zone was being inefficiently used. A messy working environment would likely occur with the current model used by the 3PL service company.

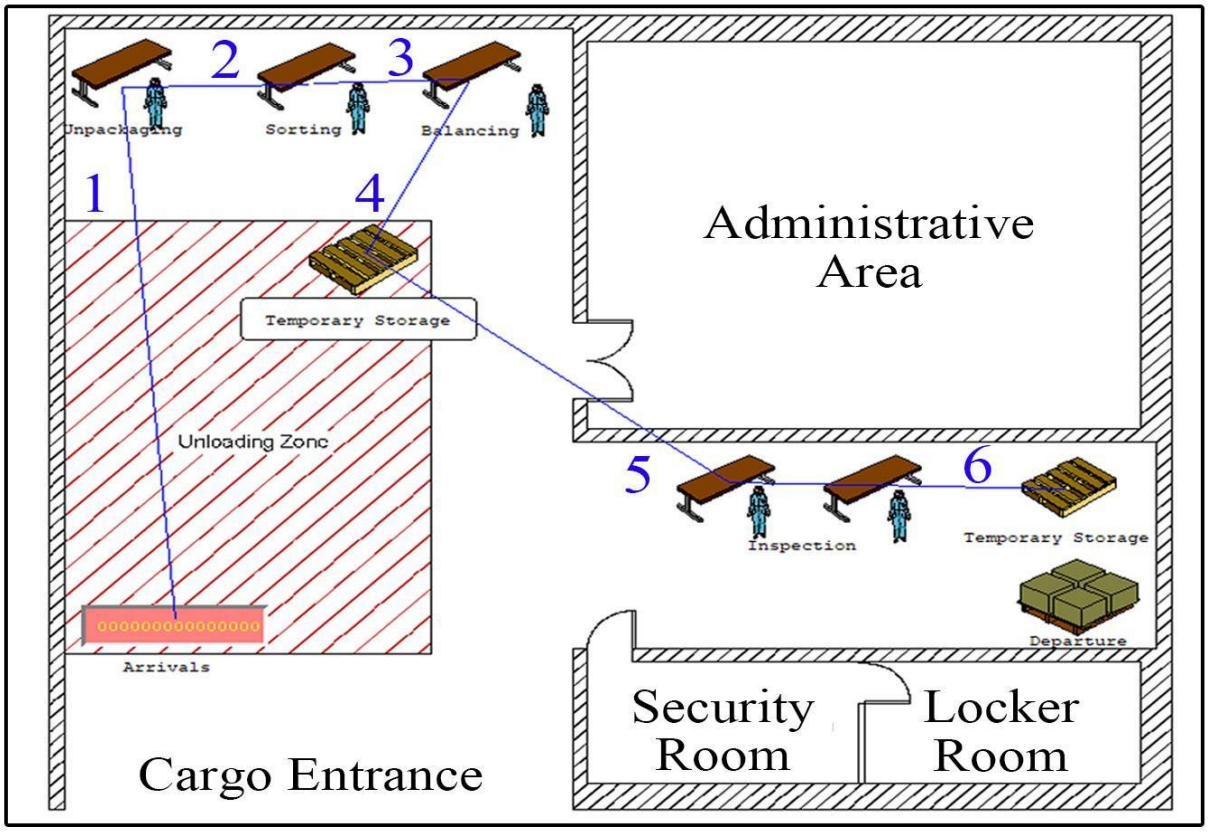

Figure 4. ProModel output of the visualized current company model

Table 2. The company's current model entity state

Entity State	**Third-party logistic service current model**
Blocked Rate	74.33%
Operation Rate	22.44%
Move Logic	3.23%

Table 2 identifies the entity state of the package in the current model, this study was able to identify the difference between blocked rate, in operation, and in moving with numerical data of 74.33%, 22.44%, and 3.23% respectively. The identified data in Table 2 means that the blocked rate of each entity was high and it may impede the whole operation especially since the current manufacturing process of the 3PL service was a progressive assembly. The blocked rate that was identified can also be prompted with the Ishikawa diagram. The bottleneck of the system due to the current use of the current model led to high block rate. The block rate can be understood as the incapability of the entities to be processed on to the next stage due to aforementioned problems in the Ishikawa diagram thus resulting to a lower operation rate.

Table 3. Scoreboard of package release in the current model of the company.

Replication	Name	Total Exits	Average Time in System (Min)	Average Time in Operation (Min)
Avg	Package	46	206.21	46.00

Table 3 identifies how many packages were released in a given time. The study identified that the total number of packages released was 46 units

Given that the company was using a progressive assembly and the blocked rate was 74.33%, this study identified according to the objectives of the study that there was a need to provide and suggest a better model for 3PL service company as the study identified that the current model of the company may be considered as inefficiency with their process. From another perspective, a complete cycle where there were 10 workers involved produced almost 42 packages in which most of their time was being held due to delay and buildup. In the identified Average Time in System which was 206.21 minutes, it can be translated to 3.43 hrs. The packages processed with a total time of 46.00 minutes before being released. With the arrival of new packages every 2 hours, the study identified that stickups or buildups of packages in the system. This results to lower shipping rate of the packages. The gap between the time in system and time in operation was huge and can already be deemed as very inefficient by applying the concept of queueing model.

Table 4. Package entry to each location in the Proposed Model from Promodel

Arrivals	Unpackaging	Sorting	Balancing	Inspecting	Shipped
96.00	72.00	72.00	70.00	46.00	46.00

Table 4 shows the package entry to each location, the study identified that the current model had a diminishing performance when it comes to each process. The study identified that the inspection poses the major blocking rate of the packages and can be identified as one of the key indicators in improving the operations of the whole 3PL company.

5.2. Proposed model for the Third-party logistic service company

Figure 5 shows the proposed model of this study where it shows the basic routing path of a single worker and routing network of all the workers in the system. This model assumes that instead of naming different locations with their respective process, the study would instead name it a working table since it accommodates the four types of processes. The model can be interpreted as if all working tables will be sharing every package they receive achieving a conditional and more synchronized model will allow for better efficiency in the working environment. The proposed model can be assumed that all working tables would have the same routing path and therefore synchronously work on the same process before moving to the next type of process. The condition stated by the study in the model is that no location would accommodate another type of process unless all locations are done with that current process. With the given conditions of the 3PL service, there would be no changes to the locations of the tables and it would still accommodate the same number of workers in the process.

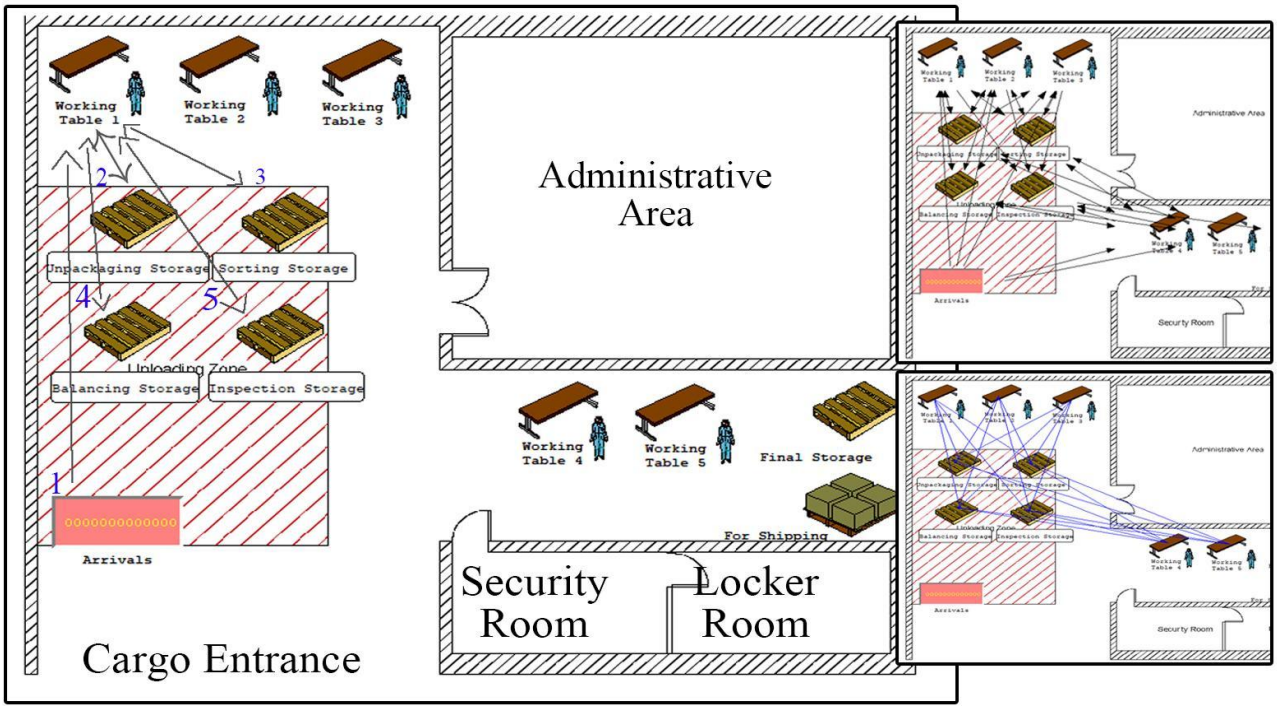

Figure 5. Proposed model for the Third-party logistic service company

Table 5. Proposed model entity state

Entity State	Proposed Model
Blocked	46.41%
In operation	41.02%
In move logic	12.58%

Table 5 shows the entity state of the proposed model using Promodel. This study identified the values of the block, in operation, and move logic with a value of 46.41%, 41.02%, and 12.58% respectively. Table 5 shows the effectiveness of the proposed model and how the package state is being identified within the system. The table above can be understood as that Blocked operation would still have a higher percentage than the in operation. This can be interpreted as the bottleneck of the system itself and one of the indicators of identified problem in the Ishikawa diagram mentioned beforehand.

Table 6. Scoreboard of package release in the proposed model of the company.

Replication	Name	Total Exits	Average Time in System (Min)	Average Time in Operation (Min)
Avg	Package	69.00	95.42	39.14

Table 6 shows the proposed model of the company and identified 69 packages was shipped on the simulation and that a package spent 1 hr and 36 minutes in the system while its processing time was 40 minutes. The study was able to

identify that the time in system of the packages was faster than the time before new packages arrive in the system which had a uniform interval of 2 hrs. The study was able to acknowledge the effectivity of the proposed model and follows the concept of queuing model.

Table 7. Package entry to each location in the Proposed Model from Promodel

Arrivals	Unpackaging	Sorting	Balancing	Inspecting	Shipped
96.00	72.00	72.00	72.00	70.00	69.00

Table 7 shows how many units have been processed by each location. 96 packages arrived and only 69 packages were released. The inspection process caused a delay to the proposed model since the study identified that there was a certain percentage that the inspection was rejected since it did not pass the inspection stage. The mode adopted a manufacturing model of batch production where every batch of each package will be processed.

5.3. Comparison of the current model and the proposed model

Figure 6 shows the difference between the current and the proposed model. The study identified the difference between the in-move logic, in-operation, and blocked rate of the current model and the proposed model with a value of +9.48%, +17.99%, and -27.47% respectively. Figure 7 shows that the proposed model had a positive impact on the production management of the 3PL service company.

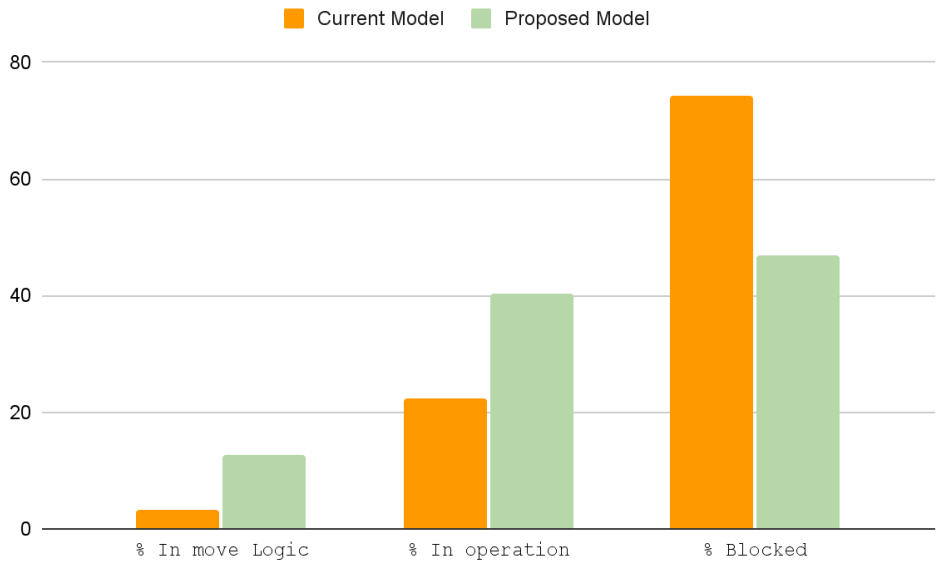

Figure 6. Percentage difference between the current and proposed model

Table 8. Location package entry difference between the current and proposed model

Model	Unpackaging	Balancing	Sorting	Inspection
Current	72 packages	72 packages	70 packages	46 packages
Proposed	72 packages	72 packages	72 packages	70 packages
Difference	No Changes	No Changes	+2 packages	+24 packages

This study identified the difference between the processing results of each location. Table 8 shows the increase of the package entry and exit on each location. This study identified that Sorting had increased 2 processed packages and Inspection had increased by 24 processed packages.

6. Conclusion

In conclusion, the study used the current model to assess the effectiveness of the progress assembly to a 3PL company. With its given data, this study was able to conclude the current weakness of the company. The study focused on the blocked rate and determined that it needs to be reduced so that the operation rate of the company would increase. This study concluded the following from the different models.

1. From the current model of a 3PL service company, the study identified that the blocked rate of the company was higher than the operation rate of the current model. The identified blocked rate of the current model was 74.33% while the operation rate was 22.44% The study identified the total package release as 36 packages and identified that the manufacturing model of the company was a progressive assembly. According to Ekren and Ornek (2008), identifying performance measures through simulation allows a better understanding of the company being reviewed. By identifying the blocked rate, the study was able to determine the point for improvements It was also stated by Werbinska (2007) that time-redundancy due to downtime leads to the inefficiency of logistic services.
2. The proposed model of this study stems from the batch production manufacturing model where only another type of process will be accommodated if all the packages are finished on that particular process. The closest study that was ever conducted in applying the principles of batch production was the article by Li et. al. (2015). The synchronous process aims to coordinate each process time to be aligned with other processors as it was studied by Anandarajah et. al. (2007) that time synchronization improves process control.
3. The proposed model of this study resulted in a package release of 69 packages. The proposed model identified the values of in move logic, in operation, in blocked rate with values of 12.58%, 41.02%, and 46.41%.
4. The difference between the current and the proposed model was 24 additional package release. The blocked rate reduction was 27.47% and there was an increase in operation rate which was 17.99% while the in-move logic increased by 9.48%.

The proposed model of the study was also under the same assumption that there will be the same number of employees and locations therefore making it very feasible for the company to adapt the model. This study concluded that the progressive assembly may be ineffective if the blocked rate of each location was high, which the study analyzed and understood that a synchronized process model that incorporates the idea of batch production would be effective. According to Cochran (2001), understanding the relationship between elements of a system design is important. The study understood that the blocked rate of the manufacturing model proves to be the greatest obstacle the company faces and just cannot be solved easily by changing processes. The study shifted its focus on the conceptual use of the company's manufacturing model and took into consideration the limitations the company faces in providing a suitable manufacturing model which was the synchronous process model. This effectively reduced the blocked rate and allowed more released packages by the company.

Simply, the study focused on the capability of manpower to effectively utilize different processes for each worker rather than designating a person into a specific process. By evening the workload to every worker since they are capable of doing each process, the study achieved synchronization between each process which effectively addresses the buildups and delays. The application of the conceptual use of batch production which may referred to here in the study as batch processing proves that synchronized processing can be utilized in the case of increased processing time for each assembly location especially for those companies that face manpower limitations and space constraints. The study explores the conceptual use of batch processing for companies that heavily rely on manpower and effectively utilize this concept to address multiple issues at once.

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Biographies

Mark Jherald Acilo, a 20-year-old Industrial Engineering student at the Technological Institute of the Philippines - Quezon City, embodies a dynamic blend of academic expertise and diverse interests. With an intense commitment to his studies, he has cultivated essential skills such as time management, critical thinking, and teamwork. Outside the classroom, Mark finds joy in basketball, anime, gaming, and the simple pleasures of rest. Fueled by his passion and

potential, he eagerly anticipates leveraging his talents to make a meaningful impact in the world of Industrial Engineering and beyond.

Trishia Anne Marie Cobalida is an industrial engineering student at the Technological Institute of the Philippines in Quezon City, Manila, Philippines. She is a consistent honor student starting from the early levels of education harboring scholarships and academic discounts including her entry into the Technological Institute of the Philippines. She is currently a third-year student in college striving for quality education and improvement of skills and knowledge. She is also a member of the Organization of Industrial Engineering Students (ORIENTS) in the multimedia guild. Some of her works are published and seen at the university.

Rhiza Anne Barbara Lopez, 21 years of age living in Cainta, Rizal, is taking Industrial Engineering at the Technological Institute of the Philippines, Quezon City. Currently a 3rd year student and also a member of the Organization of Industrial Engineering Students (ORIENTS) in the multimedia guild.

Joseling Quijano is a student at the Technological Institute of the Philippines in Quezon City, Manila, Philippines taking industrial engineering. He is a certified Lean Six Sigma white belter. He is a Guild Head of the Organization of Industrial Engineering (ORIENTS). Currently, he is also working as a business outsourcing manager at a local pharmaceutical company.

Nikko Luis Tabasa is a student of the Technological Institute of the Philippines in Quezon City, Manila, Philippines. A third-year student who aims to be a professional industrial engineer. He has published research articles and project feasibility studies. His research interests include simulation, optimization, and data analytics.

Maricar M. Navarro has the prestigious title of ASEAN Engineer (AE) and Professional Industrial Engineer. (PIE) recognized by the Philippine Institute of Industrial Engineers (PIIE). She is currently an Associate Professor and a Professor in the Graduate School Program of the Technological Institute of the Philippines. She has over 17 years of Industry, academic, and research experience. Her areas of expertise are the optimization of production processes, facility layout design, warehouse operations, and service delivery. Currently, she is pursuing an interest in financial optimization and decision-making in operations research. She holds both a master's and a Ph.D. in Industrial Engineering from Mapua University. As a committed member and Professional Industrial Engineer, Dr. Navarro actively contributes to the Philippine Institute of Industrial Engineers (PIIE).