P-ISSN 2586-9000
E-ISSN 2586-9027
Homepage : https://tci-thaijo.org/index.php/SciTechAsia
Science & Technology Asia
Vol.25 No.4 October - December 2020
Page: [20-29]
*Original research article*

# Efficiency Improvement by Simulation Technique in the Parcel Service Company

Prachuab Klomjit[1,*], Chanpen Anurattananon[1],
Alongkorn Chatmuangpak[2], Amnaht Amaluk[3]

[1]*Department of Industrial Engineering and Management, Faculty of Engineering and Industrial Technology, Silpakorn University, Nakhon Pathom 73000, Thailand*
[2]*Faculty of Engineering and Industrial Technology, Phetchaburi Rajabhat University, Phetchaburi 76000, Thailand*
[3]*Department of Industrial Engineering, Faculty of Engineering, Southeast Asia University, Bangkok 10160, Thailand*

Received 29 June 2019; Received in revised form 28 January 2020
Accepted 3 March 2020; Available online 24 December 2020

**ABSTRACT**

The objective of this research is to improve the efficiency of the distributed system of a partner's product in a parcel service company by simulation technique. This research includes the solution of 3 problems: a queueing of products problem, a duplicated work processes problem and an unsystematic working area problem. The theories that apply are simulation technique (ProModel), method study, goodness of fit test, ECRS method and material handling. The queueing of products problem and duplicated work processes problem were solved by installing a belt conveyor for sorting that combined the zone sorting process and distribution center sorting process. The unsystematic working area problem was solved by arranging the working area clearly to make product flow more linear and reduce distances. All of the solutions and the current system were created as models in ProModel. The results after improving the queueing of products problem and duplicated work processes problem are increased output about 2,530 pieces per day from the original and decreased queueing time for 49.23% from the original, unsystematic working area problem solving increase output about 1,332 pieces per day from the original and decrease queueing time for 29.41% from the original.

**Keywords:** Efficiency improvement; Parcel service company; Simulation; ProModel

## 1. Introduction

The internet of things (IoT) is causing online trade to grow rapidly. Most e-commerce businesses can perform transactions online and rapidly deliver products to customers. Every day, companies deliver a lot of parcels to offices, warehouses, retail shops and households. The stakeholders in the

***Corresponding author:** prachuab@su.ac.th
**doi:** 10.14456/scitechasia.2020.46

ecommerce business include international express firms, e-commerce companies, home shopping channels, banks, technology firms, telecom companies, financial institutes, and schools, as well as local retail chains. The growth of the e-commerce business has increased the demand for product delivery. Therefore, using technology to improve workflows and workplaces can support the increasing demand continuously. Simulation of the system can give an overview of the workflow to determine the best option for work.

A survey by the Electronic Transactions Development Agency (Public Organization) or ETDA revealed that the value of e-commerce in Thailand since 2014 has been growing continuously between 8-10% per year and forecasted that the Thai e-commerce market would have a total value of 3,200,000 Million baht in 2018. The survey result showed that investment in e-commerce business will increase every year. Therefore, it is an opportunity for transportation and logistics service providers to take a more active role in this business [1]. The rise of e-commerce has affected higher numbers of products, so companies need to be prepared to manage increased volume and delivery expectations.

### 1.1 Background of study

The parcel service company in this case study provides the service of transporting parcels for domestic and international customers. The company will receive parcels from various affiliates in the area to be sorted and forwarded to the destination with quickness and accuracy. There are 3 departments in the sample company: the international department, the domestic department, and the service partner department.

#### *1.1.1 Original system*

The service partner department has 3 types of parcels for sorting, tray roll and box. The work area is divided into 6 workstations as follows (Fig. 1):

1) Pick-up point.

2) 1st sorting point sorting by zone consists of 6 zones: Southern, Northern, Northeast, Central Eastern, and Distance exceeding 100 kilometers.

3) 2nd sorting point, sorting by distribution center consists of 19 distribution centers.

4) 3rd sorting point, sorting by zip code.

5) Parcel break point.

6) Parcel delivery point.

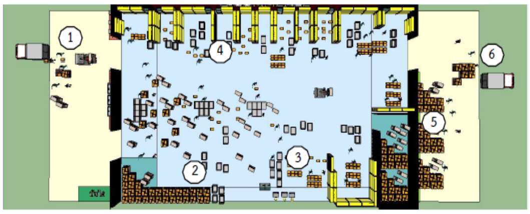


**Fig. 1.** Work area in service partner department.

#### *1.1.2 Work procedures in the service partner department.*

Work processes in service partner department are divided into 2 types: non-pallet and on-pallet. The difference is on-pallet means parcels on pallets but non-pallet means parcels without the pallet. The work process will depend on the incoming package. Work procedures are as follows (Fig. 2):

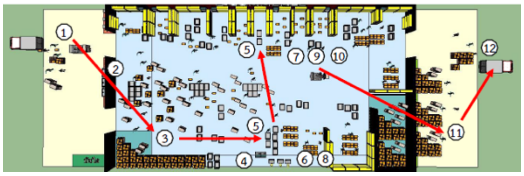


**Fig. 2.** Work processes in service partner department (non-pallet and on-pallet).

1) The car is docked. Employees move the parcel from the car to the pick-up point with the following conditions:

- Parcels with domestic destinations will be transported into the domestic service department.

- Roll and box, will be transported into the service partner department (non-pallet).

Roll and box, will be rearranged on a pallet and after that transported into the service partner department (on-pallet).

2) The parcel will be transported with a forklift to the 1st sorting point, sorting by zone.

3) Employees check the parcel by scanning the barcode and sorting the parcel by zone.

4) Employees check the number of parcels from scanner and incoming invoice. After that, they print the parcel from the scanner and combine it with the incoming invoice.

5) The parcel will be transported to the 2nd and 3rd sorting points, sorting by distribution center and sorting by zip code.

6) The parcel has been sorted. Roll will be fastened and labeled.

7) Employees will scan the parcel barcode and arrange it into the tray.

8) Print out the parcel list of each tray and print the destination sticker.

9) Enter the parcel list. Paste the destination sticker and seal.

10) Separate the parcel to the transport line and place it on the pallet.

11) Move the parcel to the parcel stop to wait for the transit time.

12) When the delivery time arrives, employees will use pick-up trucks to transport and deliver to destinations.

### 1.2 Current state

Due to the service partner department in the parcel service company there are many shipping destinations. The operation process uses employees to sort the parcels. There are redundant work processes and the current working area is not organized; therefore, there is not enough space to work (Fig. 3). The problem can be summarized as follows:

- Sorting the parcels by sight, memory and work skill of each employee is prone to mistakes because the destination has many places and the number of packages is large. Employees may be tired from repeated work for many hours. If the destination is wrong, it will waste time in transportation and reduce the reliability of service.
- The arrangement of the parcel on the pallet is too high (a lot of parcels).
- Unorganized work area, and the roll door is not closed when the package is removed causing waste of work space.

Therefore, this study uses technology to sort parcels. It ensures accuracy, less duplication of workflows, on time delivery and increased work efficiency.


**Fig. 3.** Original work area in the service partner department.

### 1.3 Research objective

The study aims to achieve the following objectives:

1. To study processes in the distribution system in the service partner department of the parcel delivery company.

2. To reduce the working time in the process.

3. To propose to management alternatives to improve efficiency and reduce duplication of work processes.

## 2. Materials and Methods

### 2.1 Work study [2]

Work study involves techniques to analyze the steps of an operation to eliminate unnecessary tasks which enable the best and most efficient way of working. It also includes standard improvement of working methods, education and work. This theory, therefore, directly relates to the productivity. The researchers used this study to help increase the productivity of existing resources and lower the investment costs.

### *2.1.1 Flow process chart [3]*

The flow process chart is a graphical and symbolic representation of the activities performed on the work piece during the operation in Industrial Engineering. Most production managers, engineers and manufacturers are familiar with the use of the flow process chart as a tool for designing production systems and plant layouts.

In this study, the flow process charts are shown in the Tables 1 and 2.

**Table 1.** Original work processes in service partner department (Non-pallet).

| FLOW PROCESS CHART (Original work process) | | | | | | | |
|---|---|---|---|---|---|---|---|
| CHART NO. 1 SHEET NO. OF | SUMMARY | | | | | | |
| ACTIVITY: Work processes in service partner department (Non-pallet) | ACTIVITY | PRESENT | | PROPOSE | | | SAVING |
| | OPERATION ● | 8 | | - | | | - |
| | TRANSPORT ➡ | 6 | | - | | | - |
| LOCATION: Service partner department | DELAY D | 0 | | - | | | - |
| OPERATOR (s) | INSPECTION ■ | 1 | | - | | | - |
| CHART BY. | STORAGE ▼ | 1 | | - | | | - |
| DATE: 22 Dec 2017 | DISTANCE (m) | - | | - | | | - |
| APPROVED BY. - DATE: - | TIME (s) | 352.57 | | - | | | - |
| DESCRIPTION | TIME (s) ± SD | SYMBOL | | | | | REM |
| Move the parcel from the car (piece) | 4.03±0.55 | ○ | ➡ | D | □ | ▽ | N = 80 |
| Move roll into 1[st] sorting point (trip) | 45.35±11.18 | ○ | ➡ | D | □ | ▽ | N = 30 |
| Check the parcel by scanning the barcode and sorting the parcel by zone | 1.54±0.17 | ● | ⇨ | D | □ | ▽ | N = 27 |
| Check the number of parcels from scanner and incoming invoice. (print the parcel and combine it with the incoming invoice) | 60 | ○ | ⇨ | D | ■ | ▽ | * |
| Transported to 2[nd] sorting point (trip) | 11.64±0.48 | ○ | ➡ | D | □ | ▽ | N = 20 |
| Sorting by distribution center (piece) | 1.53±0.29 | ● | ⇨ | D | □ | ▽ | N = 30 |
| Transported to 3[rd] sorting point (trip) | 25.45±2.08 | ○ | ➡ | D | □ | ▽ | N = 50 |
| Sorting by zip code (piece) | 2.01±0.62 | ● | ⇨ | D | □ | ▽ | N = 30 |
| Fastened and labeled | 60 | ● | ⇨ | D | □ | ▽ | * |
| Scan the parcel barcode and arrange it into the tray (piece) | 2.96±1.32 | ● | ⇨ | D | □ | ▽ | N = 24 |
| Print out the parcel list of each tray and print the destination sticker (box) | 60 | ● | ⇨ | D | □ | ▽ | * |
| Enter the parcel list. Paste the destination sticker and seal (box) | 42.00±10.04 | ● | ⇨ | D | □ | ▽ | N = 26 |
| Separate the parcel to the transport line and placed on the pallet seal (box) | 4.79±1.09 | ● | ⇨ | D | □ | ▽ | N = 44 |
| Move the parcel to the parcel stop | 31.27±8.29 | ○ | ➡ | D | □ | ▽ | N = 16 |
| Wait for the transit time | - | ○ | ⇨ | D | □ | ▼ | |
| Pick-up into trucks (box) | - | ○ | ➡ | D | □ | ▽ | ~1-2 Hr. |
| Total | 352.57 | 8 | 6 | 0 | 1 | 1 | |

* time in the table comes from inquiring employees (not include waiting and movement time)

## 2.2 Simulation [4], [14]

A simulation of a system is the operation of a model of the system. The model can be reconfigured and experimented with; usually, this is impossible, too expensive or impractical to do in the system it represents. The operation of the model can be studied, and hence, properties concerning the behavior of the actual system or its subsystems can be inferred. In its broadest sense, simulation is a tool to evaluate the performance of a system, existing or proposed, under different configurations of interest and over long periods of time. Simulation is used before an existing system is altered or a new system built, to reduce the chances of failure to meet specifications, to eliminate unforeseen bottlenecks, to prevent under or over-utilization of resources, and to optimize system performance. Modeling the situation is a highly effective way to help in analyzing the results that lead to problem solving in various areas [5], [15].

**Table 2.** Original work process in service partner department (On-pallet).

| FLOW PROCESS CHART (Original work process) | | | | | | | |
|---|---|---|---|---|---|---|---|
| CHART NO. 1 SHEET NO. OF | SUMMARY | | | | | | |
| ACTIVITY: Work processes in service partner department (On-pallet) | ACTIVITY | PRESENT | | PROPOSE | | | SAVING |
| | OPERATION ● | 9 | | - | | | - |
| | TRANSPORT ➡ | 6 | | - | | | - |
| LOCATION: Service partner department | DELAY D | 0 | | - | | | - |
| OPERATOR (s) | INSPECTION ■ | 1 | | - | | | - |
| CHART BY. | STORAGE ▼ | 1 | | - | | | - |
| DATE: 22 Dec 2017 | DISTANCE (m) | - | | - | | | - |
| APPROVED BY. - DATE: - | TIME (s) | 357.36 | | - | | | - |
| DESCRIPTION | TIME (s) ± SD | SYMBOL | | | | | REM |
| Move the parcel from the car (piece) | 4.03±0.55 | ○ | ➡ | D | □ | ▽ | N = 80 |
| Rearrange parcels on pallet (piece) | 4.79±1.09 | ● | ⇨ | D | □ | ▽ | N = 44 |
| Move roll into 1[st] sorting point (trip) | 45.35±11.18 | ○ | ➡ | D | □ | ▽ | N = 30 |
| Check the parcel by scanning the barcode and sorting the parcel by zone | 1.54±0.17 | ○ | ➡ | D | □ | ▽ | N = 27 |
| Check the number of parcels from scanner and incoming invoice. (print the parcel and combine it with the incoming invoice) | 60 | ○ | ⇨ | D | ■ | ▽ | * |
| Transported to 2[nd] sorting point (trip) | 11.64±0.48 | ○ | ➡ | D | □ | ▽ | N = 20 |
| Sorting by distribution center (piece) | 1.53±0.29 | ● | ⇨ | D | □ | ▽ | N = 30 |
| Transported to 3[rd] sorting point (trip) | 25.45±2.08 | ○ | ➡ | D | □ | ▽ | N = 50 |
| Sorting by zip code (piece) | 2.01±0.62 | ● | ⇨ | D | □ | ▽ | N = 30 |
| Fastened and labeled | 60 | ● | ⇨ | D | □ | ▽ | * |
| Scan the parcel barcode and arrange it into the tray (piece) | 2.96±1.32 | ● | ⇨ | D | □ | ▽ | N = 24 |
| Print out the parcel list of each tray and print the destination sticker (box) | 60 | ● | ⇨ | D | □ | ▽ | * |
| Enter the parcel list. Paste the destination sticker and seal (box) | 42.00±10.04 | ● | ⇨ | D | □ | ▽ | N = 26 |
| Separate the parcel to the transport line and placed on the pallet seal (box) | 4.79±1.09 | ● | ⇨ | D | □ | ▽ | N = 44 |
| Move the parcel to the parcel stop | 31.27±8.29 | ○ | ➡ | D | □ | ▽ | N = 16 |
| Wait for the transit time | - | ○ | ⇨ | D | □ | ▼ | |
| Pick-up into trucks (box) | - | ○ | ➡ | D | □ | ▽ | ~1-2 Hr. |
| Total | 357.36 | 9 | 6 | 0 | 1 | 1 | |

* time in the table comes from inquiring employees (not include waiting and movement time)

### *2.2.1 Modeling methods [6]*

In this study, there is a process to create a simulation for use in the analysis of work as shown in Fig. 4.

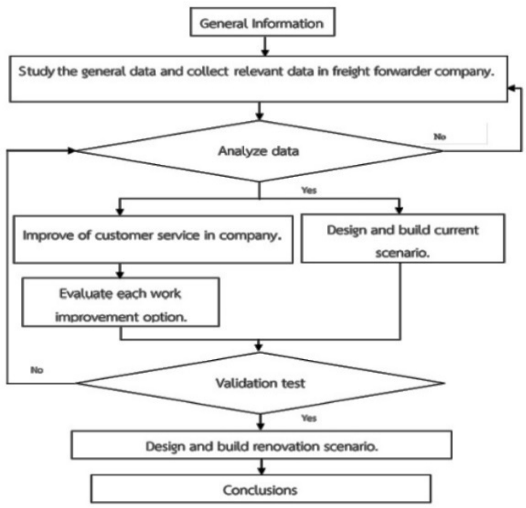



**Fig. 4.** Scenario modeling process.

*2.2.2 Replicate for processing [7]*

The results from the simulated situation processing have acceptable confidence level (Half width) does not exceed the specified value, therefore must be determined the processing cycle (number of replications). Calculated from the following equation:

$$R = R_0 \frac{h_0^2}{h^2}, \tag{1}$$

where

$R$ = replications,

$R_0$ = the first cycle of processing,

$h$ = confidence level,

$h_0$ = the error value caused by the first processing.

*2.2.3 Verification and validation of modeling [8]*

Verification means ensuring that the model behaves in the way it was intended.

Validation means ensuring that the model behaves the same as the real system. If the system currently exists, then some kind of comparison can be made to ensure that the model represents the real system. If the system does not exist, but similar ones do, then the simulation results can be compared to the similar system, and at least a partial validation can be performed. If there is no real system to compare with the simulation, then true validation cannot be performed.

*2.2.4 Goodness of Fit Test: GOF [9]*

The goodness of fit (GOF) of a statistical model describes how well it fits into a set of observations. GOF indices summarize the discrepancy between the observed values and the values expected under a statistical model. GOF statistics are GOF indices with known sampling distributions, usually obtained using asymptotic methods, that are used in statistical hypothesis testing.

The goodness of fit test is used to test a hypothesis for which the data comes from a random sample of the population with the expected distribution. [12]

**2.3 ProModel [10]**

ProModel is most popular software for simulating situations because it is a program that is very convenient to use and can display virtual motion of the system on a computer screen. The basic steps of the ProModel program are as follows:

- Location refers to the workstation or machine.

- Entity refers to raw materials or products, including containers or moving vehicles.

- Arrival refers to the number of entities, the number of times and the frequency of arrival entity.

- Processing refers to the limitation of the work of the entity or limits the work of a location such as working hours [5].

*2.3.1 Design and build the current scenario*

Collecting data for simulation of the current scenarios the data in the model consists of

1) Type and number of parcels that go into the service partner department (Table 3).

2) Times and numbers of vehicles transported each day (Table 4).

Data must be examined to find the distribution of data patterns and to estimate possible distribution parameters. The Stat:Fit function in the ProModel program was used to determine the distribution and parameter values that are appropriate for the data.

**Table 3.** The percentage of the amount parcels into service partner department.

| Type | Package | Percentage |
|---|---|---|
| 1 | Tray | 41 |
| 2 | Roll | 24 |
| 3 | Box | 35 |

**Table 4.** Distribution time and number of vehicles transported each day.

| No | Time | Distribution of transport vehicles | Average time of entering the transport vehicles (seconds) | Number of parcels per trip (piece) |
|---|---|---|---|---|
| 1 | 14.01-15.00 | U (6, 5) | 419 | 13 |
| 2 | 15.01-16.00 | N (7, 4) | 451 | 11 |
| 3 | 16.01-17.00 | N (6, 4) | 357 | 13 |
| 4 | 17.01-18.00 | N (3, 2) | 646 | 7 |
| 5 | 18.01-19.00 | N (4, 3) | 586 | 8 |
| 6 | 19.01-20.00 | N (8, 5) | 341 | 8 |
| 7 | 20.01-21.00 | N (9, 3) | 413 | 14 |
| 8 | 21.01-22.00 | N (8, 3) | 405 | 7 |
| 9 | 22.01-23.00 | N (4, 3) | 384 | 7 |
| 10 | 23.01-00.00 | N (4, 3) | 298 | 14 |

The data collection and analysis can be used to create a simulation model in the ProModel program as shown in Fig. 5.

**Fig. 5.** Model for working in service partner department.

### *2.3.2 Bottleneck in process*

From the study of the current system in the service partner department, it was observed that there were a lot of waiting parcels. There were 3 workstations that caused the bottleneck as shown in Fig. 6.

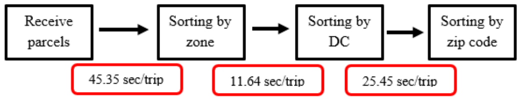



**Fig. 6.** Operating times for 3 bottleneck processes.

**Table 5.** Data recorded and p-value.

| Minute | Sorting by zone | | Sorting by DC | | Sorting by zip code | |
|---|---|---|---|---|---|---|
| | number of parcels waiting for the sorting. (actual system) | Average number of parcels waiting for the sorting. (Simulation system) | number of parcels waiting for the sorting. (actual system) | Average number of parcels waiting for the sorting. (Simulation system) | number of parcels waiting for the sorting. (actual system) | Average number of parcels waiting for the sorting. (Simulation system) |
| 5 | 27 | 21.2 | 27 | 17.2 | 27 | 12.6 |
| 10 | 32 | 20.0 | 32 | 16.2 | 32 | 12.4 |
| 15 | 34 | 19.2 | 34 | 16.8 | 34 | 11.0 |
| 20 | 29 | 19.8 | 29 | 16.2 | 29 | 10.4 |
| 25 | 23 | 18.8 | 23 | 17.6 | 23 | 9.2 |
| 30 | 26 | 18.2 | 26 | 17.8 | 26 | 10.2 |
| 35 | 24 | 19.6 | 24 | 18.4 | 24 | 9.0 |
| 40 | 22 | 20.6 | 22 | 18.4 | 22 | 7.6 |
| 45 | 19 | 18.6 | 19 | 18.0 | 19 | 8.8 |
| 50 | 24 | 18.8 | 24 | 18.0 | 24 | 8.8 |
| P-Value | 0.628 | | 0.878 | | 0.990 | |

From the flow process charts (Tables 1, 2), it can be confirmed that bottleneck has operating time each process to perform than other process.

### *2.3.3 Simulation program validation*

Models are used to predict or compare the future performance of a new system, a modified system, or an existing system under new conditions. When models are used for comparison purposes, the comparison is usually made to a baseline model representing an existing system. Sufficient accuracy means that the model can be used as a substitute for the real system for the purposes of experimentation and analysis (assuming that it was possible to experiment with the actual system) [11], [13].

Verification is a necessary to the reliability of the model between the current system and the simulation system was similar. Minitab program was used for this purpose in testing the model. The error can be accepted at 95% confidence interval with P-Value that was based on the actual system comparison. The experiment must have the value greater than 0.05 in order to be accepted as the hypothesis. In this research, we used bottleneck to compare the actual system data with the experimental system data. Data in 3 stations was recorded every 5 minutes for 50 minutes from 3 sorting points as shown in Table 5 and the analysis results are shown in Fig. 7.

From the analysis of the hypothesis to verify the simulation by considering the P-value of the bottlenecks in 3 workstations, it was found that the model was reliable in simulating situations in the processes of the service partner department.

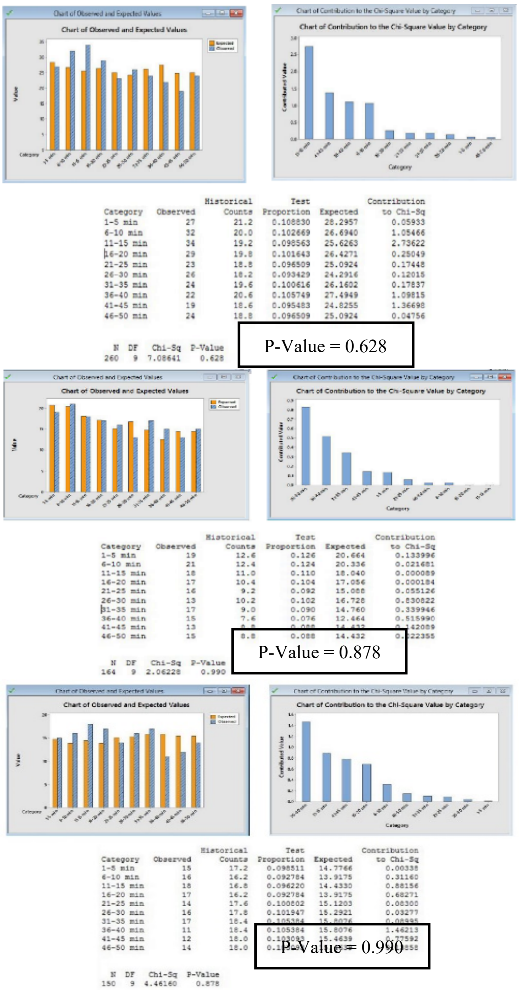



**Fig. 7.** Shows the analysis results from the Minitab program to find the p-value of the data.

#### *2.3.4 Calculating the number of replications in processing*

For the simulation model to be acceptable, it must determine the number of replications in the process, which can be calculated from Eq. (1). The results of the analysis are shown in Table 6.

**Table 6.** Parameters and results of replication analysis.

| Export Parcels | |
|---|---|
| Average | 20,903.50 |
| Confidence | 0.05 |
| $R_0$ | 10 |
| $h_0$ | 2420.04 |
| $h_0^2$ | 5856593.6 |
| $h$ | 1045.175 |
| $h^2$ | 1092390.8 |
| R (cycle) | 54 |

The model analyzed 54 cycles in the service partner department and it shows that the average number of exported parcels is 20,478.67 pieces and the overall waiting time is 76.55% (% Waiting + % Block) as shown in Fig. 8.

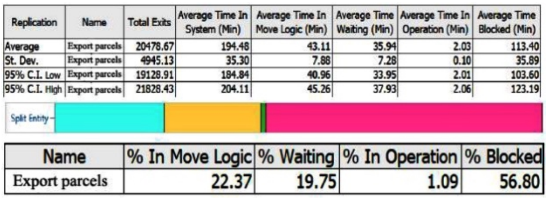



**Fig. 8.** Number of exported parcels and overall waiting time.

## 2.4 Alternative improvement

The ECRS technique (eliminate, combine, rearrange, and simplify) was used in this research for process activity optimization.

Alternative 1: Adding equipment to help sorting and manage space to organize workstations in the service partner department. The bottleneck workstation is the main cause of duplication of work. To solve the problem of duplication of work and many destinations we would use a belt conveyer to help sort out parcels. The belt conveyer was used to combine the two workstations, namely the sorting by zone point and sorting by distribution center point as shown in Figs. 9 and 10.

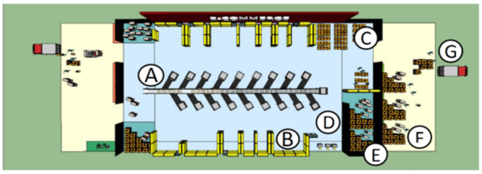



**Fig. 9.** Alternative 1 system simulation.

Workstation;
A = Sorting point 1 by using belt conveyor
B = Sorting point 2 sorting by zip code
C = Label closing area
D = Office
E = Empty container storage area
F = Storage area to wait for transportation
G = Package export point

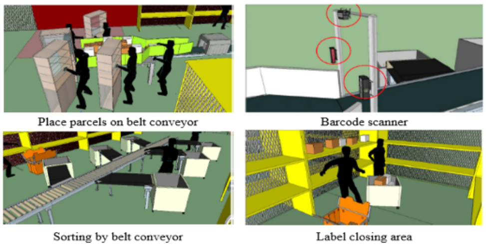



**Fig. 10.** Work procedure in workstation for alternative 1.

Alternative 2: Organize new work areas and install signs (labels) at each sorting point to avoid confusing of the parcels transported to another point and to be easily visible for employees. The layout of alternative 2 is shown in Figs. 11 and 12.

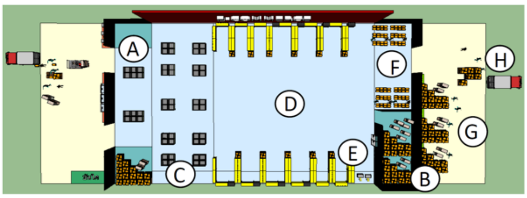



**Fig. 11.** Compare current system simulation vs alternative 2 system simulation.

Workstation;
A = Sorting point 1, sorting by zone
B = Empty tray and roll area
C = Sorting point 2, sorting by distribution center
D = Sorting point 3, sorting by zip code and empty tray area
E = Office
F = Label closing area
G = Storage area to wait for transportation
H = Export parcel point

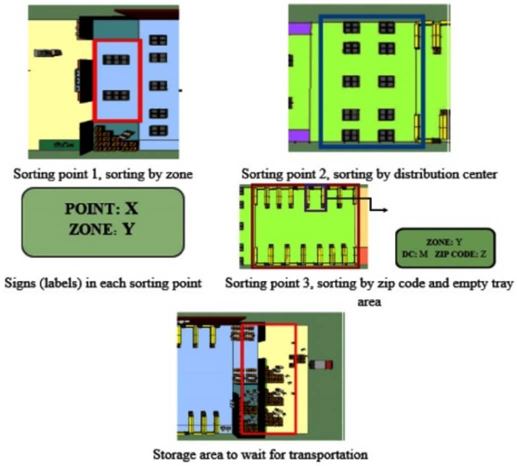



**Fig. 12.** Work procedure in workstation for alternative 2.

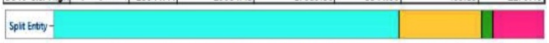
## 3. Results and Discussion

### 3.1 Results

***3.1.1 Simulation analysis of alternatives.***

Alternative 1: Adding equipment to help with sorting and to manage space to organize workstations in the service partner department. The results of the model processing 93 cycles shows that the number of exported parcels is 23,008.34 pieces and the total waiting time is 27.32% (% Waiting +% Block) as shown in Fig. 13. This alternative can reduce the process of moving the package and inspection to 1 step in both types (non-pallet, on-pallet).

| Replication | Name | Total Exits | Average Time In System (Sec) | Average Time In Move Logic (Sec) | Average Time Waiting (Sec) | Average Time In Operation (Sec) | Average Time Blocked (Sec) |
|---|---|---|---|---|---|---|---|
| Average | Export parcels | 23008.34 | 22163.65 | 16187.80 | 3507.75 | 484.71 | 1983.38 |
| St. Dev. | Export parcels | 4059.76 | 4471.06 | 5689.29 | 176.28 | 2.11 | 1408.24 |
| 95% C.I. Low | Export parcels | 22172.25 | 21242.84 | 15016.11 | 3471.45 | 484.28 | 1693.36 |
| 95% C.I. High | Export parcels | 23844.44 | 23084.45 | 17359.50 | 3544.06 | 485.15 | 2273.40 |




| Name | % In Move Logic | % Waiting | % In Operation | % Blocked |
|---|---|---|---|---|
| Export parcels | 70.37 | 16.83 | 2.31 | 10.49 |

**Fig. 13.** Number of exported parcels and overall waiting time for alternative 1.

Alternative 2: Organizing new work areas and install signs (labels) in each sorting point. Organizing new work areas to make the process flow in a straight line can reduce the time to walk between stations, reduce the overlapping of employees walking routes, and increase storage space.

Results of the model processing 93 cycles show that the number of exported parcels is 21,810.69 pieces and the total waiting time is 47.14% (% Waiting +% Block) as shown in Fig. 14.

| Replication | Name | Total Exits | Average Time In System (Sec) | Average Time In Move Logic (Sec) | Average Time Waiting (Sec) | Average Time In Operation (Sec) | Average Time Blocked (Sec) |
|---|---|---|---|---|---|---|---|
| Average | Export parcels | 21810.69 | 6014.36 | 3023.74 | 2738.44 | 166.33 | 85.85 |
| St. Dev. | Export parcels | 6429.10 | 374.67 | 426.95 | 225.55 | 1.97 | 95.80 |
| 95% C.I. Low | Export parcels | 20865.09 | 5959.26 | 2960.94 | 2705.26 | 166.04 | 71.76 |
| 95% C.I. High | Export parcels | 22756.30 | 6069.47 | 3086.53 | 2771.61 | 166.62 | 99.94 |


| Name | % In Move Logic | % Waiting | % In Operation | % Blocked |
|---|---|---|---|---|
| Export parcels | 50.09 | 45.71 | 2.78 | 1.43 |

**Fig. 14.** Number of exported parcels and overall waiting time for alternative 2.

### *3.1.2 Compare results before and after improvement*

The improvement of each alternative is shown in Table 7.

**Table 7.** Improvement in service partner department.

| Alternative | Improvement |
|---|---|
| 1 | - Reduce steps and time in working<br>- Reducing overlapping work |
| 2 | - The work area is more organized.<br>- Flow of the parcels in a straight line |

**Table 8.** Comparison of improvements for each alternative.

| | Current State | Alternative 1 | Alternative 2 |
|---|---|---|---|
| #exported parcels | 20,478.67 | 23,008.34 | 21,810.69 |
| % Waiting | 19.75% | 16.83% | 45.71% |
| % Block | 56.80% | 10.49% | 1.43% |
| total waiting time of (% Waiting +% Block) | 76.55% | 27.32% | 47.14% |

Table 8 shows a comparison of improvements for each alternative. There is a total of 20,478 pieces of parcels per day. Alternative 1 has 23,008 pieces of parcels per day and Alternative 2 has 21,810 pieces of parcels per day, as shown in Fig. 15. The waiting time of the entire process of the simulation model is 76.55%, the waiting time of process Alternative 1 is 27.32%, and the waiting time of process Alternative 2 is 47.14%, as shown in Fig.16.

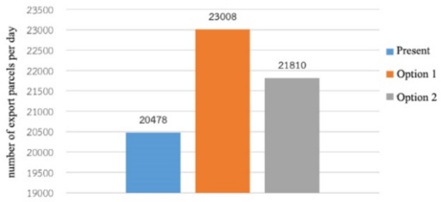



**Fig. 15.** Comparison chart of the number of export parcels.

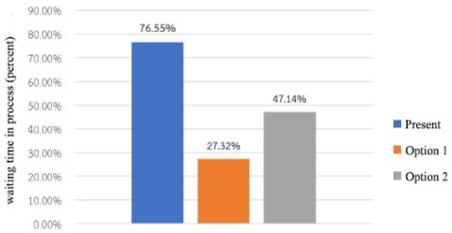



**Fig. 16.** Comparison chart of the waiting time in the process.

### *3.1.2 Discussion*

This research used the simulation program of the parcel sorting process to find alternative ways to reduce the waiting time in three workstations of a bottleneck process and to increase efficiency in transporting parcels for delivery in the department. This research studied the modeling process of various research articles in order to be aware of the process of conducting the research correctly and to provide the most realistic results

This study was short-middle term solution only; the long term may be study in the future. The cost was considered for practice but it was not declared in this article.

## 4. Conclusions

We studied the work processes of the service partner department in the parcel service company. The work in sorting by zone, sorting by distribution center and sorting by zip code are duplicate work procedures and there many parcels that must wait to be sorted. Because the time to move parcels from the receive parcel point to the 1st point, sorting by zone, is less than the time to sort, parcels waiting to be sorted accumulate more quickly than they can be sorted. Both the point of sorting by distribution center and the sorting by zip code are similar to the point of sorting by zone, thus causing these 3 points to have problems (bottleneck). Therefore, simulation models were created to find alternative solutions to this problem. The model created represents the workflow in the service partner department.

Deciding the appropriate alternative requires considering long-term possibilities. Alternative 1, using a belt conveyor system and barcode scanner is the right choice. In the future, the quantity of parcels that come in is likely to increase every year and the ability to support the sorting in alternative 1 is greater than alternative 2. Also, alternative 1 has a lower waiting time than alternative 2 at 19.82%.

## References

[1] Electronic Transactions Development Agency.org [Internet]. Thailand: The value of E-Commerce in Thailand. [cite 2019 Jun 5]. Available from: https://www.etda.or.th/publishing-detail/value-of-e-commerce-survey-2017.html,2560.

[2] Tantasuth V, et al., Work Study, Chulalongkorn University Press, 2000.

[3] Flow Process Grids and Charts. Textile Course. Retrieved December 1, 2018.

[4] Maria A. Introduction to Modeling and Simulation. Proceedings of the Winter Simulation Conference. 1997.

[5] Klomjit P, Anurattananon C, Keereewan N, and Choosombut N. A simulation of Efficiency Improvement in Customer Service of Freight Forwarder System: A Case Study of Freight Forwarder Company. Thai Industrial Engineering Network Journal, Vol 4 No 2, July-December 2018

[6] Klomjit P. and Thongsanit K. Introduction to Simulation. The Engineering Institute of Thailand under H.M.The King's Patronage, 2011

[7] Thongprasert S, Problem Modeling (Simulation), Chulalongkorn University Press, 1992.

[8] Ben H., Scott W., Francois M., Mark C., Jason E. and Edward A. Concepts of Model Verification and Validation. Southwest Research Institute. Issued: October 2004

[9] Maydeu-Olivares, A. and Garcıa-Forero, C., Goodness-of-Fit Testing. International Encyclopedia of Education., vol. 7. 2010. pp. 190-6

[10] Charles Harrell & Biman K. Ghosh & Royce O. Bowden. Simulation Using ProModel. (3rd ed). Singapore: McGraw-Hill, Inc.2012.

[11] John SC. Model Verification and Validation. Proceedings of the Winter Simulation Conference. 2002.

[12] Klomjit P., Basic Modeling, Bangkok: The Engineering Institute of Thailand under H.M.The King's Patronage, 2012

[13] Robert GS. Verification and Validation of Simulation Model. Proceedings of the Winter Simulation Conference, 2011.

[14] Christopher AC. Simulation Modeling Handbook; A practical Approach. CRC Press LLC. 2004

[15] Mizutani F. and Uranishi S. The Post Office vs. Parcel Delivery Companies: Competition Effect on Costs and Productivity. Journal of Regulatory Economics; 23:3 299-319, 2003.