The Improvement of Carton Packing Delivery Route: from Storage Room to Warehouse

Abstract

This research is Work integrated learning (WIL) cooperation KMUTT University and BETAGRO Groups in Thailand, in the form of entrepreneurial project-based assignment. This paper will present their own outcome from students who do the research in BETAGRO Groups through WIL project. The research aims to improve cargo channels from Carton pack section to the warehouse and reduce the line Carton packaging. The application of ARENA Simulation Program to assist the optimum design of process areas, transportation, and locations is proposed. The operation process charts, material flows, and work areas have been investigated. ARENA simulations have been employed to design the four alternatives Carton packaging lines and compared the performances between new layout and exist layout in term of, Wait (total time). The alternative plant layout 3 should be selected because could reduce the two packaging lines to one packaging line. The value of the wait (Total Time) was 0.01 minutes, which does not exceed the standards of the plant was 0.10. The renovation plan 3, the width is increased from 2.10 square meters is 17.43 square meters and could reduce the number of employees from 19 to 13 people. It also can optimize the packing into cartons per hour, increased to 6.53 percent per hour. The cost of improved the equipment and machinery was 420,296 baht / year. After improved process, the payback period has been started from 100 days. The all products can be moved continuously and the other events can occur simultaneously.

Keywords: Material flow / Improved Process / ARENA Simulation

1. Introduction

Poultry meat is one of the major exported products of Thailand in the livestock sector. The process of poultry meat production began with receiving broilers from farms to slaughterhouse, plucking, evisceration, and cutting chicken into different parts such as breasts and thighs. After the cut up step, chicken parts were chilled or frozen and prepared for selling as a fresh cuts product or sending to further processing. According to a survey of a broiler production company in this study, most of chilled and frozen products (~75%) were carton-packed before storage in a warehouse and then loading for a customer delivery. Since the carton pack area is rather small comparing to a work load and working routes occurred in this area, it became a bottle neck of the production process.[1-2] There were 9 overlapping working routes identified in this area. These routes consist of 1) a route of frozen products transferred from freezers to the carton pack area; 2) a route of chilled product for exporting (retailed packs) transported from carton pack area to warehouse; 3) a route of chilled product for an affiliate transported from carton pack area to warehouse; 4) a route of employees who deliver empty cartons from storage room to carton pack area; 5) a route of used trolley transported between a packing station and a cleaning station; 6) a route of cut products from cutting area transported to a weighing area and warehouse; 7) a route of baskets and containers transported to a cleaning station; 8) a route of cleaned baskets and containers transported to the cutting area; and 9) a route of employees of the cooking area requisition frozen products from the warehouse and thawing in the carton pack area.

With 9 delivery routes mentioned above, there was a bottleneck which affects the flow of the entire operation. The objective of this work is to increase efficiency

and to manage the delivery routes from carton pack area to a chilled product warehouse (LS2) and frozen product warehouse (CS2) for convenience and continuity in packing and delivering. To improve a delivery route through the carton pack area, fishbone diagram was primarily used to analyze causes of the problem. After that analysis, Systematic Layout Planning (SLP) using ARENA software (version 14.5) was then analysed to resolve the bottle neck problem. [3,4]

2. Research Methodology

In this research, there are 6 steps to improve the product delivery route to the warehouse (Figure 1).

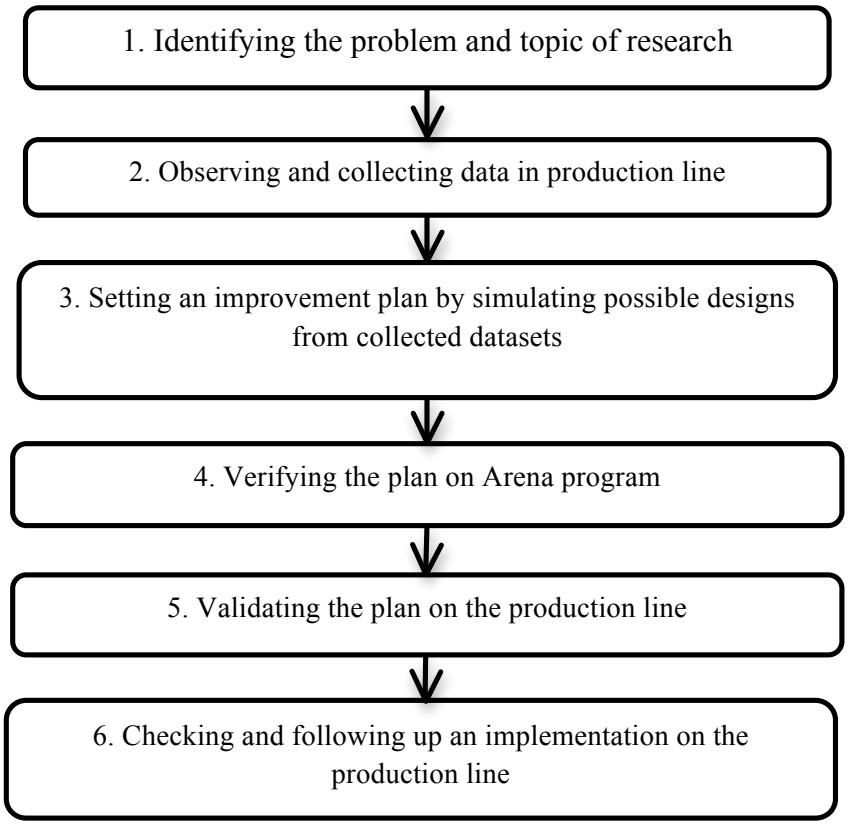

Figure 1. The Research Procedure

3. Research Results

3.1 Results from the Problems identifications

According to the manufacturing process, the freezing time for frozen products was 4 hours per a freezer and the distance between each freezing process was 2 hours that was a carton-packing period for the product from the previous freezer. Within 24 hours, there were 3 freezers were used continuously and repetitively. The information of freezing capacity was used to calculate the efficiency in carton packing (carton/minutes) of 2 packing lines. Products from one freezer could be packed into cartons within 90 minutes for 2 packing lines. It was found that all steps in the operation needed 19 employees for 2 shifts, a day and night shift. There are 7 steps for the employees; 1. The employee takes a trolley from a freezer room to carton pack area, 2. The employee walks to fetch an empty carton and form a carton for packing, 3. The employee takes out the product from a trolley and let the product pass through a metal detector, 4. When the product passes through a metal detector, the employee will pack the product inside a carton, 5. When the product is packed in a carton, a carton will be sealed, 6. The carton is strapped and placed on the conveyor belt for delivery to the warehouse, and 7. The employee places an invoice before handing it over to the warehouse.

Based on equipment arrangement in the company, the carton packing process was divided into 2 delivery routes for better flow. Since this process line was set like a Y-shape in which the products came from 2 routes at the same time, all the products would be trafficked at the carton strapping unit and the delivery channel to the warehouse. This line setting resulted in the waiting time and the discontinuity of the carton delivery flow. This was the problem that would be addressed.

3.2 Results from data analysis and problem solving

The flow chart for the packing process of a company is shown in Table 1. The distance from the moment when the trolley was taken out from the freezer to the warehouse was 34.55 meters. The total time duration was 4 minutes 21 seconds per 1 carton. There were 19 employees for 2 delivery routes. It was found that there were 4 waiting steps: 1) the employee waited for the carton (50 seconds), 2) the employee waited to bring the trolley back to a cleaning station (15 seconds), 3) the carton waited to be strapped (42 seconds) and 4) the carton waited to be sent into the warehouse (27 seconds). The present packing line is shown in Fig 2.

The delivery route was then analyzed. According to flow process chart in Table 1, concept of time study was used to eliminate the waiting time in 4 working stations indicated as "D" symbol. Process flow of an improved delivery route was shown in Table 2. Waiting time in the packing line was reduced from 4.21 to 2.70 minutes. The result also indicated that the work could run smoothly without interrupting the works of another route.

After the improvement of process flow, line improvement of equipment in the packing line was then studied. Working process based on the current equipment was simulated in ARENA software Version 14.5. The result showed that total wait time was 3.25 minutes. However, the factory did not approve this total wait time. An acceptable wait time should be 0.10 second per carton.

Table 1. Flow chart of the packing process (old version)

The Flow Chart								
Company :		Summary						
Product Type 		Symbol		Current	Proposal	Reduction		
		Working		4				
		Moving		3				
		Checking		1				
		Waiting		4				
		Storing		-				
		Delivering		1				
Employee Role: Packing the product in the carton								
Recorded by :		Distance (meters)		34.55				
Time : Date :		Time (minute/carton)		4 minutes 21 seconds				
Employees (no.)	Time (seconds)	Symbol						Working Step
2	77							Pushing trolley
	50							Fetching empty carton
	15							Storing trolley
4	3							Tray from trolley
2	8							Form the carton
	1							Checking metal
4	11							Packing the carton
4	6							Sealing the carton
	42							Waiting for strapping
	2							Taking the carton to be strapped
2	5							Automatic strapping
	27							Waiting for delivery
1	14							Putting on conveyor belt
19	261	4	3	1	4	-	1	Total

It was found that each station of the current packing process incurred a certain amount of wait time at the strapping machine. At this step, the wait time was 0.4044 minutes that was a problem in terms of packing process. The products from 2 delivery routes came here to wait for the strapping; therefore, the researchers would like to solve the problem about these 2 delivery routes. The improvement

plan was proposed that 2 packing routes should be merged to into 1 route/ packing line. The plans for improvement were proposed as follows:

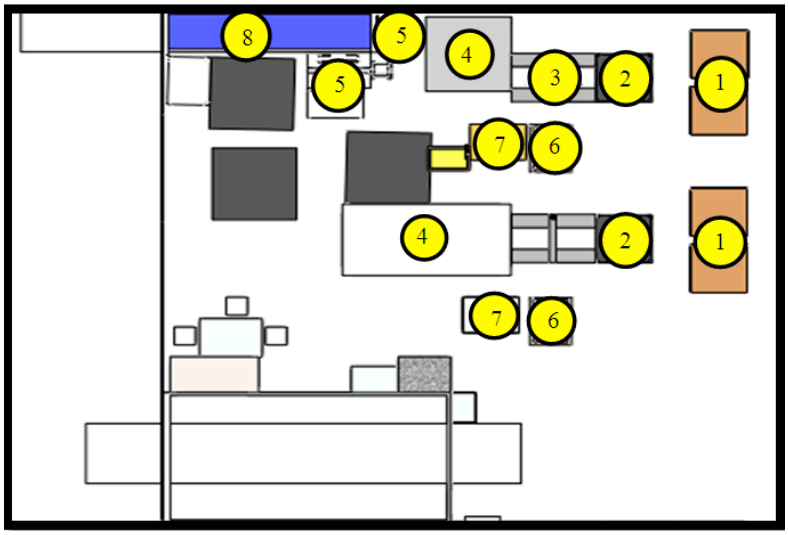

Figure 2. An arrangement of equipment in the current packing line

Note: 1.Trolley, 2. Desk for trolley, 3. Metal detector, 4. Desk for packing and sealing the carton, 5. Strapping machine, 6. Desk for carton forming ,7. Desk for the formed carton, and 8. Conveyor belt

3.2.1 Plan for Improvement 1

The process began with the employee who pushed the trolley from the freezer room to the carton pack area. There were 2 employees who pushed the trolley and 2 employees who passed the product through the metal detector. At the speed of the metal detector of 6 rounds per minute, 60 bags of chicken can pass through. When the product passed through the metal detector, there were 2 employees packing the chicken into the carton and 2 employees then sealing the carton. After the sealing step, the carton was strapped and ready to be delivered to the warehouse. For the product contained in bags, there was 1 employee strapping and 1 employee placing an invoice to the warehouse every time of changing the list of product order (i.e. a carton with strapping, a carton without strapping, and a bag with strapping). During

the packing process, there was 1 employee who formed the carton and walked to fetch the empty carton every time the trolley was changed. For this Plan for Improvement, the wait time from the entity report in the packing process slightly reduced from 15.21 minutes. It means that the wait time decreased and the total wait time in Plan 1 also slightly decreased from 3.2483 minutes in the traditional packing line to 3.0942 minutes in Plan 1. The average wait time of the strapping machine reduced in terms of module in each station, however, the wait time for the strapping process decreased from the traditional packing process. It decreased from 0.407 to 0.398 seconds.

3.2.2 Plan for Improvement 2

The process of this plan started from the employee pushed the trolley from the freezer room to the carton pack area. There were 2 employees pushing the trolley and 2 employees putting the trays out of the trolley and letting them pass through the metal detector. After the metal detecting process, there were 2 employees who packed the carton and then 2 employees who sealed the carton. The “out feed” conveyor belt was added to the step after the metal detection. This conveyor was used to convey the carton from the metal detector to the next station. Then, the carton was sealed and placed on a roller when 1 employee strapping the carton. Another employee would place an invoice to the warehouse. During the packing time, there was 1 employee forming the carton and fetching another empty carton when a new trolley was coming. This work resulted in the wait time and discontinuity in the operation. Another problem was due to the different product packaging, i.e. strapped carton , non-strapped carton, and strapped bag, needed to be delivered in the different time. The average wait time of the product increased from the entity report and the total wait time to pack the chicken in the carton increased

from Plan1, from 3.09 to 3.37 minutes. The wait time also increased from Plan 1 from 4.14 to 7.47 minutes. The average wait time of the strapping machine decreased in each station but the wait time increased from 0.407 seconds of the traditional process to 0.428 seconds of the plan 2.

3.2.3 Plan for Improvement 3

According to all 2 plans mentioned above, the wait time should be improved in order to reduce the waiting task at the packing process. The equipment series of plan 3 is shown in Figure 3. In this plan, There were 2 employees who pushed the trolley from the freezer room to the carton pack area. Afterwards, 2 employees took the tray into the "In Feed" belt which increased the efficiency of the packing process. The speed belt can be adjusted to be equal to the speed of the metal detector, which runs at 60 rounds per minute. When the product passed through the metal detector, 2 employees who worked between the desk to pack the carton and the desk for "Out Feed" belt would carry chicken from the metal detector to the out feed belt. There were 2 employees who packed the carton and then 2 employees would seal the carton. The ball desk was selected to facilitate the moving of packed carton to another desk for sealing. The desk for sealing was also a ball desk at which the employee could separate the carton into 2 sections. The first section was about the carton with and without strapping which needed to be placed on the delivery route. The second section was about the bag which was sealed, strapped, and sent to the warehouse for delivery. In some cases, the carton with strapping and the one without strapping were delivered to the warehouse but not the bag. In this situation, there should be a place for a temporary storage of the bag next to the strapping machine in which the bag can wait for delivery later. There was 1 employee who placed an invoice to the warehouse every time there was a change to the inventory. During the packing

process, there was 1 employee who formed the carton. The employee who fetched a new carton would be the same one who pushed the trolley to the cleaning room. During the idle period, the employee would do two things: pushing the trolley to the cleaning room and fetching a new carton for another employee to form the carton. Summary of the number of employees in the improvement is shown in Table 5.

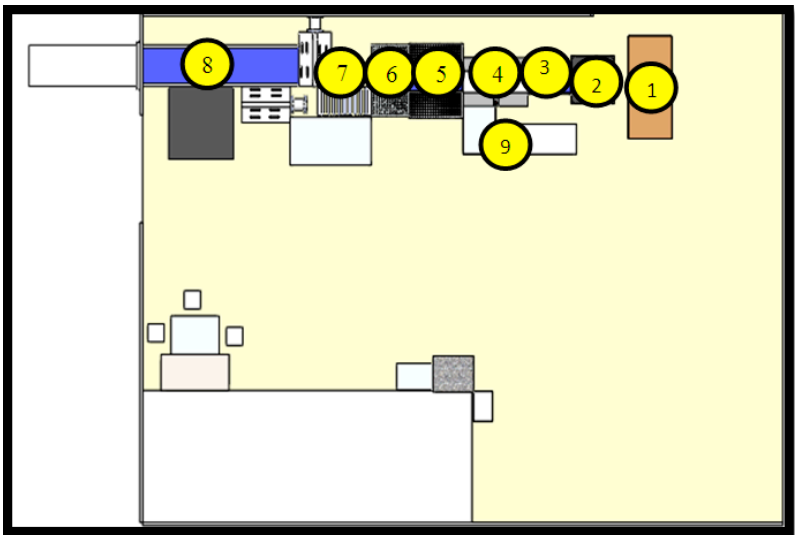

Figure 3. the arrangement of equipment in Plan for Improvement 3

Note 2(Improvement in Figure 3) : 1 The In feed belt to increase the efficiency of packing to prevent it from damaging the metal detector., 2 The Out feed belt to deliver the product to the employee who seals the carton and to increase the efficiency of the packing process., 3 The desk for sealing the carton which is convenient for the employee., 4 The desk for forming the carton to increase the space for carton storage., 5 Two desks for packing the carton which is convenient for packing the carton and can be dismantled for easy storage., 6 Roller which can move between the desk for sealing and the strapping machine., 7 The desk for bag for packing and delivering to the strapping machine

Table 5. The number of employees in Plan for Improvement 4

Duty	Number of Employees (persons)
Pushing trolley	2
Taking tray out of trolley	2
Packing the carton	2
Sealing the carton	2
Strapping	2
Forming the carton	1
Fetching a carton, keeping the trolley in storage	1
Placing an invoice	1
Total	13

According to simulation in Arena, it was found that the wait time for the product decreased in the entity report and also dramatically decreased from the old versions (plan 1-2). The total wait time decreased to 0.99 minutes because another strapping machine was added to the process (Figure 3). It was found that there was a sharp decrease in the waiting task which was in the factory approval of the 0.100 seconds time limit. According to the queue report for Plan for Improvement 4, the average wait time decreased dramatically because another strapping machine was added. The waiting time for strapping was 0.011 seconds, which is lower than the previous plan at 3.248 seconds. This improved plan also made the operation smoothly. It created the flow and reduced the loss time and the wait time in each station. From these analyses, this plan was perfect and accepted by the factory which wanted the total time to be less than 0.10 seconds.

5. Conclusion

Before the improvement, there were 2 delivery routes at the same time and there was wait time, resulting in the total time of 3.25 minutes. The width was 1 meter and it was measured at 8.3 square meters. There was waiting time for delivery

to the warehouse. The plan for improvement was a reduction of 2 delivery routes into 1 route. The analysis showed that the total wait time from Plan 3 was 0.01 minutes, which was lower than the standard time of the factory which was 0.10 minutes. In addition, the proposed plan used less space than an original plan for 1 meter in width. With this improvement, the width of working area increased to 2.10, or 17.43 square meters for the employees to deliver the products to the warehouse. The reduction of employees means that some employees will work in other departments of the factory. According to Plan 3, the factory will invest 420,296 Baht for the equipment and the adjustment and the payback period is estimated to be over 100 days.

References

[1] Assist. Prof. Chainon Srisupanon, 2012 Plant layout design to increase productivity (Revised), I Group Press Limited (in Thai)

[2] Assoc. Prof. Rachavarn Kanjanapanyakom 1996, Industrial Work study, Toptextbook Limited.

[3] Pomchai Promsolote, An Application of Systematic Layout Planning for Reducing Work-in Process, Material Handling Distance and Number of Workers in Car-Seat Assembly Factory, KMUTT Production Engineering,2009,pp.1-108(in Thai)

[4] A. Watanapa and W. Wiyaratn, Systematic layout planning to assist plant layout: case study pulley factory," in Proc 2 nd International conference on Mechanical, Industrial, and Manufacturing Technologies, MIMT, vol. 1, pp. 550-552, February 2011.