SIMULATION STUDY IN REORGANIZING DISPATCHING LAYOUT TO MINIMIZE DISPATCHING TIME

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ABSTRACT: Reorganizing a layout entails a major adjustment to current layout and a thorough planning is essential before a new layout implementation. This study is to reorganize current layout at dispatching area of a manufacturing industry which produced apparel products. Current arrangement at the dispatching area has brought to a poor efficiency rate of 48.74% that consumed 30.77 minutes to complete one dispatching job with a distance travel of 162.83 meters. Witness simulation study was used in this study and Facility Planning Process approach was applied in the experimental design to generate alternative layout. The results yielded that the alternative layout reduced the current time to 32.79% and consumed only 20.68 minutes to complete one dispatching job with a shorter distance travel of 109.44 meters.

KEYWORDS: *Layout planning, Facility planning process, Simulation*

1.0 INTRODUCTION

Layout is described as an arrangement of elements within a manufacturing plant such as machineries and materials flows from one machine or department to another [1]. The arrangement appears to minimize costs related to the plant such as material handling cost with regards to limitation which may be encountered due to plant's layout arrangement [2]. A facility layout design is associated with organizing, searching, locating equipments and manufacturing support departments [3]. An appropriate experimentation on analysis when designing facility layout leads to production performance [4]. Still, it is affected by machines number, space availability, correspondence of production process and usage of material handling system [5].

The facility planning is essential to ensure a successful establishment of production operation [6]. Efficient layout planning helps reduce operational cost and contributes to overall production efficiency [7]. In details, it is to arrange, locate, distribute equipment and support services in manufacturing processes to achieve optimum cycle time, flexibility, work-in-process (WIP) item and factory output [8]. Both layout optimization and simulation are vital tasks to every facility planning and layout study [9]. Simulation technique is an excellent tool to measure and evaluate possible arrangement in optimizing a layout [10]. It involves a development of artificial scenario and an experimentation of artificial history to illustrate assumption regarding the operation characteristics of the real system [11]. Thus, a dynamic model of actual dynamic system is designed either to understand the system's behavior or evaluate various strategies within limits imposed for the system's operation [12].

This study focused on the dispatching department whereby the issue faced is a poor working efficiency at a rate of 48.74% which was due to disorganized activities' arrangement at carton picking, palletizing, wrapping and storage area which led to high dispatching process time. A feasible layout arrangement was to be achieved to minimize the current dispatching process time. Simulation was performed to depict the current acitivities' arrangement and visualize the scattered pattern of queuing cartons. Facility planning process approach was used to develop alternative layout that consisted of six steps; define the problem, analyze the problem, generate alternative designs, evaluate the alternatives, select the preferred design and implement the design.

2.0 METHODOLOGY

2.1 WITNESS Simulation Study

2.1.1 Model Development

Methodology refers to the steps in the simulation study as depicted in Figure 1 starts with model development. In model development, the system model was studied first by getting the actual process involved in the dispatching line as illustrated in Figure 2. Figure 2 illustrates the actual location of activities' arrangement and indicates the disordered movement of workflow whereby the activities involved are arrival of cartons from production, sorting up of cartons to palletizing area, palletizing, wrapping, sending to storage customer region and dispatching. Based on these activities, the entities can be determined namely operator, machine and carton. All of its components are summarized in Table 1.

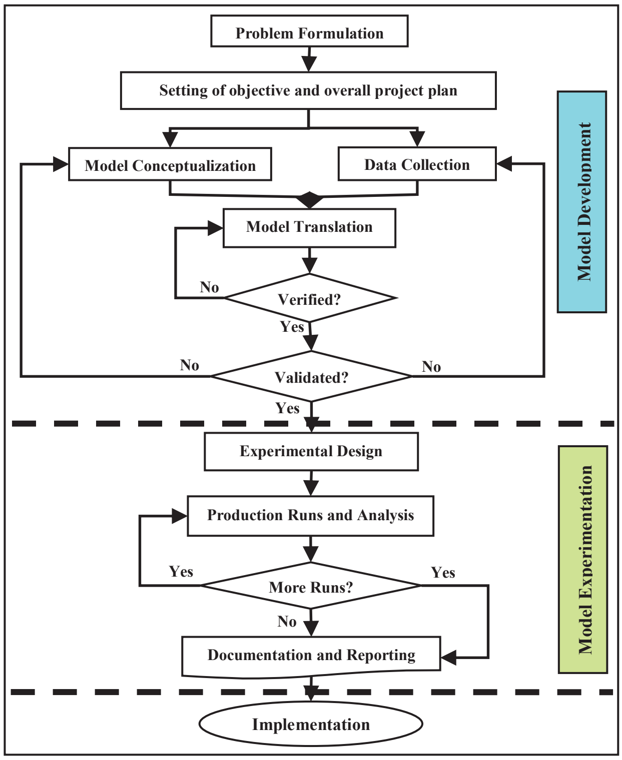

Figure 1: Steps in a simulation study (*Banks et al.*, 2010)

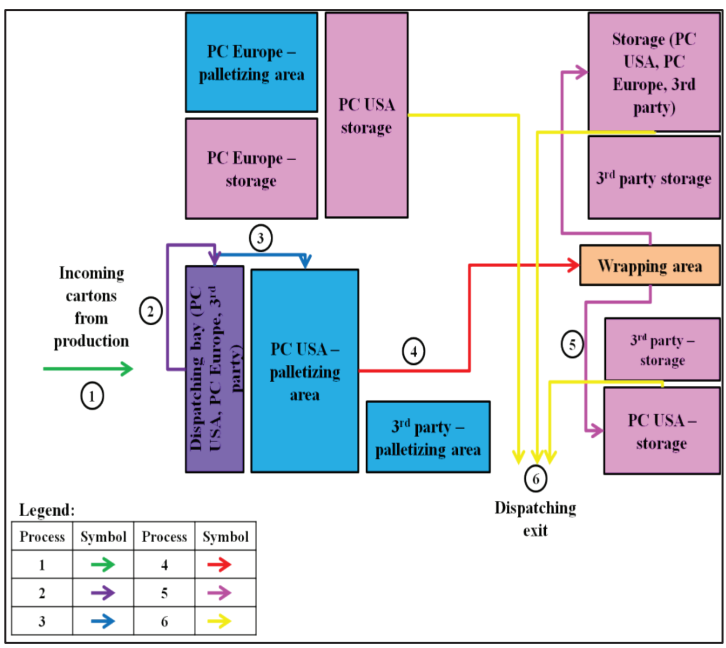

Figure 2: Current dispatching line layout of case company

Table 1: System model and its components

System	Entities	Attributes	Activities	Events	State variables
Dispatching line	Operator, machine and carton	Arrival time of cartons, processing time for each process and dispatch schedule of carton	Pick up, palletizing and wrapping process	Arrival of cartons at dispatching line and departure of cartons from system	Number of cartons waiting at each process and waiting to be dispatched out from system

The conceptual modeling involves input and output of conceptual modeling for dispatching line and model of content for dispatching line. The inputs (experimental factors) and outputs (responses factors) are summarized in Table 2. Model of content of conceptual modeling involves scopes of simulation and level of detail for simulation. The inputs were correctly interpreted and the outputs attained accurate values which were probably useful to consider in terms of the scope and level of detail.

Table 2: Input and output of conceptual modeling

Inputs (experimental factors)	Outputs (responses)
i. Arrival time of cartons ii. Processing time for each activities	i. Number of cartons waiting at each process ii. Total processing time for each activities

The scope of the model must be sufficient to provide a linkage between the inputs and outputs. The scope of the model must also include any processes that interconnect with this flow and have significant impact on the responses. The scope of simulation for dispatching line is summarized in Table 3.

Table 3: Scope of simulation for dispatching line

Components	Include/exclude	Justification
Carton	Include	Required for arrival time of cartons and dispatch schedule of carton
Operator	Include	Required for processing time for carton pick up and palletizing process
Machine	Include	Required for processing time for wrapping process

The level of detail represents the components defined within the scope and their interconnection with other model components with sufficient accuracy. The level of detail for simulation production system is summarized in Table 4.

Table 4: Level of detail for simulation of dispatching line

Components	Include/ exclude	Justification
Carton	Include	Required to determine arrival time of carton
Operator:		
i. Pick up cartons	Include	Required for picking up processing time
ii. Palletize cartons	Include	Required for palletizing processing time
iii. Send to storage customer region	Exclude	Not required as this activity is a complementary to next process
Machine:		
Wrap cartons	Include	Required for wrapping processing time

To simplify the system model, assumptions and simplifications were made. The assumption was associated with the order sequence of cartons (arrival time distribution of cartons entering the system). In terms of simplification, as the operator picked up certain number of cartons for one pallet and depended on purchase order, the cartons that enter the system were treated as one part. Hence, one part in the simulation represented one purchase order. Besides, the cartons were always considered ready to exit the system once stored in the storage customer region.

Qualitative and quantitative types of data collection were collected as shown in Table 5. Data were collected for a period of a week which provided 75 readings for each activity. The total processing time taken in a week was 2,313.65 minutes or 38.56 hours and based on daily basis on morning and evening working hour, from 8.30 a.m. until 4.00 p.m. The collection was done through quantitative measure, observation and interview with related associates. Carton inter-arrival time and processing time of carton storing were excluded as the carton was assumed always available to be processed and the labor was assumed to be available when needed.

Table 5 : Data collection

Quantitative data	Qualitative data
i. Number of carton at each area of activities (unit/day) ii. Arrival time of carton at dispatching area (minutes) iii. Processing time of each activities (minutes) iv. Amount area of each activities (meter) v. Monthly dispatching carton's quantity (unit)	i. Current arrangement of area of activities (based on Figure 2)

Model was run for warming up session for 100 days which the average of cycle time and lot products produced per day were stabilized. About 10 replication independent replications were generated and run with a length of replication runs duration of two days to obtain the average of carton's processing time to be dispatched out. The results of the replication are as tabulated in Table 6.

Table 6: Result of replication of average total processing time

Replication	Average total processing time of dispatching line (min)
1	111,057.18
2	111,055.82
3	111,046.21
4	111,045.33
5	111,042.26
6	111,042.93
7	111,042.75
8	111,039.80
9	111,033.78
10	111,030.43
Average	**111,043.65**

Verification was applied by comparing a flow diagram with the simulation model as shown in Figure 3 and the number of queuing pallet as shown in Table 7. The output of simulation model was closely examined under a variety of input parameters setting.

Table 7: Comparison of number of queued pallet at areas of activities

	Number of queuing pallet (pieces)	
Area	**Historical data**	**Simulation**
Carton picking area	24	24
Palletizing area	126	126
Wrapping area	26	26
Storage area	60	60

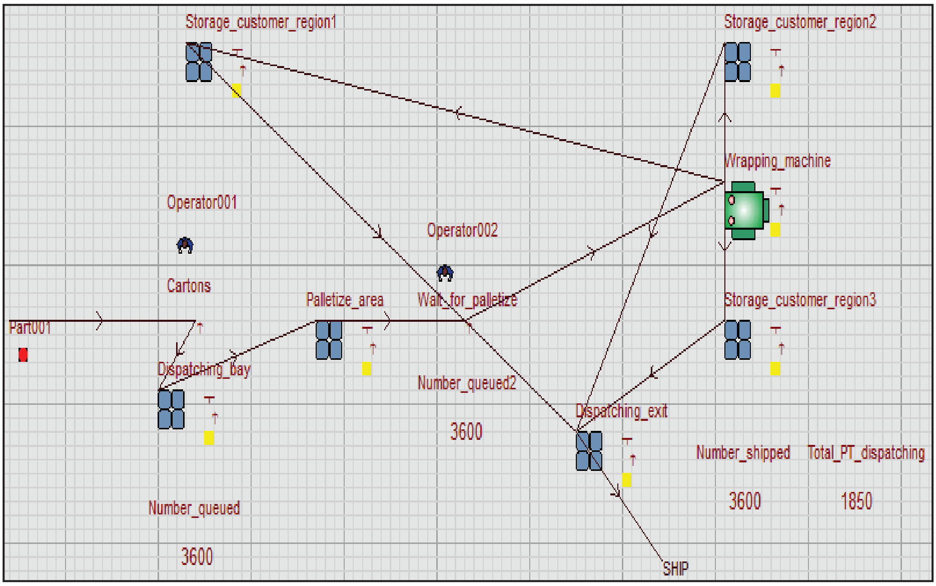

Figure 3: Simulation model of dispatching line.

For validation purpose, the average processing time data was used that required statistic description, distribution identification, normality test and determination of p-value. The data replication run for the average processing time of dispatching was conducted step by step with the data validation within 95% of confidence interval to ensure the simulation model accurately represented the real dispatching line. Results from the validation test generated the p-value of 0.897 which was greater than 0.05 and this made the average total processing time 111,043.65 minutes to be accepted and this also indicated no significance difference between the real system and simulation model.

2.1.2 Model Experimentation

The alternative layout was generated based on the facility planning process that consisted of 6 steps; define objective, analyze activity, determine space, evaluate alternative, select best design and implement design. For the first step, the objective was defined to reduce the current dispatching time. Then, the activity was analyzed by identifying the layout according to activities' sequence as shown in Figure 4.

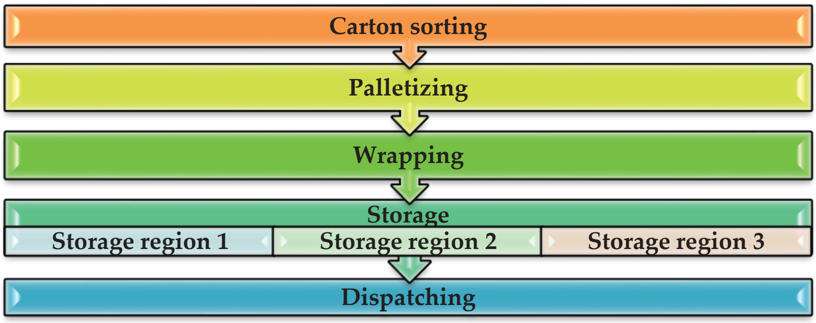

Figure 4: Sequence of activities

Next, the space requirement was determined and the results for all areas are tabulated in Table 8. The ABC inventory classification was performed to identify and separate items' annual total dispatch for the storage layout planning. The storage layout was classified according to fast, medium and slow moving items. The fast moving item was located near to the loading exit, followed by medium moving item and slow moving item.

A total number of 1,464 products were listed based on dispatch quantity in carton, dispatch frequency and total dispatch carton in a year. The cumulative of the annual total dispatch carton calculated in percentage is as shown in Table 9. The products in 80% of the annual total dispatch carton percentage were classified as A, 15% were classified as B and 5% were classified as C. Products in A classification were grouped in fast moving items, B classification in medium moving item,and C classification in slow moving item.

Table 8: Summary result of space requirement area

Area	Maximum number of pallet queuing at a time (unit)	Space requirement (m^2)
Carton sorting	24	28.33
Palletizing	126	151.33
Wrapping	26	30.92
Storage	60	71.97
Note: Area of one pallet = 1.2 m^2		

Table 9: Summary result of ABC inventory classification

Total number of product	Percentage of total number of product (%)	Percentage of annual total dispatch carton (%)	Classification
271	18.51	80.07	A
378	25.82	15.02	B
815	55.67	4.92	C

Next, the alternative was calculated whereby the current and alternative layout are as shown in Figure 5 and 6 respectively. Based on data collected, 75 readings were taken for a week giving a total of processing time of 2,313 minutes. It can be manipulated that one complete work equals to one reading. Hence, it was 30.84 minutes to do one complete work of activities. By referring to the current layout, a total distance taken to do one complete work of activities was 162.83 meter. Thus, it takes 0.189 minutes for 1 meter distance travel. This finding is used to determine time spent for each of the distance travel by the operator. The distance travel was calculated using rectilinear distance and the total time consumed for distance travel by each activity was calculated. Table 10 shows the comparison of current and alternative layout.

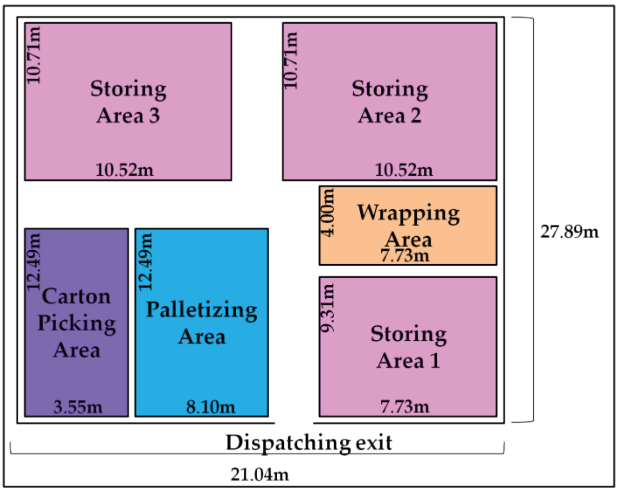

Figure 5: Current layout

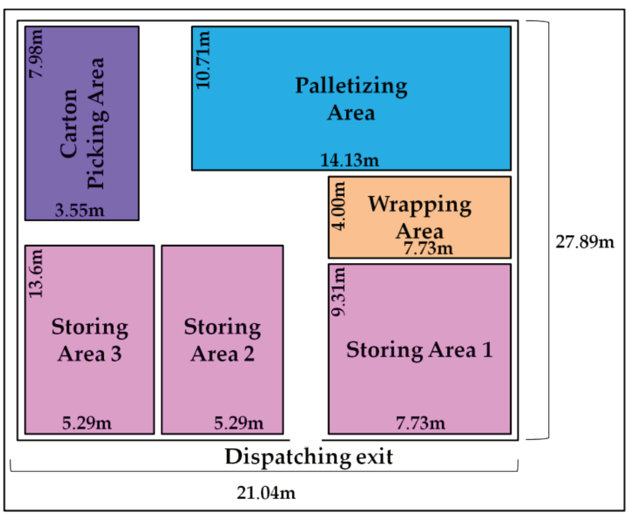

Figure 6: Alternative layout

Table 10: Comparison of current and alternative layout

Activities		Current layout		Alternative layout	
From	To	Distance travel (m)	Time consume (min)	Distance travel (m)	Time consume (min)
Carton picking area	Palletizing area	17.91	3.38	11.58	2.19
Palletizing area	Wrapping area	18.27	3.45	12.59	2.38
Wrapping area	Storage area 1	15.76	2.98	13.76	2.60
	Storage area 2	21.33	4.03	16.05	3.03
	Storage area 3	21.33	4.03	18.64	3.52
Storage area 1	Dispatching exit	9.89	1.87	9.89	1.87
Storage area 2		29.17	5.51	10.82	2.04
Storage area 3		29.17	5.51	16.11	3.04
TOTAL		**162.83**	**30.77**	**109.44**	**20.68**

3.0 RESULTS

Alternative layout reduced the total distance travel of 53.39 meters and time consumed by 32.79%. As the alternative layout has reduced the distance travel and time consumed of total dispatching time, space utilization can be evaluated. The area of each activity of current layout is compared with the alternative layout as shown in Table 11. The percentage area could be utilized about 36.11%. Hence, the current layout should cut off 36.11% from the current carton sorting area, resulting in a shorter distance travel.

Palletizing area should add on 49.58% of area to manage queuing cartons. For both Storage 2 and 3, the percentage area should be utilized by 36.12%. The same goes to carton sorting area whereby percentage area should be utilized by 36.12%, resulted in shorter distance travel. This assessment was conducted to identify the necessity of area for each activity in accordance with its requirements in reducing dispatching time.

Table 11: Comparison of current and alternative layout

Area	Current layout (m^2)	Alternative layout (m^2)	New proportion of area (%)
Carton picking	44.34	28.33	36.11
Palletizing	101.17	151.33	49.58
Wrapping	30.92	30.92	0
Storage 1	71.97	71.97	0
Storage 2	112.67	71.97	36.12
Storage 3	112.67	71.97	36.12
TOTAL	**473.74**	**426.49**	

4.0 CONCLUSION

In conclusion, this study has developed an alternative layout for dispatching area. Simulation method was used to find the best arrangement of alternative layout. The findings show that the new alternative layout can reduce the total dispatching time from 30.77 minutes to 20.68 minutes to complete one dispatching job.

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