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Redesigning the inventory management with barcode-based two-bin system

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Abstract

This research presents an integration of a simplified inventory management tool and information technology by adopting lean perspective. It is a real case study from an electronics company confronting with an inventory problem. The objective is to implement a lean concept for eliminating wastes arising in the case study. The selected C category products data were collected by using process charts for an activity classification according to the value. Barcode-based two-bin system and component storage relocation were implemented to eliminate a number of disclosed wastes. The results showed that average inventory turnovers decreased between 11.00% and 78.00%. Moreover, this approach was able to decrease waiting time by 28.01%. In addition, the overall distance reduced from 355 feet to 215 feet.

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Keywords: Inventory management; Lean concept; Barcode; Two-bin system

1. Introduction

The Board of Investment of Thailand promotes the investment policy by inviting foreign investors. Thus, a number of foreign companies are located in Thailand under the responsibility of the Industrial Estate Authority of Thailand. Foreign electronics companies have played a vital role in the Thai economic structure. Various researches have been also proposed for improving in electronics operation efficiency. Wanitwattanakosol and Sopadang [1] developed a

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conceptual framework to perform a value chain approach for the electronics sector. It was found that the lean concept was employed to develop the framework.

The problem of setting appropriate lead times is a classical problem in a context of an inventory management system. ABC analysis is often a useful first step for managing multiple items in inventory [2]. ABC analysis consists of separating the inventory items into three groupings, by considering their annual cost volume usage. A items, B items and C items are a high, an intermediate and a low dollar usage, respectively. Each categorized-item is controlled using different efforts. Hopp and Spearman [3] summarized that A items are ordered only when imminently needed. Reorder point in a continuously-monitored approach is used for B items. A two-bin system is typically adopted for C items. This simple system has two bins which an empty bin signals the need for a replenishment order and the other bin is used to satisfy the demand [4]. The two-bin system is often used in the lean concept.

Lean production is a management philosophy based on the elimination of non-value added (NVA) activities. This philosophy has been implemented in various industries for evaluating the real applicability. The redundancy program and a lack of employee education were found to be the main stumbling blocks in a traditional aerospace manufacturing company [5]. Moreover, Serrano et al. [6] extracted the results obtained from the real-world practices in six industrial companies. Information technology (IT) plays an essential role for facilitating the lean implementation. Lean manufacturing practices and IT have been taken to reduce lead times. IT has also an impact on the efficiency and quality of manufacturing, especially in the manufacturing process control, production control level and business function support [7]. Ward and Zhou [8] affirmed that integration between lean practices and IT could reduce lead times in manufacturing.

This research presents the implementation of IT by adopting lean perspective in a real case study from an electronic company confronting with an inventory problem. The objective is to implement a lean concept for eliminating wastes arising in the case study. The rest of this paper is organized as follows. In Section 2, research methodology is described. Results and discussion are mentioned in Section 3. Conclusions and further research directions are provided in the final section.

2. Research methodology

2.1 Collect data

The selected C category products data were collected by using process charts. The chart is a useful way of recording the essential features of a work situation for subsequent analysis. Operation, inspection, transport, storage and delay are used as symbols to link together in a vertical chart representing the process.

2.2 Construct AS-IS value stream mapping

Value stream mapping (VSM) was adopted for the current situation to categorize value of activities. VSM is a visual lean tool for classifying the manufacturing processes in terms of value or wastage. All bottlenecks were also disclosed in the production flow. This research focused on inventory waste, transportation waste and waiting waste.

2.3 Map TO-BE value stream mapping

A future state map was drawn as a picture of how the system should improve the inefficiencies. This map becomes the source for making the required changes to the system. The proposed future state map was aimed to eliminate wastes by applying on technical implementation related to the use of the lean concept such as the two-bin system combined with IT.

3. Results and discussion

To investigate the wastage reduction, a data set from the electronic company was utilized as numerical experiments. Four selected C category type data were Earth-terminal 06, Contact earth, Contact earth load and Earth-angle as shown in Table 1. Moreover, basic data of each item are listed in Table 2. Average inventory turnovers of each product were 3,525 EA, 19,258 EA, 17,053 EA and 2,613 EA. It should be noted that each item has a lead time of 30 days.

Table 1. The selected C category products.

Earth-terminal 06 (221614)	Contact earth (226763)	Contact earth load (227079)	Earth-angle (403566)

Table 2. Consumption and inventory data.

Month	Consumption (EA)				Inventory (EA)			
	221614	226763	227079	403566	221614	226763	227079	403566
March	2,166	12,516	16,186	923	5,989	31,069	35,693	3,013
April	5,079	8,219	13,979	232	3,823	18,553	19,507	2,090
May	2,534	14,040	18,160	558	1,744	18,814	19,499	2,358
June	4,800	19,490	22,090	445	2,190	16,651	15,166	1,800
July	1,836	17,400	23,240	381	2,060	15,011	5,935	3,355
August	626	12,770	17,490	275	3,129	20,591	13,034	2,974
September	-	-	-	-	5,743	14,116	10,540	2,699
	Average				3,525	19,258	17,053	2,613

A physical flow of raw material started from Receiving and Inspection Quality Control (IQC) department. Raw material from suppliers was stored for checking quantity and quality until it was transferred to a warehouse and then moved to a production department for manufacturing. Finally, finished goods were packed and located at shipping department. Process charts were used to record activity types, time and distance as summarized in Table 3.

Table 3. Summary of process charts.

Department	Symbol					VA activities		NVA activities		Distance (Feet)
	○	□	⇒	▽	⊖	Time (mins)	%	Time (mins)	%	
IQC	5	1	4	1	0	17.00	30.88	38.05	69.12	185
Warehouse	2	0	1	1	0	4.00	43.01	5.30	56.99	30
Production	5	1	2	0	1	17.00	58.22	12.20	41.78	140
Shipping	3	1	2	1	0	13.00	61.32	8.20	36.68	20
Total	15	3	9	3	1	51.00		63.75		375

Thus, a current value stream mapping was drawn for detecting bottlenecks in the system as illustrated in Fig.1 (a). It was found that there were waste processes occurring in involved departments. Based on limited time and budget, processes in IQC department, warehouse and production departments were selected to analyze and decrease NVA by using lean perspective and IT which is represented as TO-BE value stream mapping in Fig.1 (b).

First of all, component storage was changed from the warehouse to the production area as shown in Fig 2. Next, the traditional inventory system was replaced by using the two-bin system. The reorder point of the bin size is

$$R = \bar{d}L + Z\sqrt{L}\sigma_d \tag{1}$$

where R is the reorder point, an average consumption is \bar{d} , L is lead time, Z is an appropriate value from a table of standard normal distribution probabilities and σ_d is demand during the replenishment lead time standard deviation.

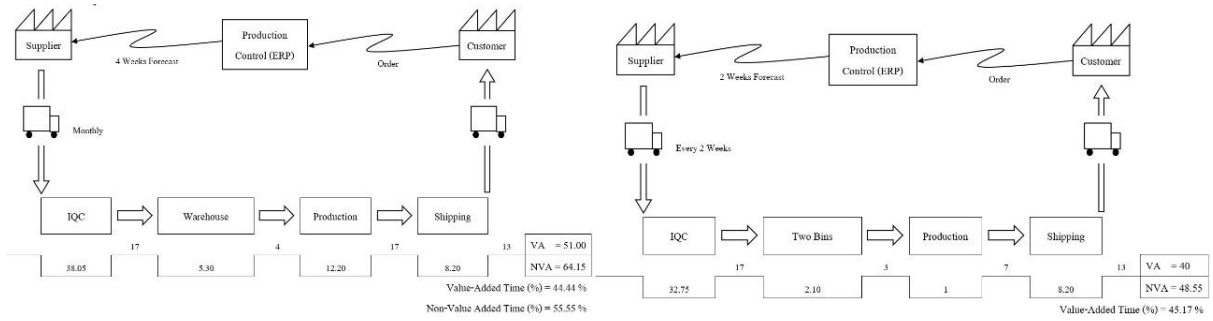


Fig. 1. (a) AS-IS value stream mapping (left); (b) TO-BE value stream mapping (right).

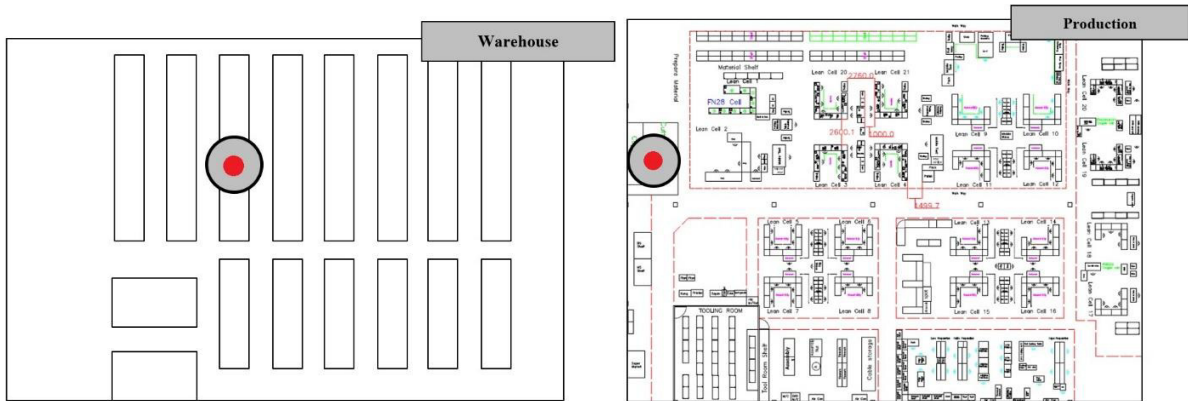


Fig. 2. New component storage area in production department.

Suppose safety stock is desired for any item that the probability of stocking out in any given replenishment order cycle is 0.1, hence, the production plan is always satisfied. An example of the two-bin system for Earth-terminal 06 is exhibited in Table 4. Therefore,

$$R_{221614} = (2,840 \times 1) + (1.28 \times \sqrt{1} \times 1,598) = 2,840 + 2,045 = 4,885$$

Table 4. The two-bin system for Earth-terminal 06.

Month	Inventory	Consumption	Diff with Avg. Consumption	Incoming Order
March	4,885	2,166	454,501	
April	2,719	5,079	5,012,375	4,885
May	2,525	2,534	93,738	4,885
June	4,876	4,800	3,840,947	
July	76	1,836	1,008,351	4,885
August	3,125	626	4,902,534	
September	2,499			
Summary		17,041		
Average		2,840		

The Earth-terminal 06 empty bin signals the need for a replenishment order as 4,885 EA and the other bin is used to satisfy the demand. All products were calculated to set the reorder point and average inventory turnovers for comparing with the traditional inventory system as shown in Table 5. The results showed that average inventory turnovers decreased 16.00%, 57.00%, 11.00% and 78.00% for 221614, 226763, 227079 and 403566, respectively.

A rapid prototyping approach of rapid application development was applied to develop software for receiving a digital signal of barcode-based two-bin system. The implementation of IT by adopting lean perspective in process charts was summarized in Table 6. This approach was able to decrease waiting time by 28.01%. In addition, the overall distance reduced from 355 feet to 215 feet.

Table 5. Inventory system comparison.

Month	Traditional (EA)				Two-bin system (EA)			
	221614	226763	227079	403566	221614	226763	227079	403566
March	5,989	31,069	35,693	3,013	4,885	18,711	22,648	1,526
April	3,823	18,553	19,507	2,090	2,719	6,195	6,462	603
May	1,744	18,814	19,499	2,358	2,525	16,688	15,131	371
June	2,190	16,651	15,166	1,800	4,876	2,648	19,619	575
July	2,060	15,011	5,935	3,355	76	1,869	20,178	130
August	3,129	20,591	13,034	2,974	3,125	3,180	19,586	512
September	5,743	14,116	10,540	2,699	2,499	9,122	2,096	237
Average	3,525	19,258	17,053	2,613	2,958	8,345	15,103	565

Table 6. Inventory system comparison.

Department	Symbol					VA activities		NVA activities		Distance (Feet)
	○	□	⇒	▽	⊖	Time (mins)	%	Time (mins)	%	
IQC	5	1	4	1	0	17.00	31.34	37.25	68.66	145
Warehouse	1	1	1	1	0	3.00	58.82	2.10	41.18	10
Production	3	0	2	0	0	7.00	87.50	1.00	12.50	60
Total	9	2	7	2	0	27.00		40.35		215

4. Conclusions and further research

The implementation of IT by adopting lean perspective has played a promising approach for leading companies to outperform their peers. Research results show that barcode-based two-bin system and component storage relocation worked efficiently to improve the inventory system. As shown in Tables 3 and 6, IQC, warehouse and production departments have improved performance such as operation reductions, shorter distances and efficient work-time. There are a number of gaps in the case study which will be applied with IT lean perspective such as a production control problem, a supply chain management problem.

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