MANAGING HAZARDOUS WASTE OF CHEMICAL INVENTORY: A CASE STUDY OF TEXTILE MANUFACTURER IN THAILAND

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ABSTRACT

This research is a case study of textile manufacturer in Thailand. Being a manufacturing industry, the company is facing a lot of hazardous waste generating in their chemical storage to preparation area. The objective of this research was to find the certain root cause of the waste in the process, which is not adding value. The research is also trying to find the solution and implement appropriate methodology to eliminate non-value added activities from the hazardous chemical inventory. Recommendation, necessary action plan and solution were provided to get rid of non-value added activities and prevent repeated problem. This research mainly applied the process mapping, 5S and 7 wastes to identify the root cause of the problem and eliminate them. The researcher also suggested a continuous improvement plan in order to achieve a sustainable operational improvement of the company. The research observed that the main cause of an increase in hazardous waste is PVC Drums placed in the main inventory area. These PVC Drums were used in 13 different kinds of chemical generating 61.90% of hazardous waste in the process.

Keywords: *Hazardous waste, chemical storage, textile manufacturer, Thailand*

บทคัดย่อ

งานวิจัยนี้เป็นกรณีศึกษาของผู้ผลิตสิ่งทอในประเทศไทยที่ต้องเผชิญกับของเสียอันตรายที่เกิดจากการจัดเก็บสารเคมีในพื้นที่เตรียมการ งานวิจัยนี้มีวัตถุประสงค์ เพื่อหาต้นเหตุที่ทำให้เกิดของเสียในกระบวนการ ซึ่งไม่ก่อให้เกิดมูลค่าแต่อย่างใด รวมถึงเพื่อหาแนวทางแก้ไขและดำเนินการตามวิธีที่เหมาะสม เพื่อกำจัดกิจกรรมที่ไม่เพิ่มมูลค่าจากการจัดเก็บสารเคมีอันตรายและป้องกันไม่ให้ปัญหาเกิดซ้ำ งานวิจัยนี้มีการนำการวาดผังกระบวนการ 5ส และ ความสูญเสีย 7 ประการ มาใช้เพื่อหาต้นเหตุของปัญหาและกำจัดมัน นักวิจัยยังได้เสนอแผนในการปรับปรุงอย่างต่อเนื่องเพื่อปรับปรุงการดำเนินงานอย่างยั่งยืน ทั้งนี้จากการสังเกตพบว่าสาเหตุหลักของการเพิ่มของเสียอันตรายเกิดจากถังพีวีซีที่จัดเก็บไว้ในพื้นที่เก็บวัตถุดิบหลัก โดยมีการนำถังพีวีซีมาใช้กับสารเคมี 13 ชนิด ซึ่งก่อให้เกิดของเสียอันตรายในกระบวนการถึง 61.90%

คำสำคัญ: ของเสียอันตราย การจัดเก็บสารเคมี ผู้ผลิตสิ่งทอ ประเทศไทย

INTRODUCTION

TEXTI Company is one of the largest textile manufacturers in Thailand, a composite manufacturing unit of denim fabric (from spinning to finishing fabric) since 2006. TEXTI Company is a fully automated manufacturing industry integrated with state-of-the-art machinery from Europe and other parts of the world to produce the best quality of denim

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fabrics. It has the capacity of producing 2 million meters of fabric per month. Large scale manufacturing industries have a lot of processes from upstream to downstream. Likewise, TEXTI Company, a large and growing textile manufacturing industry, is going through the same set-up and facing the problems of hazardous waste and extra movements in the chemical inventory process, which are not adding value. Currently they are using 65 types (Liquid and Dry) of chemicals from different suppliers; but 25 out of 65 chemicals are from one major supplier with different types of hazardous class and pack size. From unloading to storage and preparation area, there are a lot movements and hazardous waste.

Therefore the researcher used one major chemical supplier in this study who delivers almost 50% of the major chemicals to TEXTI Company, in order to find an appropriate method to get rid of non-value added activities and hazardous waste from the chemical inventory process.

Thus the researcher then attempted to study various technique of process mapping along with 5S and 7 wastes, a Japanese technique of standardizing work and eliminating waste. In order to recognize the problem the researcher used the primary and historical data of TEXTI Company from July 2017 to December 2017. The objectives of this case study are as following; (1) To identify and reduce non-value added activities from inbound section in order to avoid reworking; (2) To create more visibility in the storage system; (3) To recommend a practical procedure for hazardous chemical handling.

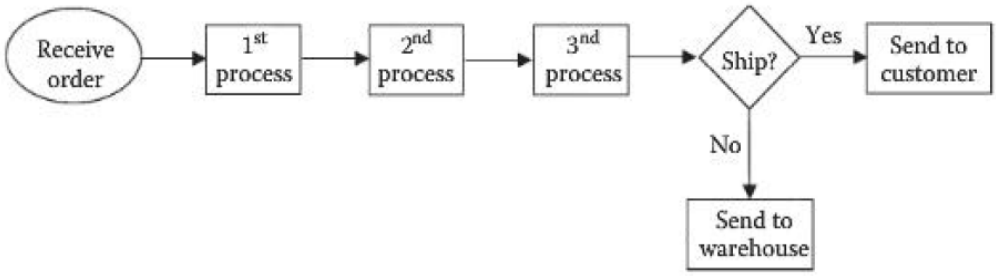
REVIEW OF RELATED LITERATURE

United Nations Environment Program (2011) found that in recent years, chemicals contained in textile products have been given an increased attention; and production countries need to take notes of workers working with hazardous chemicals, and environmental effects. Bullington (2003) described that 5S is not only an initial step of lean but also very much emphasizes in getting rid of NVA (non-value added). If inventory increases, it will definitely lead to an increase in costs in the form of invested capital, damaged finished goods, scrapped product, and expensive inventory control system (Kilpatrick, 1997).

Andersson (2012) explained that process mapping is a kind of procedure that sees through not only the activities within the process, but also integrates with other departments like mutual influence. Bicheno and Holweg (2009) had another perspective about process mapping that it should be the combination of information flow as well as physical flow. Bicheno (2000) explained very specifically about value stream mapping that it can help specify processes with integrated single piece flow, defect prevention, production pull, continuous waste reduction, flexible team-based work and active involvement of close integration with suppliers. Chapman (2003) viewed simple metric time-based process mapping allows a rich understanding of the symptoms of poor performance and is effective in identifying and diagnosing waste. In addition, Rogers and Tibben-Lembke (2001) stated separation of logistics flow costs double or creates an investment in separate physical facilities along with the system. Therefore, a combined flow will typically lead to increased complexity because the two flows differ greatly in nature.

Figure 1 is a basic tool of process mapping shows various step. According to Barsalou (2014), a flow chart helps to understand a process by using different symbols to represent the activities and decision points within the flow.

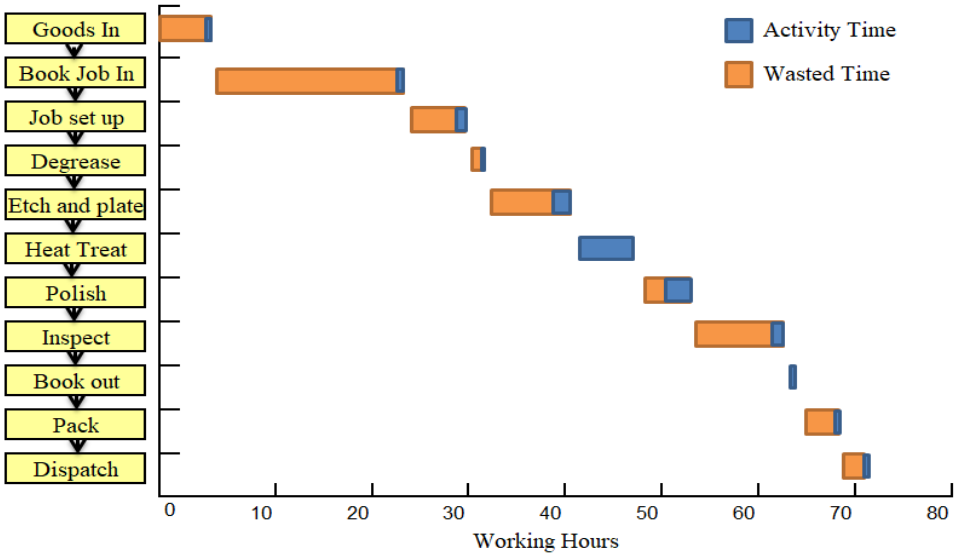
Figure 1: Flow Chart Sample



Source: Barsalou (2014)

Figure 2 illustrates the time-based process mapping, where it differentiates activity time and idle time simultaneously.

Figure 2: Time-Based Process Mapping Sample



Source: Chapman (2003)

METHODOLOGY

The researcher collected the relevant documents and extensively reviewed as well as interviews in order to discover the historical scenario and figure out the problems effectively. Documents were collected from procurement section, inventory and waste department report during July 2017 to December 2017. The interviews considered in this issue define the occurrence of hazardous waste of each section along with difficulties in using different types of tanks in preparation area. As a result data analysis demonstrates that the major chemical supplier delivers almost 50% of chemicals to TEXTI Company. Those 50% chemicals contain different hazardous class and pack type as shown in table 1.

Data also demonstrates that PVC Drums and MS Tanks are completely unusable, which means 100% waste. Another major issue is to maintain waste management section as per ISO standard and find certified waste buyer.

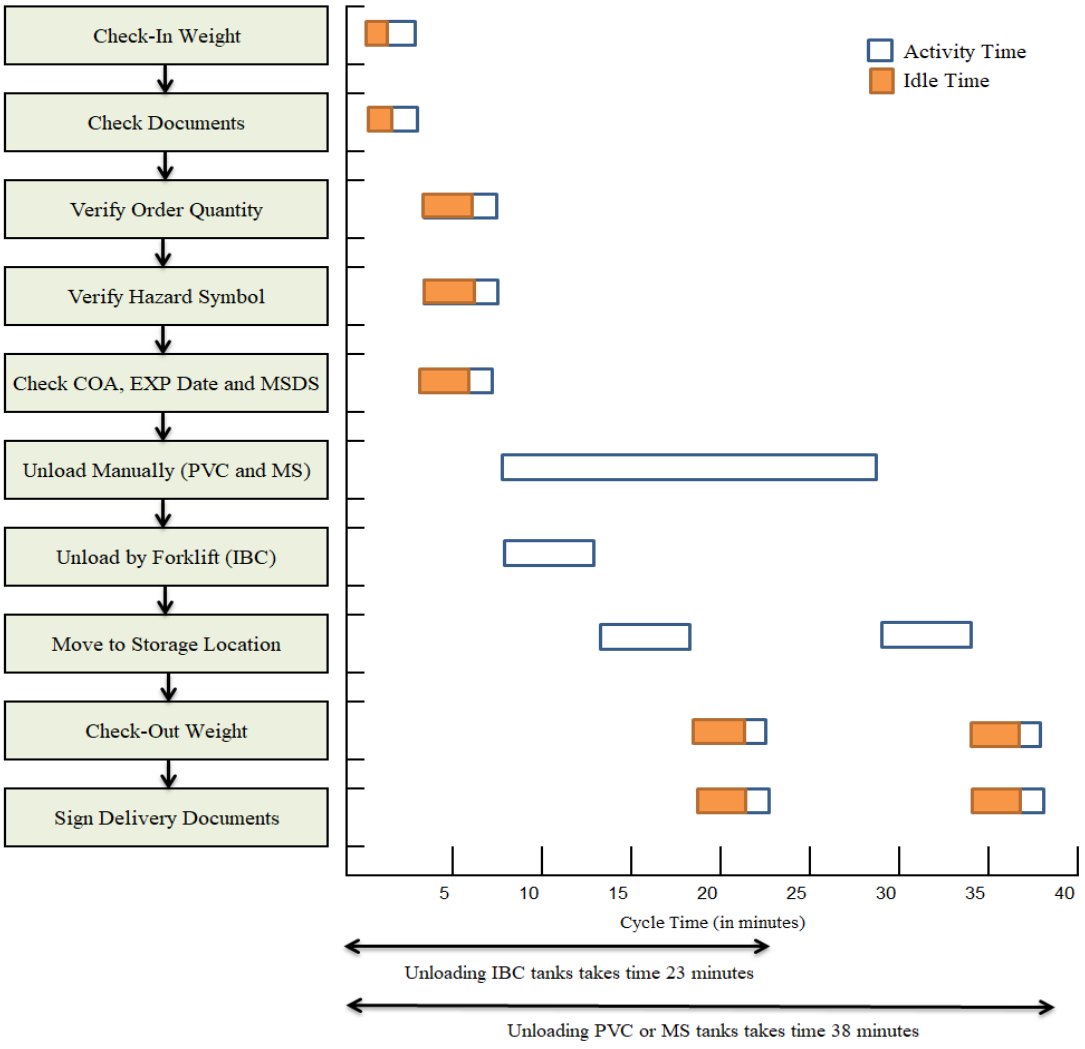
Table 1: Types of Inventory and Waste

Inventory Type		Hazardous Waste	
Hazard Class	**Total Inventory**	**Packing Type**	**Total Waste**
GHS 05	45.45 %	PVC Drums	64.43 %
GHS 07	18.18 %	IBC Tanks	26.17 %
GHS 08 and GHS 07	4.55 %	MS Tanks	9.40 %
GHS 05 and GHS 07	13.64 %		
No Hazard	18.18 %		

Source: Author

Similarly Figure 3 demonstrates time based process mapping of chemical unloading. A comparative analysis between IBC Tanks and PVC or MS Tanks delivery can significantly explain value added and non-value added activities. One PVC pallet contains 5 drums which take 2.5 minutes to place in each pallet. However, each MS Tank has more weight and it takes 3.4 minutes to unload every single pallet which contains 4 tanks. In compare to both PVC and MS, IBC tanks just takes just 1 minute to unload each tank.

Figure 3: Time-Based Process Mapping of Chemical Unloading



DISCUSSION OF RESULTS

Based on raw data and a comparative analysis, eliminating few of PVC Drums together with a change in the capacity and tank type can bring out a significant result. The researcher saw that there was an opportunity to reduce number of hazardous tanks from the process. Considering the data analysis PVC drums are 64.43% in the process, which has been reduced to 33.68%. Also the changes helped to improve the utilization of IBC tanks, improved storage and waste management and more importantly eliminate non-value added activities by improving unloading time from 98.90 minutes to 75.90 minutes.

Table 2: Result of Changing Tank Type (Waste Generation and Disposal)

Type of Tank/Drum	Waste Generation	Percent	Waste Disposal			
			Sale Out	Percent	Return	Percent
PVC Drum	32	33.68	32	33.68	0	0.00
IBC Tank	49	51.58	31	32.63	18	18.95
MS Tank	14	14.74	14	14.74	0	0.00
Total	**95**	**100.00**	77	**81.05**	**18**	**18.95**

77 + 18 = 95 Tanks, 81.05 + 18.95 = 100 %

Table 2 demonstrates that changing only three chemical in terms of capacity and type from PVC to IBC is not only reduces the hazardous waste by 45.39% from 141 tanks per month to 77 tanks, but also increases the IBC tank utilization by 125%, return to supplier for recycling from 8 tanks per month to 18 tanks.

Table 3: Result of Changing Tank Type (Cycle Time)

Type of Tank/Drum	Unloading Time (Per Pallet)	Number of Tank/Drum	Total Pallet	Cycle Time (Monthly)
PVC Drum	2.5	32	6.40	16.00
IBC Tank	1	48	48.00	48.00
MS Tank	3.4	14	3.50	11.90
Total	**6.9 (Minutes)**	**94**	**57.9**	**75.90 (Minutes)**

Table 3 shows another result of unloading cycle time which is very favorable. Although unloading process is a mandatory task in an inbound section, during data collection the researcher observed that one particular type of chemical tanks (PVC), takes too much time during unloading and movement. As explained in the previous table, the result shows that changes in the capacity and types of three different chemical tanks can bring an astonishing result. After changing the tank capacity, the number of PVC Drums has decreased from 96 to 32, as a result the cycle time has also decreased from 48 minutes to 16 minutes, which is very substantial. Even if IBC Tanks unloading time has increased, but the total unloading cycle time is still better and reduced by 23.26%.

Table 4 justifies the cost saving analysis of the project. Although it is not a big number in terms of savings, but other factors such as improvement in hazardous waste handling procedure and disposal along with eliminating non-value added activities are as effective as big numbers. The project is combining all factors and creates a win-win situation to

concerned stockholders, such as chemical suppliers, inventory section, production process and waste management along with sustainable environment.

Table 4: Cost Saving Analysis

Chemical	Current Quantity	Existing Unit Price (THB)	New Unit Price (THB)	Difference	Cost Saving
A	2,520	34.24	33.71	0.53	1,335.60
B	2,160	83.46	81.86	1.6	3,456.00
C	3,360	92.56	90.42	2.14	7,190.40
			Total Saving (THB/Month)		**11,982.00**
					2.07%

Note: Cost saving assumed as minimum unit price based on historical data of TEXTI Company

TEXTI Company is saving THB 11,982 per month without any further investment, seems very effective for small changes. TEXTI Company can utilize this saving to enhance other resources and improve their operational activities. They can save more in the future by doing the same if the current scenario can give them a long term return.

The researcher had collected relevant data in order to analysis the root cause step by step and apply the appropriate methodology required in this research to meet the research objectives. The researcher realized that "Process Mapping" is a good method of systemic thinking that enables a manufacturer to recognize the waste and standardize the work process. The consequences of the study are hazardous waste and non-value added activities in an inventory process of TEXTI Company. The researcher figured out a crucial cause of the study using value stream mapping and time-based process mapping to understand the root cause of hazardous waste and non-value added activities followed by 5S and 7 Waste. The result of a data analysis represents the factor that leads to non-value added activities and hazardous waste which is PVC Drums. All the results significantly validate that changes in tank capacity of three different chemicals with the same hazardous class can make a big impact in the inventory process along with preparation area and waste procedure of TEXTI Company.

Figure 4: Before and After Comparison

	One Month Scenario	
	Before	**After**
Total number of tanks	149.00	95.00
Total unloading time (minutes)	98.90	75.90
IBC Tank utilization (return to supplier)	8.00	18.00
Cost saving (THB)	0.00	11982.00

Figure 4 demonstrates a before and after comparison of this case study. The numbers are very substantial and favorable, considering the kind of problem TEXTI Company faced.

Data analysis and face to face interviews demonstrates that though there are no changes in To-Be process from As-Is process as shown in figure 5, yet the cost is improving significantly by 2.07% (11,982.00 THB/month). Moreover, the unloading time is reduced by 23.26% (from 98.90 to 75.90 minutes) and the utilization of IBC tanks is increased by 125% (return from 8 to 18 tanks per month). Additionally, hazardous waste is reduced by 45.39% (from 141 to 77 tanks per month).

This case study gives a win-win opportunity to all the stakeholders involved. The main purpose of this study was to eliminate waste from chemical inventory and preparation area which helps TEXTI Company to improve the utilization of a storage location, enhance unloading time, and better utilization of IBC tanks.

Advantages of changing tank and capacity

Fundamentally this project is about eliminating waste (non-value added activities and hazardous waste).The research progresses from the problem statement to review of related literature and data collecting till analysis and validation. The outcome is to change the tank type and capacity. As a result, there are many advantages as explained below;

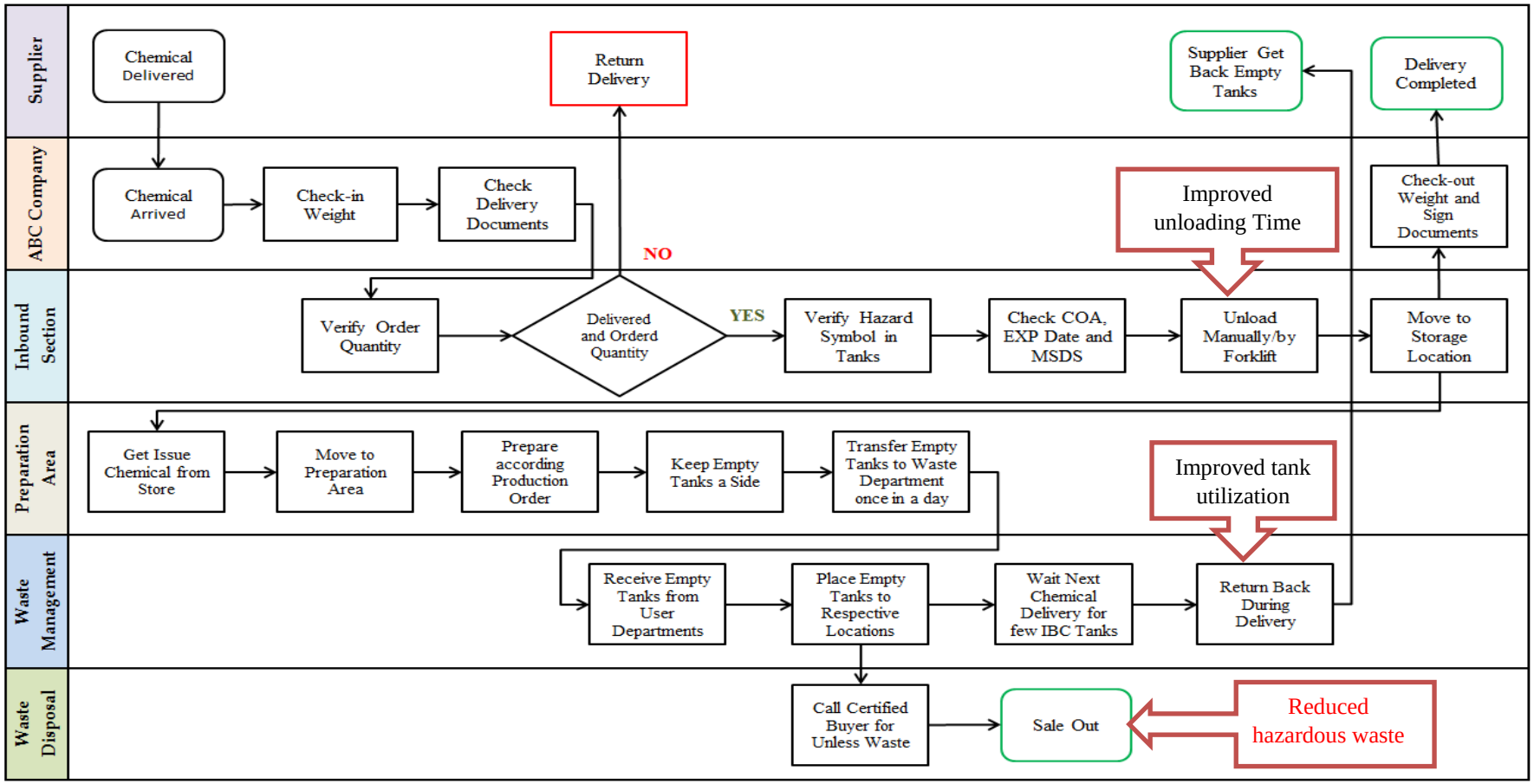
- Improve hazardous waste generation and disposal process
- Reduce hazardous waste and enable the organization to be more sustainable
- Improve unloading time and internal movement
- Increase the number of IBC tanks in the process, which is more durable, easy to handle, and better in utilization of storage area
- Less movement in the inventory area as well as on the production floor
- Improved utilization of reverse logistics due to more uses of IBC tanks
- Create a win-win situation for all stakeholders

Key benefits of IBC tanks

There are some very important benefits of using IBC Tanks in large scale industries as follows:

- **Space Efficiency:** IBC Tanks enable the organization to maximize the volume of liquid chemicals which can be stacked up to four levels high as well.
- **Time Saving:** IBC Tanks are very easy to load and unload either by forklift or pallet jack because unloading normal tanks is not only a laborious task, but also uses up valuable time which costs more money.
- **Waste Elimination:** More capacity means more chemicals in one IBC Tank, which offers advantages in terms of eliminating waste.
- **Eco-Friendly:** IBC Tanks are fully recyclable and an eco-friendly way to store chemicals which provides a more sustainable solution.
- **Durability:** With iron frame and strong bottom base, IBC Tanks are extremely durable and non-combustible.
- **Easy Categorization:** Particularly in large scale industries where verities of chemicals are in the production process, IBC Tanks are easier for categorization during storage and movement as well as labeling.

Figure 5: Holistic View of To-Be Process of Hazardous Chemical



CONCLUSION

In manufacturing industries, particularly textile industries where chemicals are major raw materials in order to produce fabric, companies are more conscious about environmental regulations, waste management, and sustainable working environment. This study provides a concept of lean methodology to TEXTI Company in order to get rid of hazardous waste and non-value added activities. This concept is a kind of learning by doing and understanding the waste and the activities which are not adding value in the process. It is easy to adopt by any industry or organization as a mandatory concept of improvement.

Applying various concepts of process mapping helps to recognize the problem and find the root cause. The purpose of this study is to explain the as-is process flow of inbound section in chemical inventory section in order to find the root cause of hazardous waste and non-value added activities and find the best appropriate solution to solve the problem. By using process mapping, TEXTI Company improves as well in some other concerned areas such as reverse logistics, storage utilization of waste as well as chemical storage area. This method enables TEXTI Company towards a sustainable improvement and encourages a re-engineering of the process in the future if necessary.

This case study was conducted to identify the root cause of hazardous waste and non-value added activities concerned in chemical inventory, preparation area and waste management section. This case study, using lean methodology, is from one of the biggest textile manufacturers in Thailand. However, the research has some limitations as follows:

The researcher mainly focused on the primary and historical data from “July to December 2017” along with interviews of the concerned departments of TEXTI Company. Based on the data, the researcher analyzed the root cause of the problem. Then, to validate the problem, the researcher did an interview before implementing the improvement plan. The problem was mostly affected by PVC Drums, which are not only the cause of hazardous waste, but consume more time during unloading and internal movement. By changing only three chemical tank capacities and types, both generation of hazardous waste and time consumption have significantly improved with better reverse logistics and storage utilization.

The researcher recommends the company to apply this concept in other related field and re-engineer the process whenever required. The researcher would also like to recommend that the company should be more conscious about cross functional with concerned departments and integrate with important suppliers. Integrating with suppliers will enable the awareness of new policies and future amendments so that the company can utilize their resources and strengthen the relationship with its stakeholders.

REFERENCES

Andersson, B.,& Brink, T. (2012). Mapping and analysis of distribution process in a make- to- order supply chain. *Department of Industrial Management and Logistics, Faculty of Engineering, Lund University.*

Barsalou, A. M. (2014).*Root Cause Analysis: A Step Guide to Using the Right Tool at the Right Time.* New York, NY: The Productivity Press.

Bicheno, J. (2000). *The Lean Toolbox.* Buckingham, UK: Picsie Books.

Bicheno, J., & Holweg, M. (2009). *The Lean Toolbox: The Essential Guide to Lean Transformation.* Buckingham, UK: Picsie Books. 4th edition.

Bullington, K.E. (2003). 5S for suppliers. *Quality Progress, 36*(1), 56-60.

Chapman, P.(2003). A Tutorial on Time Based Process Mapping. In: Supply Chain Knowledge Conference, Cranfiled University.

Kilpatrick, A.M. (1997). Lean manufacturing principles: A comprehensive framework for improving production efficiency. *Unpublished master's thesis. Massachusetts Institute of Technology, USA.*

Rogers, D.S.,&Tibben-lembke, R. (2001). An Examination of Reverse Logistics Practices. *Journal of Business Logistics, 22*(2), 129-148.

United Nations Environment Program (2011, January). *The Chemicals in Products Project: Case Study of the Textiles Sector*. Retrieved from http://www.health.gov.vc/health/images/PDF/cip_textile_case_study_report_21_feb_2011.pdf