Applying Lean Technique to Reduce the Waste of Soda Ash in Glass bottle Industry

Ahmed Mohamed Samir Amine[1], Walid KamalAhmed[2], Mohamed Aly Mohamed[3], Ahmed Mahdi Hossian[4]
[1]*Middle east for glass manufacturing*
[2,3]*Arab Academy for Science Technology and Maritime Transport – Productivity and Quality Institute, Cairo, Egypt*

***Abstract*- A project of lean technique takes place in a glass bottle manufacturing plant, to reduce the waste of soda ash material that considered the most expensive raw materials batched in this industry, based on assignment released from top management to lean quality team who had been beginning to implement lean management to reduce all waste forms of soda ash found in its high stock, losses occurred in its handling and its percent in glass as a final product and how to be the lowest without any negative effect on the productivity.**

The net results of this project is reducing the stock of soda ash in store, reducing the handling losses and finally save considerable quantity was batched without any added value to final product.

1. INTRODUCTION

The main challenge for any glass manufacturing company today is how to reduce the cost of the production to increase the competitiveness especially after contraction in the market of glass bottles to plastic, in any glass factory the chemical and raw materials lab is the most discourse with the raw materials and its store. Since soda ash considered the most expensive material in glass forming batch ingredients because its cost represents one half of total cost of glass forming batch ingredients and 13.5 % from the production cost of one ton glass

Based on this fact, one of the main priorities of top management is reducing the consumption of this material in glass industry by reducing its stock in store, losses occurred in each step in its handling and finally producing glass with lowest allowable percent of sodium oxide.

Hypotheses questions of quality team are the following

First hypothesis question (H0-1)

Is there a relation between lean technique and reducing the stock of soda ash in raw materials store?

Second hypothesis question (H0-2)

Is there a relation between lean technique and reducing the losses of soda ash in glass bottle industry?

Third hypothesis question (H0-3)

Is there relation between lean technique and reducing the consumption of soda ash in glass forming batch?

The answer of previous questions consider a project took place in company

2. METHODOLOGY

Waste is all around us. In all organizations we have never seen a perfect process. There may be individual steps in a process that appear virtually impossible to improve, but if we look at any end-to-end process that goes from the inkling of a need in a customer's head (internal or external) to the satisfaction of that need, there is always waste somewhere (and usually everywhere). These eight wastes are always present, but until being aware of their existence are not recognized, and so nothing is done to reduce these wastes.

Lean manufacturing was applied through the following steps:

1. Analysis of the processes
2. Workplace standardization.
3. Determining the wastes.
4. Training people.
5. Waste elimination.
6. Continuous improvement of built-in quality.

The researcher depends on several tools of collecting data in the consumption of soda ash in bottle glass industry by the following methods

1. Direct interview with general manager, production manager and purchasing manager
2. Questionnaire to all workers in all stages of soda ash handling
3. Data from store keeper and batch plant including shipments quantities, losses, stock and consumption(daily, monthly, annual)
4. Historical Analysis results of soda ash and glass samples from chemical lab reports
5. Collecting documented data about international and local production from soda ash and its consumption in glass industry

3. DISCUSSION

Is a manufacturing philosophy that shortens the time between the customer order and the product build/shipment by eliminating sources of waste? Yes, Lean Manufacturing will take some waste out of the value-added (VA) activity shrinking it down as in the mass production approach, but more importantly, it reduces the pure non valued-added (NVA) activities, which has the large impact on Lead-Time and the efficiency of process.

Lean Principles are focused on reducing process waste which are clearly found in our case in inventory , waiting, transportation, motion and over processing which are considered the main deadly wastes should be eliminated Therefore, the researcher thinks that, Lean Manufacturing Methodology is suitable for this study. Lean manufacturing is appropriate technique to reduce the losses of soda during all steps of its process from receiving, storing till weighting and mix with other glass batch ingredients .also it needs employees, culture change, knowledge and commitment.

according To this conclusion top management review decide to form quality team assists lean tools to identify the causes of waste represented in reducing high stock of soda in store and eliminate the losses occurred in each step of using soda in glass bottles industry and produce glass with lowest allowed percent of sodium oxide to get the lowest soda consumption to produce the same glass tonnage.

3.1.Critical priorities in business process, table (1)

Business CT`s	
CTQ QUALITY	Glass melting process done efficiently to give glass melts free from defects convenient to forming process.
CTD Delivery	Proportionality between rate of delivering and consumption .to get rid of the inventory
CTP price	Reduce the total cost of production by reducing soda consumption to minimum boundary.

Table 1. Business process critical priorities

3.2. Problem statement

1. What is the problem?
   High waste and consumption of soda related to produced glass
2. Where does the problem occur?
   In Batch and furnace department during receiving, storing, handling and batching soda ash as major ingredient in glass batch.
3. When the defect observed?
   After upgrading done in melting furnace
4. How extensive is the problem?
   Each receiving new soda shipment and inventory process each 3 months and higher sodium oxide % in glass analysis
5. How do you know the problem is a problem?
   a. From inventory report
   b. Also it is observed in tracking the percent of sodium oxide in flint glass.

The value added and non value add in soda usage in glass process figure (1).

To obtain the added and non added value in the process a value stream map should be made with the total set of using soda ash in glass bottle industry. Value added: The process steps which have a pure positive result and reduce the time and cost. Non

Value added: The process steps cause lost time, waste and cost. A sample had been collected from the records of soda ash shipments delivered from Siesecam(external supplier of soda ash). Project prioritization the first objective to determine all possible causes of wastes and reduce them. A (VSM) should build to depict the process flow, people flow, equipment, product, procedure. As seen in figure (2).

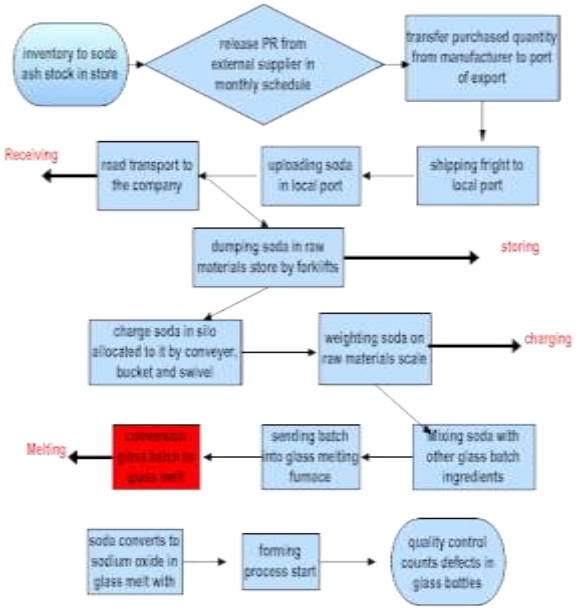

Figure 1.flow chart of using soda in glass bottle industry

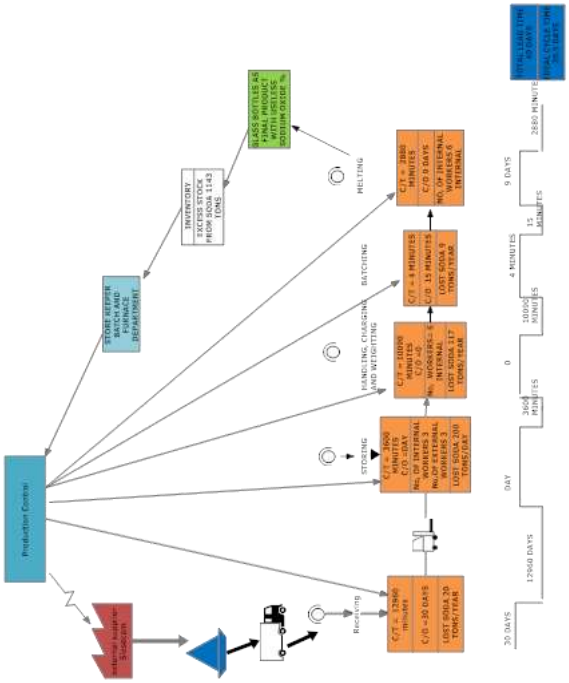

Figure 2. Current VSM of using soda in glass bottles industry

Using Brainstorming Technique to obtain the metrics affecting the process and cause soda waste. The result as the following

1. Depending on external supplier prompting company to receive large quantity of soda in each shipment to satisfy process needs from one shipment to next that cause overstock in store.
2. Stages of marine transport cause soda losses and jumbo bags bad state
3. Excess stock of soda in store cause waste and losses during its handling(inventory)
4. Bad state of store ground cause losses during the handling and charging of soda.
5. The Forklifts used in transfer soda to charge may in unsuitable case
6. Soda jumbo bags not arranged in store properly
7. Lost soda in its charging stages (opening jumbo bags, on belt conveyer and on upper swivel distributer).
8. Raw materials scale sometimes be imprecise
9. Useless sodium oxide in glass composition not essential to customer requirements.

3.3. Create the future state

In order to reduce soda wastes and consumption of soda in glass bottle industry suitable lean tools should be selected to be used as in table (2). Waste in using soda in glass industry and proposed lean tools in figure (3).

No.	Defect	proposed lean tool
1	Depending on external supplier prompting company to receive large quantity of soda in each shipment	Just in time
2	stages of marine transport causes losses in soda	Just in time
3	excess stock of soda in store	Just in time and safety stock
4	Bad state of store performance	5Ss, Kaizen
5	Unsuitable case of Forklift	TPM
6	Upper swivel state	TPM
7	soda jumbo bags not arranged properly	U-shaped
8	lost soda in charging steps	Kaizen
9	raw materials scale sometimes imprecise	TPM
10	Useless of sodium oxide in flint glass composition	Standard work

Table 2. Waste in using soda in glass industry and proposed lean tools

Figure 3. Lean tools used to eliminate the waste

4. RESULTS

4.1. 5S

4.1.1. Sorting

From time to time accumulation occurs from oil drums special to car repair unit beside raw materials store and backing materials of bottled glass and befallen maintenance equipments, if we ignore this problem for a long time it will lead to deduction from the warehouse area by about 20% and hinder the bath of raw materials trucks including soda ash trucks during unloading in raw materials store

4.1.2. Shines and inspect through cleaning

Keep workplace safe and easy to work by paving the store floor and pour concrete In non paved area to be the thickness of the smoothed paved concrete layer all over the store area 15 cm to prevent the losses occurred in storing and charging steps estimated to be 70 tons from soda ash annually due to instability in the movement of transportation equipments as forklifts and trucks.

4.2. U-Shaped

Rearrangement of soda jumbo bags in store to be U-shaped to the point of raw materials hopper will reduce the distance of movement between soda stores to hopper in average 10 m and save 400 m2 can be exploited in other purposes and reduce the cycle time of charging soda to be 4 minutes instead of 7 minutes in average and can be reduced the number of workers to be 2 instead of 3, figure (4).

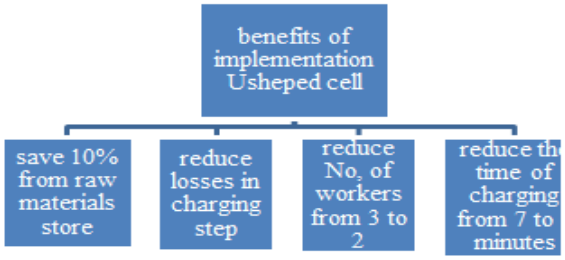

Figure 4. The benefits of implementing U-shaped cell

4.3. Just in time and safety stock (reorder point)

The main purpose of just in time to move the material through the value stream at a time without inventory and waste. The lean team will design and utilize lean tools but everyone will be responsible for maintaining the standards that exists to ensure just in time with respect to waiting point in value stream map if we replace current continuous replenishment method (Shish kabob method) by just in time method we will dramatically reduce the waiting time of shipping from 9 days to a day if company depend on local supplier that should be found. Also we can save 20 tons lost in waiting step in external shipping, Maritime transport and unloading step in Alexandria(local port). All transportation means can be saved in particular transportation from manufacturer to port of export , maritime transport , the need for shipping and custome Clearance Company to end the measures inside the port, also by applying continuous flow approach storing step that takes 2, 5 days in each shipment equal to 25 days /year and about 200 tons lost and 3 more external workers to unload soda jumbo from truck to store equal to 36 external workers /year can be saved because the small pitches received from soda will directly charged to silo allocated to it .so will also reduce the motion of workers and equipments in the store. All these forms of waste eliminations can be found in next two figures (5,6).

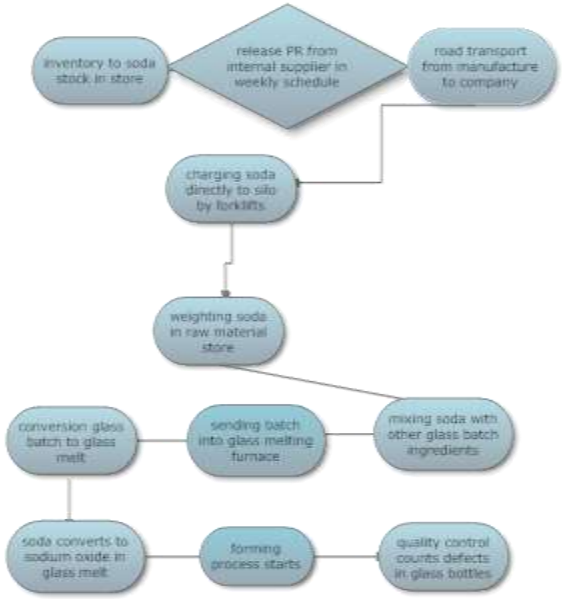

Figure 5. Flow chart of using soda after implementing JIT technique

		Current situation	Just in time
Waiting	Time	9 days	Day
	Losses	20 tons	None
Transportation	Transportation means	External and maritime	None
Storing	Time	2,5 days	0
	No. of workers	3 internal , 3 external	3 internal worker
Inventory	Stock in store	1143 tons	111
Reorder point method	Stock	777 tons	111 tons
Process parameter	Lead time	40 days	7.5 days
	Total cycle time	20.5 days	7 days
	Orientation	Narrow variety and lot of stock	Wide variety and small lot
	Space	Take up a lot of space	Does not take much space
	Approach to efficiency	Efficient process	Efficient system
	Conveyance	Required	Not require
	No. of workers	15 internal workers , 3 external	12 internal worker
	Total soda losses	337 tons	117 tons

Table 3. Results of implementing Just in time technique

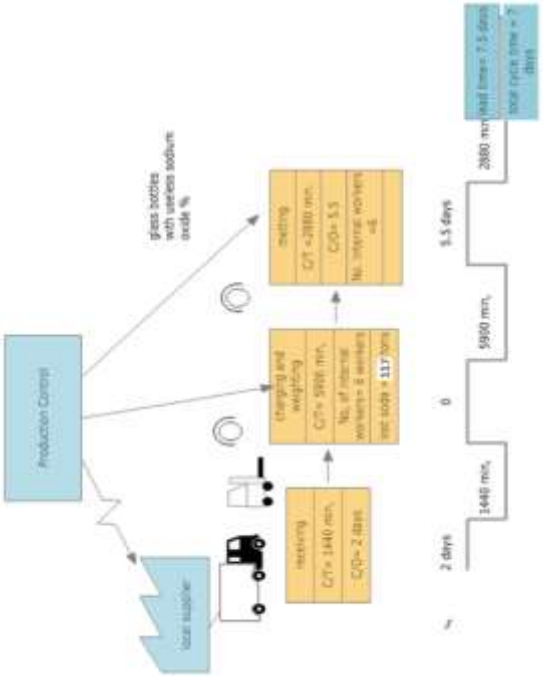

Figure 6 VSM after implementing JIT technique

Implementing just in time technique and safety stock (reorder point) change the flow chart and VSM of handling soda ash in glass bottle industry to be as previous figures (5,6) and reduce wastes as shown in table (3).

4.4. Kaizen improvement, table (4)

Event	Task	Responsible	Required time Months
Coverage store with galvanized steel roof	Losses reduction in storing step	Projects manager	2
Installing dust filter on charging hopper	Reduce losses in charging step	Mechanical maintenance manager	1
Coverage raw materials belt conveyer	Reduce losses in transfer soda to silos	Mechanical maintenance manager	1

Table 4. Kaizen improvements

By implementing three proposed kaizen improvements we expect to eliminate the losses occurred in storing charging and handling soda ash with estimated quantities shown in following Pareto chart, figure (7)

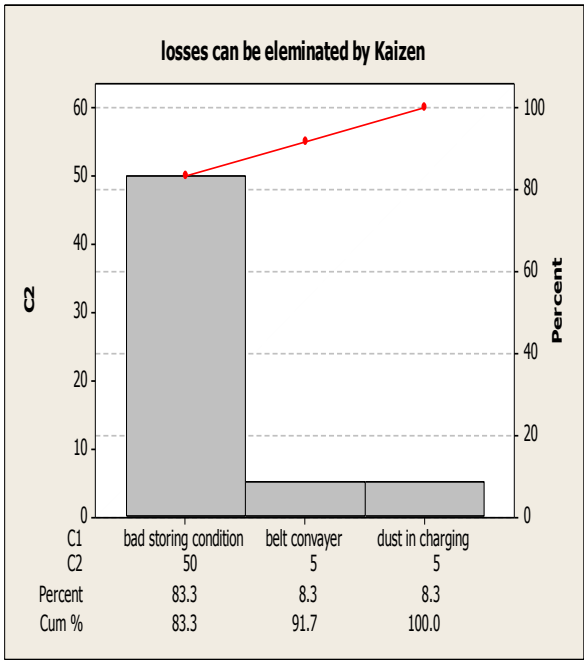

Figure 7. Pareto chart to soda wastes can be eliminated by Kaizen

4.5. Standard work

In average we will save 1.3 tons/day from soda, so if we produce flint glass for 8 months in year as the production schedule in 2013 we will save about 312 tons /year equivalent to 515000 Le/year.

The productivity of forming machine with this process is high related to the productivity in other two cases with the lowest energy consumption such the machine speed is 111.3 bottles /minute .that confirms the productivity of glass forming machine increase with lower sodium oxide percent in glass.

4.6. Total productive maintenance (TPM)

TPM program is proposed lean tool to improve overall equipments effectiveness like that used in soda handling as Forklift used in weighting materials like raw materials scale, and used in charging process as final swivel distributes raw materials to their allocating silos, figure (8).

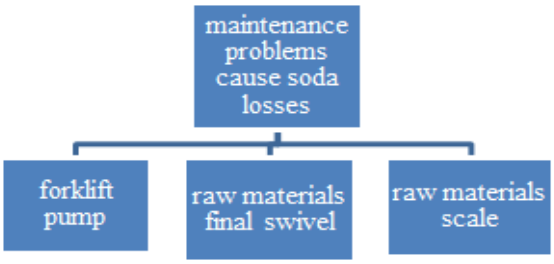

Figure 8. problems cause soda losses solved by TPM

The expected soda ash quantity saved by implementing TPM program on previous three items is 120 tones. All in charging step.

6. CONCLUSION

The company will have to get rid of all non added values in using soda in glass bottle industry. There are the eight wastes of lean which are; over processing, inventory, motion, waiting, transportation, defects, underutilization of people (unused talent) and overproduction. The existed wastes discovered in our project were the first five ones. The researcher summarized the wastes and tried to relate them to the eight wastes trying to categorize them.

By implementing just in time technique as a lean tool is a magic solution to reduce the stock of soda ash from from 1143 to only 111 tons, proving the first hypotheses that lean is the effective tool to eliminate the inventory. Secondly, implementing 5S, Kiezen improvement and TPM program to reduce the handling losses of soda ash from 337 to 117 tons/ year, proving the second hypotheses lean is the effective to reduce the soda ash handling losses. Finally, implementing standard work reduce the consumption of soda by 312 tons / year in glass industry was batched without any added value to the final glass product, proving the third hypnoses lean is the effective tool to reduce the consumption of soda in glass industry.

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