Activity-Based Costing (ABC) for Manufacturing Costs Reduction and Continuous Improvement: A Case Study

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Abstract

Activity Based Costing (ABC) is an accounting system that collects and analyze all costs related to activities occur in an organization based on their nature. ABC can overcome many of the limitations of Traditional Cost Accounting (TCA) methods as it helps to discover hidden or distorted cost information and remove the generalization of TCA. In this project, Company XYZ is suffering from a major drop in their 2017 sales compared to previous years as new competitors are joining the glass-bottling manufacturing industry in Kuwait. Their sales dropped significantly by 51.35% during the last two years, thus ABC is used to investigate their costing system and try help them know the root causes and overcome this drop. Time and cost information about each step in Company's XYZ Pepsi glass bottles production line is collected, work stations were analyzed, activities were defined, and cost information were assigned to them. Value Stream Mapping (VSM) is used to analyze and capture all flows of information and materials in the production system and identifies the value and non-value added times and activities. TCA results were compared to ABC and discussed, improvements and recommendations were discovered and presented.

Keywords

Activity Based Costing (ABC), Traditional Cost Accounting (TCA), Value Stream Mapping (VSM), Value Added and Non-Value Added, Glass Bottles Manufacturing.

1. Introduction

Manufacturing companies are looking for ways to help them manufacture high quality products at the lowest possible cost. Companies should be more productive, efficient, flexible, and have an accurate cost information to reach their goals. Labor, machines, and time are important factors that affect the productivity and the efficiency of any manufacturing company and need to be taken into consideration. Activity Based Costing, ABC, is an accounting method that take into consideration all types of activities in an organization and collect all related costs based on their nature. Even though ABC is complex and expensive to install, it's better than Traditional Costing Methods, TCM, as it gives more precise information about the costs and identifies wasted costs, and unnecessary activities. Also, ABC discover the root causes behind any problem to solve it. Moreover, it considers the time each activity takes to improve any system as wasted time affect the efficiency and as a result affects the cost while TCM gives general costs information and don't take into account the unexpected expenses. ABC is needed to be applied to XYZ Company to help them trace the root causes behind the significant drop in their sales as it seems that they cannot decide accurately on how much to produce and at what cost. XYZ Company is using the Exponential Smoothing forecasting technique which seems to be giving them higher unrealistic values; their sales continue dropping and inventory is palling up.

2. Background

In manufacturing there are different types of direct and indirect costs, depending on what a company producing. However, there are mainly two conventional costing methods (Edu Pristine, 2018):

2.1 Traditional Costing Formulation

Most companies use the traditional costing system because it's very simple, doesn't take long time to analyze and easy to implement. This method helps the company to control the manufacturing performance, the deviation between the actual costs and standard costs helps the accounting managements to view how well each cost center is working (Lopez, Santos & Arbos, 2013). The behavior, and dynamics of the traditional costing systems made the cost management both; more manageable and less manageable. It also created behaviors that are; desirable behavior and undesirable behavior (Yu-Lee, R. T., & Yu-Lee, R. T., 2001). The main objective of the Traditional Costing Systems is to save time and reduce the wastes in the production line. This is a good time for the organization to make the decisions if and only if the production is very focused and they must keep tracking of every details. Moreover, the idea of optimizing the process can be applied in a mix type production line and set ups that aim to reduce costs or optimize them. As for the undesirable behaviors, these behaviors focus on two topics:

- Believing that focusing on the production and units' costs is the way to understand the costs dynamics.
- Believing that to enhance the profit we must reduce the units' costs.

2.2 Activity-Based Costing Formulation

ABC is an accounting system that define the activities in the organization and deal with them as a core cost object. In other words, ABC concentrate on the activities occur in the organization by collecting all costs related to these activates based on their nature and extent (Cecily & Michael, 2009). The activities can be tasks performed by worker, operating machines, and products produced by the company. Moreover, activities of an organization can be value added or non-value added activities. It's a value added activities when its add value to the product and it consider as important stage to make the product while the non-value added activities increase the time required to make the product without adding a value to the products as its considered as an unnecessary step that increase the costs of making the product. ABC aim is to reduce the overhead costs of the organization and to eliminate the non-value added activities. This method considered as complex and expensive method but tend to give accurate costing results. If a company applies ABC, it should provide training for their employee, so the employees can use their knowledge about the subject to improve the company. Managers and management accountant need to communicate to set the goals and what kind of improvement need to be done (Horngren, Datar, & Rajan, 1988). ABC is useful when its applied on an organization that manufacture multiple products, so there are multiple costs that need to be taken into consideration. Direct costs are easy to recognize as each costs or amount of money the organization pay is assigned to specific machine or product while the indirect costs are the problem as companies cannot recognize them easily as these costs are assigned to different things such as department, processes, and product. ABC divide the indirect costs pool into some smaller pools and each pool deal with different activity (Cecily & Michael, 2009).

2.2.1 ABC Steps

1) Define and understand the different departments, tasks, and products of the organization.
2) A production / manufacturing process is a set of consecutive activities that are achieved to reach a specific goal, so it need to be identified and analyzed to detect the non-value added activities.
3) A detailed flow chart for each process is required and it's important to identify each step for each process and a second chart is required to assign the value and time consumed from the beginning to the end of the process. From this step, the value added and non-value added activities can be detected:
   - Value-added activities: process time, service time, and for some companies packing time. In addition, these times are important to make the product and without one of them the quality of the product will be affected.
   - Non-value added activities: transfer time, Idle time, inspection time, and frequent delays as these times increase the total time, affect the efficiency, and increase the costs of the products. These activities should be reduced or eliminated to increase the efficiency, improve the quality, reduce the overall time, and therefore reduce the costs.

$$Cycle\ time = Value\ added\ time + non - value\ added\ time \quad \textbf{(1)}$$

Equation (1) used to calculate the total time that the product takes from the beginning to the end of the manufacturing process

$$Manufacturing\ cycle\ efficiency = \frac{(Total\ value\ added\ time\ )}{(\ Total\ Cycle\ time)} \quad \textbf{(2)}$$

3. Literature Review

3.1 New techniques of activity based cost estimation in Push\pull advance manufacturing system

This paper is selected to understand the nature of the selected organization and to benefit from these techniques to improve the system. With everyday new advanced technology in manufacturing field aiming to produce high-quality products more quickly with least costs in wide manufacturing area. To reach these goals, should be followed today's manufacturing organizations updates which required to become more flexible, integrated and highly automated. Seemingly there are many of competitiveness worldwide that looking for the greatest quality with lowest costs, with simulation based model that uses ABC method to estimate every single activity and product costs under either push and pull approaches (M. Ozbayrak et al. 2004).

3.2 The basic Model that been used

Simulation – based model is used to help to estimate the costs of a manufacturing organization, with new advanced approaches studies where to use ABC method under push or pull system that is run under either material requirement planning (MRP) system which is the (push) or just in time (JIT) system which is the (pull approach)**,** where is concerned with creating a model that calculates the manufacturing costs using ABC for each of the manufacturing planning and control strategies. The model developed uses simulation as a modeling tool to observe the manufacturing cost behavior under two manufacturing planning and control strategies, of the push and pull types, respectively. Where some manufacturing company consider it as a great model to reduce time using for modeling and avoiding the barriers that present in creating a cost model (Spedding and Sun, 1999). The simulation model identifies every single activity that either directly or indirectly affects the cost of an item, in a prototype manufacturing system under both push and pull control strategies and uses the ABC-based mathematical model to calculate the manufacturing and product costs (Bonney et al., 1999). JIT approach has been widely preferred, accepted and gained superb attention among researchers as well as practitioners (Huang and Kusiak, 1998; Baykoc and Erol, 1998; Thesen, 1999; Koufteros, 1999).

- Pull approach:

JIT, (just in time) uses a 'pull' approach, it's mainly the work center start any of manufacturing products or producing after the whole process finished first and get the products for next manufacturing request when it required so that queues and work in progress (WIP) are greatly eliminated.

- Push approach:

In contrast, an MRP (Material requirements planning) based on 'push' system rule is to schedule the jobs in advance for a series of work centers, and each work center pushes its completed jobs to the succeeding work centers. This approach focuses on the overload processes and try ignoring them or in another way it completes the uncompleted job parts or in partial progress of next work center, so that WIP queues and stock levels increase and long delays often occur. There are some steps and processes they fallowed, briefly, described alongside a mathematical model, which calculates the unit costs of manufactured products using ABC analysis.

- Comparison between the two approaches

The experimental briefly differentiate the calculation of the manufacturing product cost estimation with various scenarios to detect the effects of these two approaches on costs, where we can compare and recognize the importance of this improved approach. one of four scheduling rules, which are: shortest processing time (SPT), longest processing time (LPT), first come first served (FCFS), and SLACK, and are transferred on pallets of variable sizes that form the transferred batches (M. Ozbayrak et al. (2004).We can wrap up after much of calculations and steps that they went under the process, that ABC Provides more precise pricing products system where it provides the amount of costs with clear visibility and shows respectively the costs when passed down by such activities. Seemingly ABC is a beneficial tool which can provide a unique and unrivalled insight of overall of workings of the manufacturing system especially for the management department a product pricing system. It improves the system by valuable simulation method, effects of manufacturing plan and control strategies by different approaches (push \pull). The most important results of the experimentation reveal that the manufacturing planning and control strategies play an important role on the level of manufacturing costs of product. The reliance of push system on larger batch sizes and relatively high level of inventory to provide the relative independence among the work centers automatically creates a considerable amount of WIP between machines and results in longer average waiting, flow, and completion time which leads to a higher manufacturing cost. Finalizing the result of the outcomes, we realized that the pull-based planning and control strategy has given lower manufacturing costs in applying each scenario. The major cost differences come from lead times differences. The pull-based batching policy is having smaller batches in comparison to push-based batching policy. Therefore, the time spent for a batch in either set-up operations or in machine buffers is consistently less in pull-based planning and control and conversion of these time-based activities to costs has resulted in lower cost figures. So, we can reach that Pull approach overcomes the difficulties that the push approach can't solve. (M. Ozbayrak et al. 2004).

4. Design

The XYZ is a well-known company in the glass bottles manufacturing sector, and it had its long history. However, even with those years of experience they weren't able to implement the ABC, so there was no guidance to help them implementing ABC and possibly improve and solve their problems. In this project, XYZ Company had been visited and investigated in relation to their production line, production amounts, timings, and existing system costs information in order to comprehensibly underhand their manufacturing and production system and be able to develop a current, AS-IS, Value Stream Map of their system, go ahead with the project and find the root causes of the problem.

4.1 XYZ Company Glass Bottle Manufacturing Process Explanation

Figure (1) shows the manufacturing process that start with preparing the batch. Then, it sent to the mixing processes for approximately 30 min. The batch is sent to the furnace where it melted to produce glass. After that, the batch is sent to the forming processes where glass take container shape. The bottles are gradually cooling for approximately 2 hours. Moreover, outer layer of a container cool more rapidly than inside surface causing stress and the process of removing this stress is called annealing. Since the company don't have enough space to complete operations at same floor, the bottles are moved through spiral lower tar to the ground floor. Then, the bottles are sent to the automatic inspection to check the bottle height and width the machine check 1 bottle every time, so there is a long queue in this station and when the bottles left this machine, the bottles enter another machine to check the bottle diameter, and this machine also check 1 bottle each time. Bottles sent to the visual quality where operator check the glass. Finally, bottles are sent to the printing and decoration. Bottles are sent to heat treatment process to dry the ink. The last stage is packaging where the bottles are packed using Palletizer and Shrink Wrap Machines and it takes 20 min.

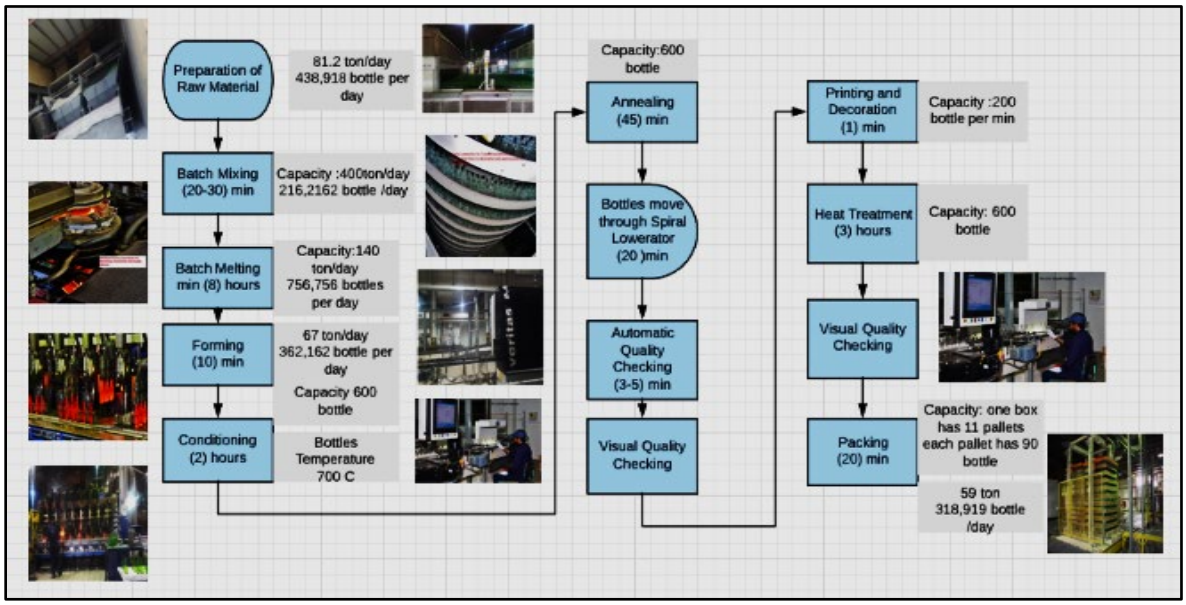

Figure 1: Glass Bottles Manufacturing Process from the beginning till the end

4.2 Analysis of Company Costs:

Each company categories its costs pool differently, Company's XYZ costs are divided to three categories: Industrial Costs, Marketing Costs and Administration Costs. Table (1) shows the current cost categories of the company. XYZ consider the marketing costs and administration costs as indirect costs, then the industrial cost consists of both direct and indirect costs as shown.

Table 1: Costing Categories of XYZ Company

1- Industrial Costs				
1-Salaries	15.03%			
Direct costs	Contract for workers 88,000Kd			
Indirect Benefits	Employees skives, services, Insurance, etc			
2-Raw materials	33.16%			
3-Energy (6.12%)	Diesel 40,600L\day 0.055fils\L	Electricity 200,000Kd\Month	LPG (Liquefied Petroleum Gas)	Water
4- Decorations (12.37%)	Labels	Sleeve	ACL	
5- Packaging (9.87%)	LDPE sheet for each pallet .0.93fils \sheet	Tray	wooden Pallet 3,750kd\pallet	LDPE Rolls :2 kg\Pallet.0.560fils \2kg.
6- Depreciation (9.62%)	7-Molds (3.6%)	8-Consumable consumed (1.2%)	9-Spare Parts (1.4%)	10-Land (0.7%)
11-Sundry Expenses (0.4%)	12- Marketing Costs (1.17%)	13- Deprecation and sundries	14-Administration Costs (5.36%)	15-Deprecation and sundries
The overall costs for one bottle	Industrial costs 0.0182922 KD (93.47%)	Marketing costs 0.0002293 KD (1.17%)	Administration costs 0.0010485 KD (5.36%)	

Cost categories in addition to their percentages in respect to the total cost per a glass bottle which is 0.01957 KD are shown in Table 2, and Figure 2. Company consider that all costs are the same for its five production line.

Table 2: Current Cost Analysis

Particular	Product	Cost per bottle / KD	%
Salaries	250 ml NRB AXL Pepsi	0.0029405	15.03
Raw Material consumption	250 ml NRB AXL Pepsi	0.0064895	33.16
Energy Consumption	250 ml NRB AXL Pepsi	0.0011984	6.12
Packing Material	250 ml NRB AXL Pepsi	0.0019309	9.87
Decoration	250 ml NRB AXL Pepsi	0.0024210	12.37
Depreciation	250 ml NRB AXL Pepsi	0.0018832	9.62
Other Costs	250 ml NRB AXL Pepsi	0.0014287	7.3
Marketing Costs	250 ml NRB AXL Pepsi	0.0002293	1.17
Administration Costs	250 ml NRB AXL Pepsi	0.0010485	5.36
Total Cost per bottles / KD		0.019570	100

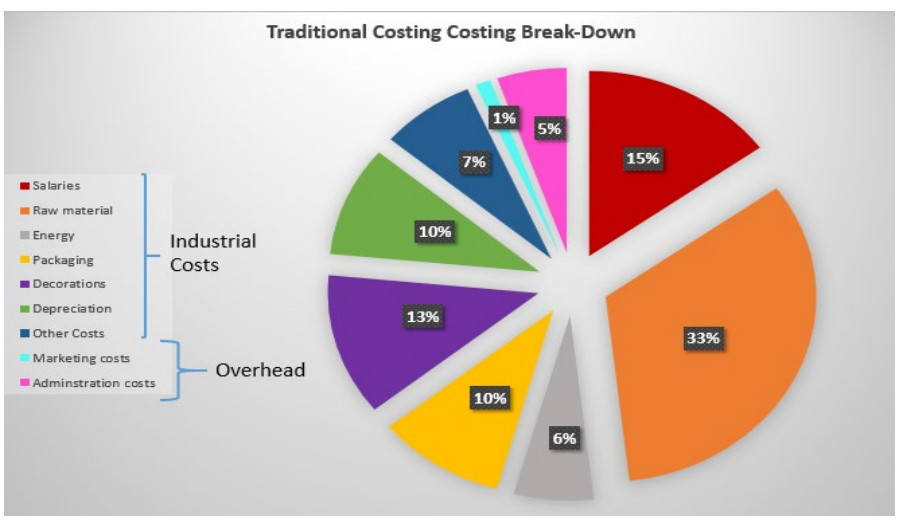

Figure 2: Current Cost Categories

4.3 Problem Statement

The sales of company XYZ have been dropped by 51% during the last two years. As shown in Figure 3, it has dropped to 12.67 in 2016 from 30.38 and continued dropping to 10.45 in 2017. In 2015the forecasting was 32.49, when the sales were 30.28, 14.67 has been left as unsold inventory. In 2016 the forecasting was 25.55, the sales dropped to 12.67, 27.55 has been left as unsold inventory. In 2017 the forecasting was 24.46, the sales continued dropping to reach 10.45, 41.56 has been left as unsold inventory. It seems that the forecasting method that they are using which is the exponential smoothing is them higher production values. However, the sales continue dropping and inventory is piling up.

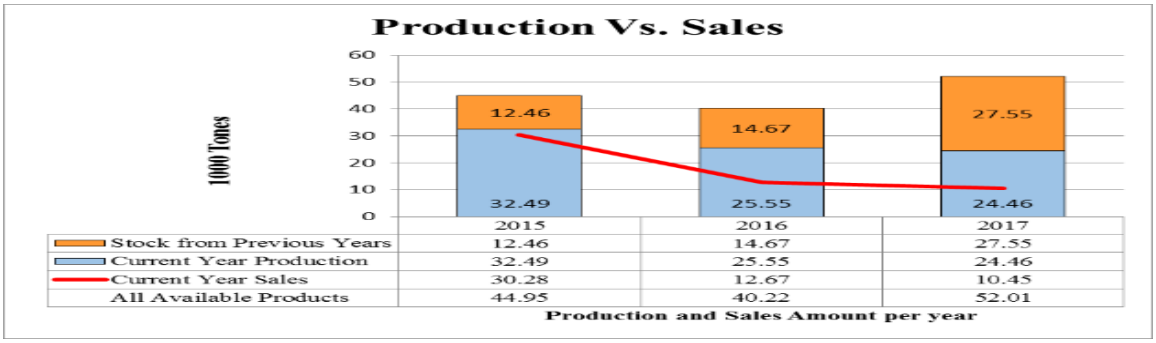

Figure 3: XYZ Company Production Vs Sales

4.4 Key performance indicator

The Key Performance Indicator of Company's XYZ are:

- Cycle time as it's the time that consumed to make the product from the very beginning to the end and
- Throughput as its mean number of the parts exit the system (output).
- Effectiveness of the resources is important to judge whether the system is good or not and to determine the resources utilization.
- Idle time and down times need to be as small as possible.

4.5 Value Stream Mapping (VSM)

By developing a VSM we will be able to allocate the value added and non-value added activities. It's a significant a tool that capture all flows of information, materials, and work in one production line. it helps to quantify and identify the waste (especially with time and costs). Figure 4, the VSM of XYZ Company shows the current production line processes, which smoothly can trace the procedure from demand customer ordering until last finishing product. The production line has several processes starting with batching, melting, forming, hot end coating (conditioning), annealing, transferring, automatic quality inspection, manual inspection, decorating, heat treatment, manual inspection and packaging. Each of process is defined with available capacity, cycle time, process time, setup time, the number of workers needed and WIP inventory units that are waiting in each workstation as shown in Figure4.

In order to allocate, and calculate the value added, and non-value added activities, the following equations were used to get the total cycle time, and efficiency. Table 3 shows the timing of the original system in categories in addition to the value of the cycle time, and efficiency

$$Cycle\ time = 1313.33\ min \quad \textbf{(3),}$$

$$Efficiency = \frac{965.33}{1313.33} \times 100 = 73.50\% \ (\mathbf{4})$$

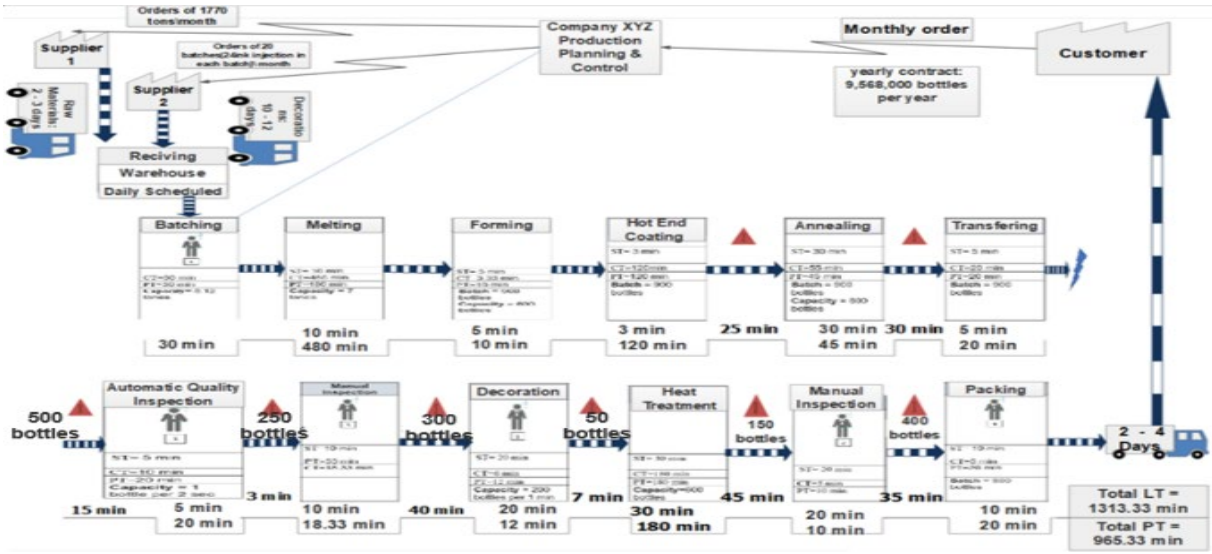

Figure 4: Company's XYZ Current, As-Is VSM

Table 3: As-Is System Value & Non-value Added Time

Value Added Activity	Time (min)	Non-Value Added Activity	Time (min)
Manufacturing Processing	877	Idle time	0
Packing Process	20	Inspection time	58.33
		Setup time	138
		Transfer time	20
		Frequent Delays	200
Total Value Added activity Time (min)		Total Non-Value Added Activity Time (min)	
897		416.33	
Total Cycle Time = 1313.33			
Efficiency = 0.735			

4.6 Improved Scenarios

- New investment of automated inspection machine with higher capacity of bottles from 1 bottle per time to 250 bottles per time while keeping the last visual labor checking. With well trained workers. And removing the non-value added manual inspection next to the automatic inspection.
- Adopt the ABC Costing method in order to precisely breakdown the indirect cost and identify any hidden cost.

5 Results

5.1 XYZ Company Should-Be Value Stream Mapping

After implementing the improving scenario, we were able to build the Should-Be VSM of system as shown in Figure 5. In the should be scenario, the manual quality checking is removed from all stations and only two workers are kept before packaging because it's important to have humans to check and to make sure that everything is fine as sometime machines cannot detect errors that human detect. Also, the capacity of the automatic quality checking machines is increased which leads to decrease the waiting time before transferring and decreasing the process time. Also, printing machines is adjusted to fit the speed of the quality checking machines. The resulted improved Cycle time and efficiency are summarized in Table 4 and as below:

$$\boldsymbol{Cycle\ time = 1203\ min} \quad \textbf{(5)},$$

$$\boldsymbol{Efficiency = \frac{897}{1203} \times 100 = 76.20\%} \quad (6)$$

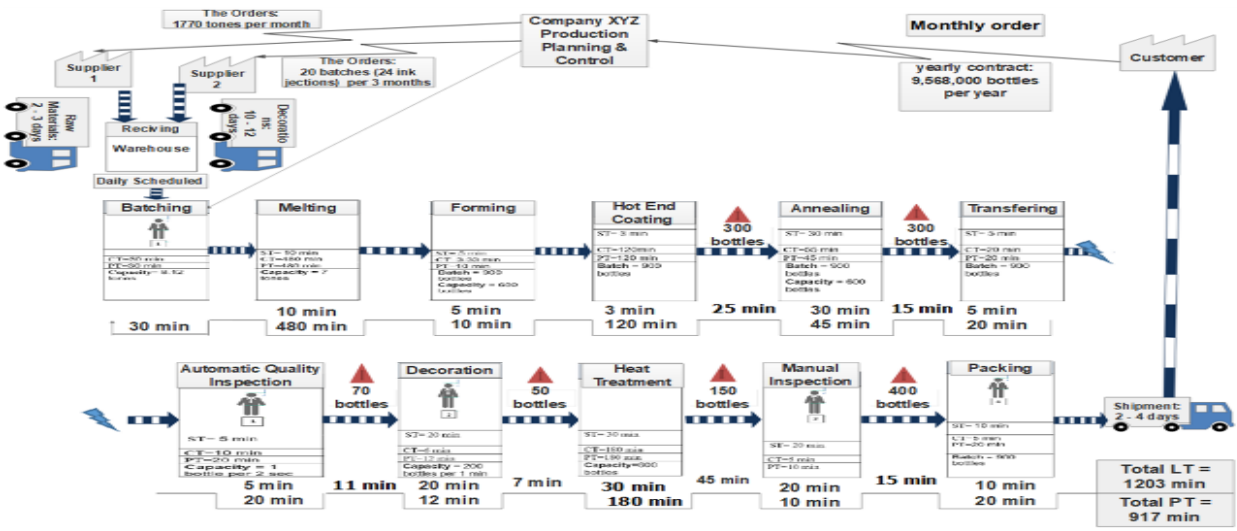

Figure 5: Company's XYZ Current, Should-Be VSM

Table 4: Should-be System Value & Non-value Added Time

Value Added Activity	Time (min)	Non-Value Added Activity	Time (min)
Manufacturing Processing	877	Idle time	0
Packing Process	20	Inspection time	30
		Setup time	138
		Transfer time	20
		Frequent Delays	118
Total Value Added activity Time (min)		Total Non-Value Added Activity Time (min)	
897		416.33	
Total Cycle Time = 1203			
Efficiency = 0.762			

5.2 Application of Activity-Based Costing Method

After considering the suggested scenario, the Activity-Based Costing Method was applied on the adjusted manufacturing system. The next step was to break down the system into activities as shown in Table 5. With the improvement scenario the production line works as following: preparation, mixing, furnace, pouring into mold, cooling, spraying, spiral lower ator, 2 Inspection machines, printing, heat treatment, manual inspection and packaging. Since we are applying the Activity-Based Costing Method we couldn't ignore the marketing and administration costs. In Activity-Based Costing Method, the cost is divided into two main categories; direct and indirect cost. For the direct cost, it is divided into two sub-categories: Direct labor and direct material. The indirect cost sub-categories are: Indirect

Labor, Maintenance, Depreciation, Energy Source (like electricity, diesel and water), Supplies (materials used in packing and preparations), insurance, land rent and warehouse.

Table 5: ABC Cost Break Down of the Chosen Product of Company XYZ

	Direct Costs		Indirect Costs				
Resource Type	Direct Labor	Direct Material	Indirect Labor	Maintenance	Depreciation	Energy source	Supplies
Preparation	0.000564	0.00648	0	0	0	0.0008	0.000937
Mixing	0	0	0	0.000015	0.0000196	0.000055	0
Furnace	0	0	0	0.000015	0.000026	0.00023	0
Pouring into Mold	0.0002258	0	0	0.000015	0.000058	0.000074	0
Cooling	0	0.000568	0	0.000015	0.0000695	0.00061	0
Spraying	0	0.000128	0	0.000015	0.000045	0.000085	0
Sprial Lower Ator	0	0	0	0	0.000043	0	0
Automatic Inspection	0.000338	0	0	0.00003	0.0000564	0.000132	0
Manual Inspection	0.0002258	0	0	0	0	0	0
Printing	0.0003387	0.000346	0	0.000015	0.000067	0.00036	0
Heat treatment	1.112E-05	0	0	0.000015	0.00013	0.00095	0
Packaging	0.0005645	0	0	0.000015	0	0.00052	0.00065
Marketing & Administration	0	0	0.0006	0	0	0.00098	0.000214
Insurance	0.0001085						
LR & WH	0.000069						
Sub-total	0.0022679	0.007522	0.0006	0.00015	0.0005145	0.004796	0.001801
Total Cost /fils	**0.0178289**						

Looking at the pie-chart in Figure 6, we can note that the direct materials takes the greatest part of cost followed by energy sources, direct labor and supplies. After calculating the cost of each category in each activity and summing them, the new cost per bottle will be equal to 0.01817. This reduction in the cost is due to the improvements that were made in the VSM, for example the students were able to eliminate a buffer zone which led to a decrease in costs pools usage such as energy consumption.

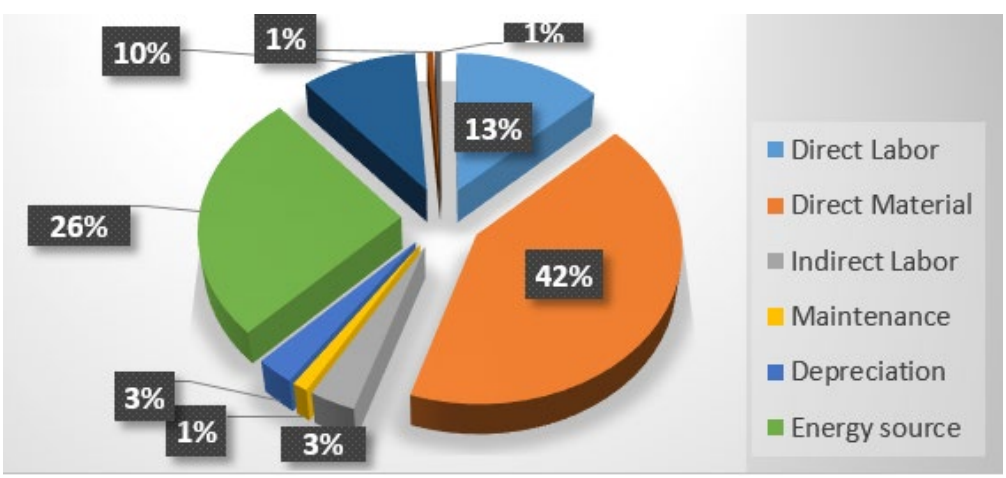

Figure 6: XYZ Company Cost Pools Percentages

5.3 The Improved ABC Results

All the changes are based on the improvement scenario be summarized so the engineers can now compare the three key identifiers of this specific problem as shown in the below Table 6.

Table 6: (As-Is) VS (Should-Be) Results

	Current System VSM As-Is & TCM	Improved System VSM Should-Be & ABC	Improvements
Cycle time (min)	1373.2	1179.2	14.13%
Cycle efficiency	73.5%	76.2%	2.7%
Total cost (fills /bottle)	0.01957	0.01782	8.94%

From Table 6, it's clear that there has been a reduction in the cycle time which led to a higher efficiency in the system. This significant rise in the efficiency shows that the system is improving in its production rate, reducing wait, etc., and based on it the company is motivated to keep this improvement and strive for a better result in the future. Moreover, the total cost got noticeably lower thanks to the ABC method, this shows that the true value of this product is much lower than what they have found in the Traditional Costing method due to taking into consideration one cost pool. This reduction in the total cost led to a better cost planning and the company will surely rise its profit.

5.4 ABC Improving

The ABC highlighted the cost categories with the highest percentage of the cost, and we can see that in the three categories mentioned above that took the majority of the cost, where direct materials took 42% of the total cost of the bottle, energy sources that included 26% of the total cost and direct labor that included 13% of the total cost. ABC helped to identify two new cost categories, the indirect labor and insurance. The rest of the cost categories weren't change but the cost at each one changed. The current costing system divides the costs of each category based on the number of products being produced by the company, so the company finds most of the categories costs by dividing the cost of this category over 5, in this case each product is responsible for 20% of the cost of this category even if the consumption of the category does not meet the 20%. An example of that is the energy sources category, the current calculated to be 0.001809 files/bottle, that number was found by multiplying the total energy sources cost (of water, electricity, LPG and diesel) that were used in the factory monthly by 20% since this product is one of five products being produced by the company and then divided by the daily rate of production to get 0.001809 files/bottle. But if we considered ABC way of dividing the cost, the cost for the energy sources will be different. According to ABC, the total cost of this category should be multiplied by the percentage of the Pepsi bottles production percentage out of the factory's total production, in other words the Pepsi bottles production involves 53.6% of the factory's total production. Using the ABC methodology, the energy sources category cost was calculated by multiplying the total energy sources by 53.6% and then divided by the daily rate of production to get 0.004664files/bottle. The same way was applied on the other cost categories. Taking advantage of the highlighted categories by the ABC, since the row materials is consuming the major part of the cost with 42% of the total cost, an idea of finding a local supplier that will reduce the need for transportation cost and provides a lower cost of the row materials was brought up as a way of reducing the cost of the row material supplies. A local supplier was found with a price that is 5% less than the current supplier, so the cost of the row materials changed by the 0.000028225 files/bottle to become 0.000645files/bottle after it was 0.00648files/bottle. Insurance category, is one of the categories that were discovered by the ABC. The company has a good record according to accidents rate; they did not have any accidents for the past three years and the company did not do anything about it. The improvement that was applied is negotiating with the insurance company. Since the glass company's accidents record is clear, so they negotiated the insurance company for the insurance payment and they got a 10% reduction in for the insurance payment, so the cost of the insurance changed by the 0.00001085 files/bottle to become 0.000009765 files/bottle after it was 0.0001085 files/bottle. The second category that was hidden and was discovered by the ABC is the indirect labor category. In fact, it was inaccurately located as the marketing and administration department, but ABC helped to understand that marketing and administration should be considered as

an activity and the cost of this activity can include more than one cost category, like how the marketing and administration activity costs were divided into three cost categories: indirect labor, energy sources and supplies. The indirect labor cost for this activity was investigated by experts in business and management and got decrease by 50%. The indirect labor cost decrease by 0.0003 files/bottle to become 0.0003 files/bottle after it was 0.0006 files/bottle. That cause the total cost of the bottle to change from 0.01782 files/bottle to be 0.01189files/bottle as shown in Table 7. A comparison between the two costing systems is shown in |Table 8, it shows the new cost breakdown after improving the system again.

Table 7: (As-Is) VS (Should-Be) Improved

	Current System VSM As-Is & TCM	Improved System VSM Should-Be & ABC	Improvements
Cycle time (min)	1373.2	1179.2	**14.13%**
Cycle efficiency	73.5%	76.2%	**2.7%**
Total cost (fills /bottle)	0.01957	0.01189	**39.2%**

Table 8: ABC Analysis after Improvement

	Direct Costs		Indirect Costs				
Resource Type	Direct Labor	Direct Material	Indirect Labor	Maintenance	Depreciation	Energy source	Supplies
Preparation	0.000564	0.000645	0	0	0	0.0008	0.000937
Mixing	0	0	0	0.000015	0.0000196	0.000055	0
Furnace	0	0	0	0.000015	0.000026	0.00023	0
Pouring into Mold	0.0002258	0	0	0.000015	0.000058	0.000074	0
Cooling	0	0.000568	0	0.000015	0.0000695	0.00061	0
Spraying	0	0.000128	0	0.000015	0.000045	0.000085	0
Sprial Lower Ator	0	0	0	0	0.000043	0	0
Automatic Inspection	0.000338	0	0	0.00003	0.0000564	0.000132	0
Manual Inspection	0.0002258	0	0	0	0	0	0
Printing	0.0003387	0.000346	0	0.000015	0.000067	0.00036	0
Heat treatment	0.00001112	0	0	0.000015	0.00013	0.00095	0
Packaging	0.0005645	0	0	0.000015	0	0.00052	0.00065
Marketing & Administration	0	0	0.0006	0	0	0.00098	0.000214
Insurance	0.000009765						
LR & WH	0.000069						
Sub-total	0.00226792	0.001687	0.0006	0.00015	0.0005145	0.004796	0.001801
Total Cost /fils	**0.011895185**						

6 Conclusion

The sufficient cost reduction with continuous improvement is without doubt one of the companies traceable seek.
The main problem of "XYZ glass manufacturing company that has huge drop in their sales of 2017" The main comparison point is comparing the two systems of As-Is system which refers to traditional technique of current system, and Should-Be system that refers to ABC method. Based on the result we can recommend the XYZ company to follow new forecasting technique rather than the incorrect result of exponential smoothing method, and invest new scenario of inspection machine with higher capacity, reduce the number of visual labor checking and precisely breakdown the

indirect cost and identify any hidden cost by adopting the ABC Costing method. As ABC method is a valuable tool in providing smoothly accurate cost information by allocating each cost to its resources and activities, as well eliminating or reducing the non-value added activities, so obviously improved scenario with the ABC efficiently can lead the XYZ Company to support their decisions management with unrivalled insight of the production manufacturing system while our goal as industrial engineers always attempt to have such a significant development and enhancement to the optimized system with higher efficiency, less cost and less total lead cycle time.

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Biographies

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Walid Smew Dr. Walid Smew is an Assistant Professor in Industrial Engineering at the American University of the Middle East (AUM), Kuwait. He earned B.Sc. and M.Sc. in Industrial and Systems Engineering from Benghazi University, Libya and PhD in Lean Supply Chain Management from the School of Mechanical and Manufacturing Engineering in Dublin City University (DCU), Ireland. Dr. Smew is a Chartered Engineer and member of Libyan Engineers Association; he is also a certified Lean Six Sigma Greenbelt and Product and Process Validation engineer in Ireland. Dr. Smew has published several journal and conference papers and supervised many graduation projects. He has an excellent experience, both theoretically and practically, in manufacturing processes and the application of Lean Six Sigma for problem solving and finding optimized solutions through the application of different statistical techniques. Dr. Smew has done consulting in the area Supply Chain Management (SCM) and Simulation Modeling along with Dr. John Geraghty from DCU; they developed a comprehensive production and distribution simulation model for Ireland's future oil supply on behalf of Byrne Ó Cléirigh for engineering and management consultancy. Dr. Smew research interests include Quality Control, Lean Six Sigma, SCM, Manufacturing Processes, Simulation and Optimization. Recently Dr. Smew and his different graduation project students won the first place of the Undergraduate Research Competition in IEOM 2018, Bandung-Indonesia, the first place of the Senior Design Poster Competition in IEOM 2018, Paris-France, the first place of the Lean Six sigma Competition in IEOM 2018, Washington DC-USA, and the first place of the Undergraduate Research and the Supply Chain Management Competitions in IEOM 2019, Bangkok-Thailand.