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Application of Lean and Quality Management in AB Brewery

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Abstract

The Introduction of new product brands into the Nigerian market as a strategy to attract new customers has had breweries' struggling to meet product demands with the available capacity. In order to increase production output and satisfy customers, operational efficiency is a topmost priority. Production analysis reveals that the brewery is underutilizing her available production capacity due to high machine breakdown, external and planned downtimes coupled with huge amount of waste generation within the system. These led to a comprehensive analysis of production problems of line 1 for 13 weeks, with the application of Correlation Analysis, Pareto Analysis, quality Analysis and Toyota's problem solving framework. The result of correlation analysis of running time against production volume was 0.8, which is a positive trend and an indication of worthiness of production volume positive relationship with running time, hence the need to reduce downtime to increase running time. The result of Pareto Analysis shows that the External downtime was 46% of total downtime, while Empty Bottle Inspector (EBI) and Washer were 12% and 10% respectively. The Un-packer has the lowest downtime of 2%. In Quality Analysis, quality of raw material input affect machine operation and increase waste generation. In Filler, when bad crowner hooked at the rectifier, production automatically stopped, delay of 2 minutes will result in high reject of filled bottles to avoid foreign gas introduction to the beer. Stoppage at Filler and Labeler mostly affect production flow. 50% of total wastes were generated at the Filler and Washer while Labeler recorded high reworks and rejects.

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Keywords: Put Lean and quality Management; Variation and Waste Assessment; Supplier's Selection Criteria, Toyota Production System performance.

1. Introduction

The influx of different alcohol and non-alcoholic drinks into Nigerian market (largest in Africa with population of more than 150 million) has triggered different breweries to develop strategies to increase their products demands. Consequently, many have introduced different products at reduced prices to attract new customers. The challenge has been how to cope with the ever increasing demands of their different brands while meeting daily production targets with the limited production capacities. Investing in new production lines is capital intensive. Analysis of AB brewery has shown that the maximum number of production lines in each location is four with each location producing a minimum of six different product brands with their daily demand outstripping the available capacities. Existing production lines have recorded high waste generation (extract loss), high machine breakdowns at; Conveyors, EBI, Filler, Labeler, Packer, Pasteurizer, Un-packer and washer, and external downtimes (non-availability of bright beer, forklift delay, No pallet, power failure, weathered bottles) and planned downtime (changeover, cleaning, speed losses, startup). These losses and downtimes have led to underutilization of available capacities.

When total downtime was calculated, and correlation between production running time and production volume was obtained, it was found that there is a strong positive correlation between production running time and production volume, which indicates that reduction in downtime, will increase actual production time, which will eventually increase the production capacity (Shah, R., & Ward, P.T., 2003).

The industry has been practicing traditional method of problem identification and solving, with the maintenance team attending to problems without critically examining the root cause of such problems. Operators and maintenance team carry out cleaning, machine setup, and startup without considering the best approach to carry out such activities to enable them reduce operational time. The approach has failed because of recent competition caused by influx of different brewery industries in Nigeria with new products at reduced price. Application of lean approach and quality management strategy in operations time reduction, problem identification and solution has not been pursued.

The problem has not been solved because the managers are hesitant to adopt the lean approach in their production system due to limited knowledge of potential benefits. Abdullah and Rajgopal, (2003) stated that the applications of lean manufacturing in the continuous process sector has been far fewer because such industries are inherently more efficient and have a relatively less urgent need for major improvement activities. Managers have also been hesitant to adopt lean manufacturing tools and techniques to the continuous production because of characteristic large, inflexible machines, long setup times, and the general difficulty in producing in small batches (Suzanne and John, 2006). They forget that competition and price reduction can cause them to find a way to reduce those inherent problems in process industries.

The problems of high downtime, high operating cost, waste generation and reduction in production capacities have persisted because of the neglect of the lean approach; Pareto Analysis, Supplier Selection Criteria and Toyota problem solving framework in identifying the area of focus, root causes of problems and how to solve the problems.

2.0Methodology

The analytical and case study research design applied was based on weekly production volume, running time, machine breakdown, external and planned downtimes data obtained from Week 1 to Week 13 of production Line 1 of AB brewery in 2014 and other information collected through direct observation and interviews with production and maintenance personnel of the company. The data collected were analyzed using Correlation and Pareto Analysis to determine the area of focus, while Toyota's problem solving framework, Supplier Selection Criteria were used to analyze the method used to identify and solve root causes of identified problems.

2.1 Correlation Analysis.

The main objective of the companies is to increase production volume and meet customer's daily demands for different product brands in a timely manner, it is important to find out worthiness to consider the production volume based on running hours. To achieve that, the study determined the degree of correlation(r) between running time (min) and production volume (cartons). The production data and running time were obtained for 13 weeks to calculate the correlation of independent variable (running time) on dependent variable (production volume). Equation (1) and (2) represent the relationship between the running time and production volume.

$$\sum xy = a\sum x + b\sum x^2 \quad (1)$$

$$(\sum y) = Na + b\sum x \quad (2)$$

2.2Pareto Analysis

Tackling different problems associated with production lines ranging from machine breakdown, external and planned downtime will be cost intensive. Pareto analysis was applied to determine 20% of the problems that will be tackled to bring about 80% improvements rather than tackling the whole production problems. Various downtimes were collected for 13 weeks and grouped into External downtimes, Machine breakdown and planned downtimes from which Pareto analysis and graph were obtained.

The production volume loss can be calculated with equation (3).

$$WPVL = \frac{WPV * PRTL}{APRT} \quad (3)$$

Where WPVL=Weekly Prod. Volume Loss

WPV=Weekly Prod. Volume

PRTL=Production Running Time Loss

APRT=Actual Production Running Time.

*2.3***Toyota's problem solving framework**.

Gertner, (2007) stated that management theorists attribute Toyota's success to the so-called Toyota Way's that is, the firm's culture of efficiency and problem solving. Getner, (2007); Stewart and Raman (2007) adopted the approach to Toyota's problem solving framework, which involves first questioning the existence of variance, then detecting the variance, and then investigating the causes of this variance. This was applied wherever downtime occurred. The investigations assisted in setting target specifications that could result in standardization. Also, Cause and Effect Analysis were conducted to ascertain the causes of variance. These causes could be triggered by parts or products, people or personnel, procedures or methods, equipment or machines, or others (weather, noise, pollution, and poor quality material input by suppliers).

Supplier's Selection Criteria is about establishing a long term relation with supplier to ensure just in time delivery of high quality products because including suppliers in problem solving infuses external inputs in improvement initiatives, and the resulting learning is shared among organizations (Spear and Bowen, 1999; .Lander and Liker, 2007)

***2.4* Root Causes Analysis.**

The 5-Why method of root cause analysis requires you to question how the sequential causes of a failure event arose and identify the cause-effect failure path. 'Why' is asked to find each preceding trigger until we supposedly arrived at the root cause of the incident

3.0 Results and Discussions

3.1Correlation (r) Analysis

Production performances for 13 weeks were tabulated in table 1 to find correlation (r) between production running time (min) and production volume (Cartons) and the result was0.81. The strong positive correlation is an indication of the worthiness to consider production volume based on production running time. These can give the estimated running time (min) when production volume is given. These has proved the justification to reduce machine breakdown, external and planned downtimes to increase the production running time, which will have positive increase in production volume.

Table 1: Correlation analysis of production running time and production volume

Week	**Run Time RT(hr)**	**Run Time RT(min)**	**Prod. Volume PV(Cartons)**	**RT(x) (Min)*** 10^4	**Cartons PV(y)**			
	RT (hrs)	**RT(min)**	**PV**	**RT**	**PV**	y^2	x^2	xy
1	102	6,120	43,386	0.61	4.3	19	0.37	2.66
2	118	7,080	54,578	0.71	5.5	30	0.50	3.86
3	135	8,100	70,364	0.81	7.0	50	0.66	5.70
4	101	6,060	46,953	0.61	4.7	22	0.37	2.85
5	138	8,280	68,901	0.83	6.9	47	0.69	5.71
6	138	8,280	71,404	0.83	7.1	51	0.69	5.91
7	99	5,940	50,102	0.59	5.0	25	0.35	2.98
8	155	9,300	68,225	0.93	6.8	47	0.86	6.34
9	140	8,400	61,121	0.84	6.1	37	0.71	5.13
10	113	6,780	56,895	0.68	5.7	32	0.46	3.86
11	130	7,800	75,919	0.78	7.6	58	0.61	5.92
12	149	8,940	70,962	0.89	7.1	50	0.80	6.34
13	144	8,640	62,212	0.86	6.2	39	0.75	5.38
TOTAL			**801,022**	**9.97**	**80.10**	**506.70**	**7.81**	**62.63**

$$r = \frac{[N\sum xy - (\sum x)\times(\sum y)]}{\sqrt{N\sum x^2 - (\sum x)^2}\times\sqrt{N\sum y^2 - (\sum y)^2}} \qquad (4)$$

$$r = \frac{[13*62.63 - (9.97)\times(80.10)]}{\sqrt{13*7.81^1 - (9.97)^2}\times\sqrt{506.70^1 - (80.10)^2}} = 0.81$$

3.2Pareto Analysis.

Pareto Analysis of 13 Weeks of breakdown, external and planned downtime was collected and analyzed to find the area of focus, by which solving 20% of the problem, will give 80% improvement

Table 2: Weekly machine breakdown, external and planned downtimes

ISSUES	MACHINE	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9	WK10	WK11	WK12	WK13	Total Downtime
External	External	1710	365	885	2260	1270	655	790	845	975	2010	1245	1185	1063	15258
Breakdown	EBI	35	570	650	515	280	85	270	380	275	95	50	270	575	4050
Breakdown	Washer	**60**	175	280	720	30	65	90	280	170	420	410	305	275	3280
Breakdown	Filler	425	100	110	95	170	40	165	665	555	210	75	70	130	2810
Planned	Planned Downtime	360	125	210	90	210	730	150	60	130	120	145	60	325	2715
Breakdown	Labeler	0	65	0	0	200	15	210	85	150	120	240	125	15	1225
Breakdown	Packer	0	90	0	55	120	740	85	0	25	140	15	70	175	1515
Breakdown	Pasteurizer	0	120	0	110	110	0	0	80	0	0	105	105	305	935
Breakdown	Unpacker	0	205	0	100	84	40	40	40	0	0	0	125	80	714
Breakdown	Conveyor Breakdown	0	0	0	0	0	0	190	190	35	0	0	175		590
	Total Downtime	2590	1815	2135	3945	2474	2370	1990	2625	2315	3115	2285	2490	2943	33092
	Running Time	6120	7080	8100	6060	8280	8280	5940	9300	8400	6780	7800	8940	8640	
	Act. Prod. Time	3530	5265	5965	2115	5806	5910	3950	6675	6085	3665	5515	6450	5697	
	Production Capacity	43386	54578	70364	46953	68901	71404	50102	68225	61121	56895	75919	70962	62212	
	Production Loss	31833	18815	25185	87579	29359	28634	25241	26830	23253	48357	31455	27395	32138	

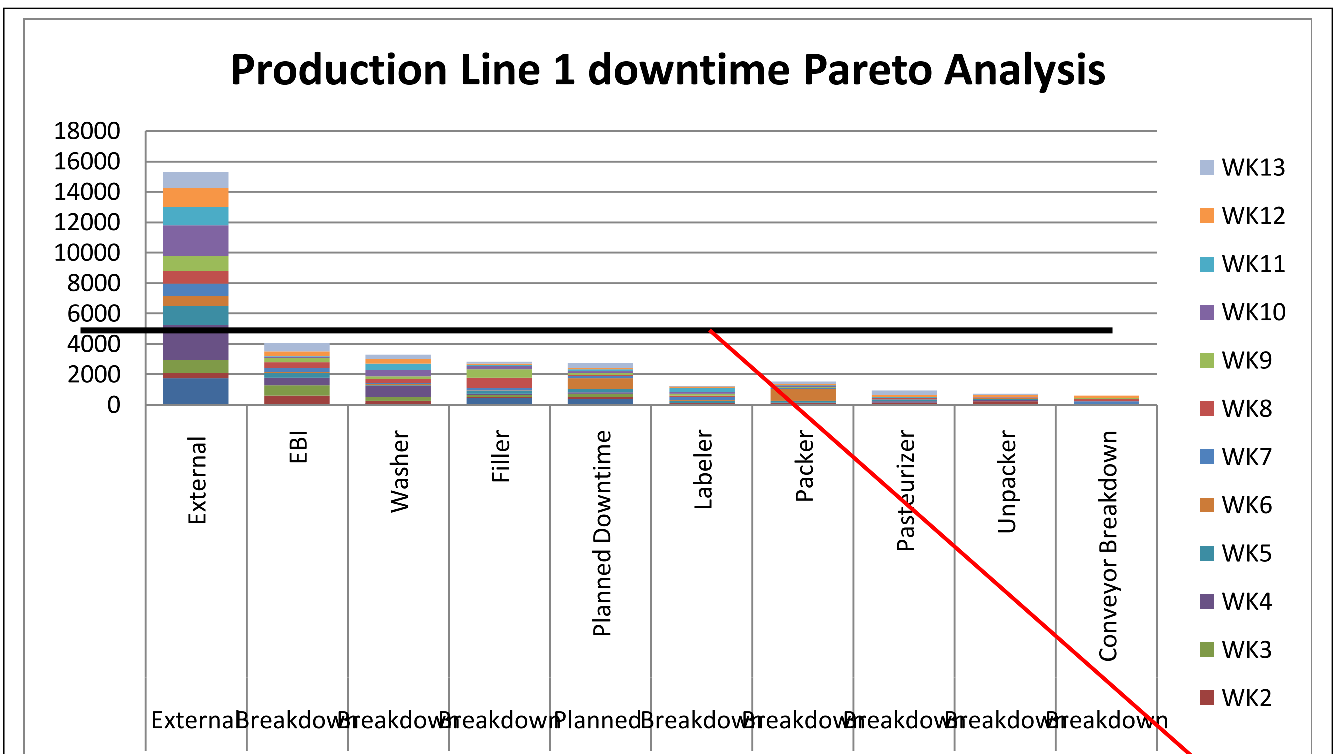

Figure 1: Pareto Analysis of production line 1 downtime

Figure 1 showed the graph of Pareto Analysis results, which was obtained from table 2. External Downtimes, EBI, Washer, Filler and Planned downtimes recorded about 73% of the total downtimes. Focusing on external, EBI, Washer and Filler according to Pareto Rule will bring the overall improvement on production flow efficiency, rather than tackling the entire problems, which will result in huge expenditure. Almost all the 13 weeks recorded high external downtimes. The downtime reduction target is represented with thick black line.

3.3Production Volume losses Analysis

Equation 3 was used to calculate the production volume loss and was represented in graphical form in figure 2. Looking at Figure 2, it was observed that the production loss was very high, amounting to an average of 33, 544 Cartons weekly. These losses were attributed to the high downtimes recorded on the External, Washer and Filler of Line 1. From the graph, it is important to tackle the problems head on to reduce production downtimes, which will increase the weekly average production.

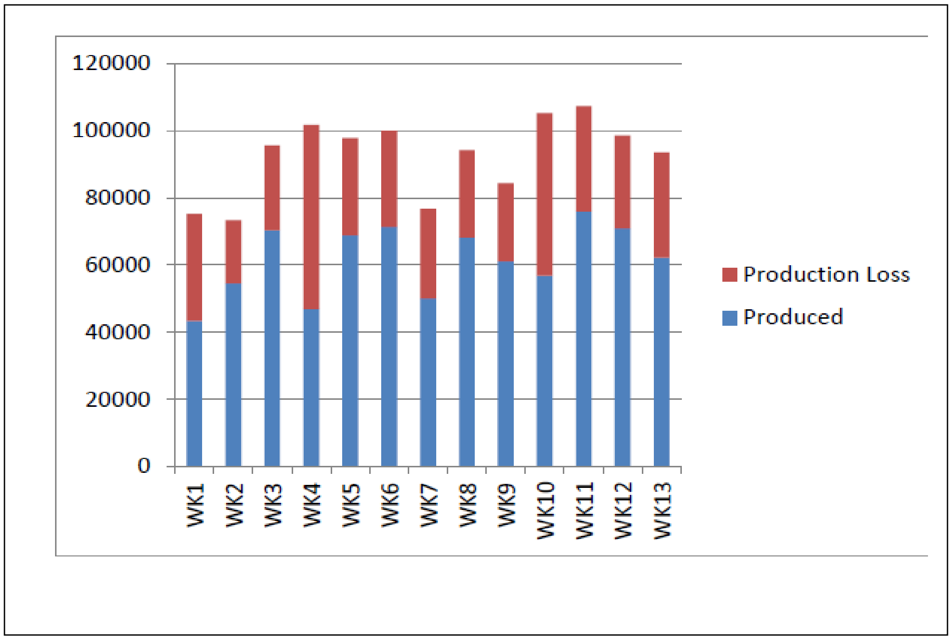

Figure 2: Weekly production volume and losses

3.4Toyota's problem solving framework

Toyota's Problem Solving Framework approach was applied to detect downtimes and its causes. These down times were triggered by: parts or products; people or personnel; procedures or methods; equipment or machines; and others (weather, noise, pollution, poor quality materials). The following results were obtained: 1.Over 80% of the external downtimes were caused by weathered bottle and bottle rejection at EBI. 2. 50% of stoppages occurred at Filler and Labeler. These frequent minor stoppages at Filler and Labeler were caused by poor raw materials input to Filler and other machines (deformed crown-cork, poor labeler and poor quality of laser jet ink).Again, the result shows that when downtime and minor stoppages occurred, the responses of operator determine the duration and waste generation. Filler generated highest quantities of wastes while Labeler and Washer had the highest number of reworks. In planned downtime, only the setup and startup had the highest downtimes. Single Minutes Exchange of Die (SMED) was applied to reduce time taken for setup and startup.

4.0Conclusion

The paper revealed the bottleneck and hidden problems of the production system and the applied methodology has reduced the downtime and increase the production running time which has direct relationship with production outputs. It has revealed the critical areas of focus when carrying out production system improvement rather than trying to solve all the existing production system problems. The paper will help brewery industries to increase the existing production capacity through downtime reduction as 80% of external downtime is caused by weathered bottle and power failure while poor raw material input to Filler, Labeler and Washer causes minor stoppages. Focus on these critical areas will improve the system performance and increase production outputs.

5.0Recommendation

It is recommended that the operators should undergo training on identification and problem solving skills. Also the supplier's should be audited from time to time to ensure supply of high quality raw materials. Continuous improvement team should be formed and trained to standardize and sustain the improvement made.

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