

ANDON AND LEAN MANUFACTURING: A CASE OF SONY SUGAR COMPANY, AWENDO, KENYA

Kunyororia Ogora Joseph

Author's email: kunyorijaj@gmail.com

ABSTRACT

This study investigates the effect of andon as a lean manufacturing practice on organizations performance, a Case of Sony Sugar Company, Awendo, Kenya. The study objective was to establish the effect of technology adoption on organizational performance in Sony Sugar Company, Awendo, Kenya. The target population was 371 with a sample size of 79, the researcher adopted correlation research design and questionnaires to collect data. Results show No andon system as the indicator directly connected to organizational performance with a mean of 3.37 and Std.Dev of 1.260, while Full andon system with a mean of 3.35 and Std.Dev of 1.473 and Partial andon system had a mean of 3.28 and Std.Dev of 1.398. Finding shows a high level of correlation between andon and organizational performance. Therefore, in conclusion chapter, andon system makes the condition of manufacturing process readily and easily visible to employees. With the application of the andon system, it brings immediate attention to problems as they occur in the process and it ensures that processes are being carried out efficiently and productively and this results to a realization of organizational performance.

KEYWORDS– Andon, lean manufacturing, organizational performance

1. INTRODUCTION

Background of the Study:

Faced with ever-increasing challenges such as the globalization of the market- place, increased competition and increased customer expectations, organizations are pursuing strategies to improve overall performance and competitiveness in the global market. A variety of improvement methodologies and approaches are available to organizations, many of which have yielded encouraging implementation successes. Liker (2004) has stated that andon is a term for a visual control system using an electric light board (or other signal device) hung in a factory, so that worker can call for help and stop the line. In a study on quantitative analysis of a transfer production line with andon (Jingshan Li & Dennis E. Blumenfeld, 2006), andon originates from Toyota Production System and has been used in many Japanese and American manufacturing plants as an effective approach to improve product quality. The idea of andon is that worker can pull the so-called andon cord, triggering the light and/or music as a call for help and stopping the line when a defect is discovered. It has been claimed that, although productivity is lost due to line stoppages, the overall system performance improves (Liker, 2004). With the onset of Lean manufacturing, the focus of productivity shifted from the individual to teams or modules (Abernathy et al. 1999), and from total output to the continuous flow of high quality, in-demand styles. The piece-rate often traced a similar path, moving from an individual to a “group-based piece rate” or “group rate” (Bloom and Reenen 2011, Helper et al. 2010). Research has shown that group-rate systems can raise productivity in team-based workplaces (Bloom and Reenen 2011, Boning et al. 2007). WOMACK, J.P. & JONES, D.T. (1996) *Lean Thinking: Banish Waste and Create Wealth in Your Corporation* (New York, Simon & Schuster). Striving to eliminate product

defects in the manufacturing process, many vehicle manufacturing companies look to implement Andon system (Li & Blumenfeld, 2006). The purpose of Andon is to detect defects as they appear, find the root cause of the defect, fix the defect and to make things right the first time by stopping production as defects are detected (Li & Blumenfeld, 2006). According to Monden (1994), this is the most effective and cost saving techniques to handle product defects in the manufacturing process as undetected defects requires disassembly and rework which takes longer time and has a higher cost. Andon is one of the visual control tools in Lean, usually displayed as different colored alarm lights. These are used to indicate problems or shortages of material in production.

Statement of the problem

The word Andon means paper lantern in Japanese and is a system which provides visual feedback to the plant floor (Zidel, 2006). Typically, the Andon system indicates the line status and shows when assistance is needed. The Andon system empowers operators to stop the production process if any quality issue arises and assistance is needed (Lean Manufacturing Andon, 2015).). In the financial year ended 30th June 2015 Sony Sugar Company registered pretax loss of KShs. 1,154 million up from KShs. 529 million of the previous year Gross sales of the year was KShs. 4.5 billion compared to 5.3 billion achieved in the previous year. All these were as a result of operating below capacity (Auditor General Report, 2014/2015). Sugar production cost in Kenya is higher than those in other producing countries in East Africa and COMESA member states. The Kenya Sugar Industry Strategic plan (2010-2014) puts the cost of producing sugar in Kenya at 415-500 USD/ tonne while that of Uganda 180-190 USD/ tonne and Tanzania at 140-180 USD/ tonne. This is due to but not limited to: use of outdated technology, organizational culture, improper waste elimination process and use of employees physically and not intellectually.

Objective of the Study:

This study was guided by the following objective:

To determine the effect of andon on organizational performance in Sony Sugar Company, Awendo, Kenya.

Research Hypotheses:

Ho There is no significant relationship between Andon and organizational performance in Sony Sugar Company, Awendo, Kenya.

2. LITERATURE REVIEW

Resource Based View Theory:

This study was modeled on resource-based view theory advanced by Penrose (1959). In the resource-based view theory, firm's performance is affected by firm-specific resources and capabilities. In view of RBV theory, andon and lean manufacturing are taken as a strategic decision which can be used to fill gaps in the firm's resource and capabilities. This implies that, the adoption of andon will result to firms' ability to utilize resources and capability to ring shortened time between customer order and the product build/shipment by eliminating sources of waste hence resulting to increasing firms' competitive edge.

Theory of Constraints:

This study was also be guided by theory of constraints developed by Eliyahu (1984).In the theory of constrains any element or factor that limits the system from doing more of what it was designed to accomplish (i.e., achieving its goal) is a constraint. In view of theory of Constraints, organizational performance is directly uplifted with the blending of andon and lean manufacturing as catalyst of elimination of constraints with a view of ensuring systems do more of what they are designed to accomplish. This implies that to initiate and implement breakthrough improvement through focusing on a constraint that prevented a system from achieving a higher level of performance directly requires lean manufacturing practices hence increasing firms’ competitive edge.

Andon and Organizational Performance

Inman et al. (2003) have recognized the study of Andon systems as an important research opportunity to address the tradeoffs between quality and throughput. There are three types of transfer lines: no Andon, full Andon; and partial Andon systems. A line with no Andon is also known as a paced line, where a job is passed to the next machine at the end of the cycle no matter whether it is complete (with good quality) or incomplete (with defects). In a full Andon system, for every defect that cannot be fixed within the cycle, the line is stopped to allow additional time to fix the problem and partial Andon is only applied in signaling the problem without stopping the line every time, or the workers are encouraged to reduce the number of line stoppages, Jingshan & Dennis (2006).

It has been reported in Mayne et al. (2001), Strozniak (2001), Liker (2004) and Tierney (2004) that every assembly line worker at Toyota is empowered to stop the line by pulling the Andon cord when they see defects or problems, in order to correct them. A production line at Toyota may stop hundreds of times during each shift. As addressed by Liker (2004), implementing Andon is one of the approaches used to “build a culture of stopping to fix problems, to get quality right the first time”, and to “use visual control so no problems are hidden”.

Conceptual Framework of andon and organizational performance

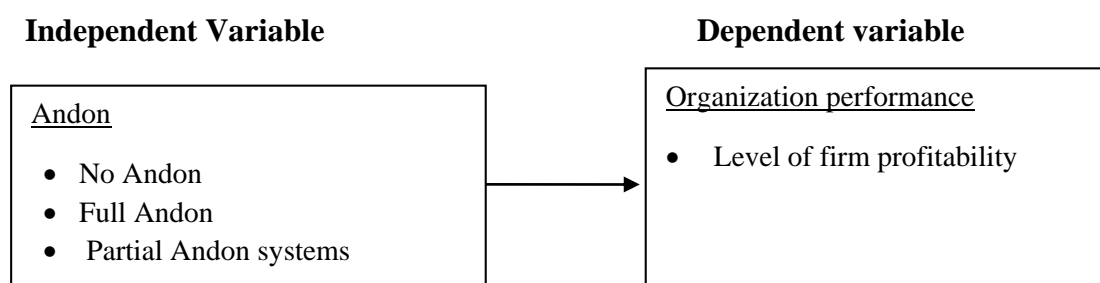


Figure 1: Conceptual framework on effect of Andon and lean manufacturing: A case of SONY Sugar Company, Awendo, Kenya
 (Source: researchers own concept)

The Independent variables Andon whose indicators are no andon, full andon and partial andon and if enhanced it will contribute to organizational performance. The dependent variable for this study is organizational performance whose indicator is level of firm profitability.

3. RESEARCH METHODOLOGY

The researcher used descriptive research design method in carrying out his study. The study targeted HoDs, Divisional HoDs and Supervisors of Sony Sugar Company in nine departments namely Manufacturing Department, Agricultural Department, Human Resource Department, Finance and Accounting Department, General Administration Department, Procurement Department, Company secretary Department, Sales and marketing Department and ICT Department.

Sample Size

This study adopted the formula proposed Nassiuma (2000) for determining sample size, to arrive at 79 out of 371 employees of Sony Sugar Company.

$$n = \frac{NC^2}{C^2 + (N - 1)e^2}$$

Where,

n = Sample

N = Population

C = Coefficient of variation

e = Standard error

Nassiuma (2000) recommends a margin error ranging between 2% - 5% and coefficient of variation ranging between 20% - 30%. For this study N = 371 respondents, C = 20% and e = 0.02 as illustrated below:

$$79 = \frac{371 \times 0.2^2}{0.2^2 + (371 - 1)0.02^2}$$

The choice of C=0.2 was informed by the fact that coefficient of variation indicates how scattered about the mean of a given set of data is. The sample for the various departments was identified through stratified random sampling. In all the categories, the sample selected was proportionate for each department as shown in Table 1.

Sampling procedure

The sample size table was arrived using statistical formulae and it consisted of 79 employees selected from Sony Sugar Company, Awendo, Kenya, 79 was therefore be a representative for a population of 371 as show in table 1.

Table 1: Sample size

Department	Population	Sample Size	Percentage
Manufacturing	62	13	16%
Agricultural	124	27	34%
Human Resource	67	14	18%
Finance and accounting	38	8	10%

General Administration Department	30	6	7%
Procurement Department	21	4	5%
Company secretariat	7	2	3%
Sales and marketing	9	2	3%
ICT	13	3	4%
Total	371	79	100%

Research Instrument

The data collection instruments were questionnaires for HoDs, Divisional HoDs and Supervisors.

Questionnaire

The data collection instruments were questionnaire to collect data from 79 employees of Sony Sugar Company, Awendo, Kenya. This study used closed questions which is one where responses are restricted to small set of responses that generate precise answers to develop the empirical study. In designing the questionnaire, a five point liker-type scale was used in order to provide the extent of the respondents feelings or opinions on the effect of lean manufacturing variables under consideration on organizational performance where by a scale of one implies strong disagreement with an issue or statement while a scale of five implies a strong agreement in that order (Patton, 2002).

Reliability and Validity Tests

Reliability gauges the level to which a measure provides consistent results. It is concerned with the internal property of a measure (Cooper & Schindler, 2006). The Cronbach's alpha test of reliability recommended by Burns and Bush (2010) was used to find out how reliable the research instrument was. It shows the degree to which research instrument items are homogeneous and measure the same underlying construct (Cooper & Schindler, 2006). Values that are close to 1 suggest a high level of consistency. Gliem and Gliem (2003) note that the alpha value that is greater or equal to 0.7 is sufficient. The 23 items in the research instrument were tested using the Cronbach's alpha test and an alpha value of 0.998 was found. This meant that the instrument on andon culture and organizational performance was very reliable.

Validity of a survey instrument is measured by assessing whether it measures what it was intended to measure. Dillman (2000) suggested that a pilot study should be conducted to ensure clarity and proper interpretation of the questionnaire by the respondents. A pilot survey was done by exposing selected members of the population to the questionnaire. Their feedback was used to improve the questionnaire to be used in the survey.

Data analysis

The quantitative data was analyzed through descriptive statistics and inferential analysis by use of statistical package for social sciences (SPSS) version 21 software. Data analyzed descriptively was presented in tables because they gave a systematic record of analysis. Both Correlation and Multiple Regression analysis was used to test the relationship between the independent variables and the dependent variables.

Regression model: the equation was expressed as follows:

$$Y = \beta_0 + \beta_1 X_1 + \epsilon$$

Y–Organizational performance,

ϵ -is the Model error variable

β_0 – is a constant term of independent variables, $\beta_1 X_1$,

X_1 -elimination of waste,

Study Findings:

Table 2: Andon and organizational performance

Statement for respondent	SD	D	N	A	SA	Mean	Std.Dev
No andon system makes the condition of manufacturing process readily and easily visible to employees	7(10.8%)	9(13.8%)	16(24.6%)	19(29.2%)	14(21.5%)	3.37	1.269
Full andon system brings immediate attention to problems as they occur in the process	9(13.8%)	15(23.1%)	5(7.7%)	16(24.6%)	20(30.8%)	3.35	1.473
Partial andon system ensures that processes are being carried out efficiently and productively	11(16.9%)	8(12.3%)	13(20.0%)	18(27.7%)	15(23.1%)	3.28	1.398

Three statements were developed to measure the extent of effect of lean manufacturing on organizational performance as shown in table 2. The statements were, no andon system makes the condition of manufacturing process readily and easily visible to employees, full andon system brings immediate attention to problems as they occur in the process, partial andon system ensures that processes are being carried out efficiently and productively.

Statement (1) no andon system makes the condition of manufacturing process readily and easily visible to employees had a mean of 3.37 and a standard deviation of 1.269. This results indicate that majority 19(29.2%) of respondents agreed that) no andon system makes the condition of manufacturing process readily and easily visible to employees, this was followed by 14(21.5%) who strongly agreed and the mean was lowest at 7(10.8%) who strongly disagreed. Statement (2) Full andon system brings immediate attention to problems as they occur in the process had a mean of 3.35 and a standard deviation of 1.473.

This results indicate that majority 20(30.8%) of respondents strongly agreed full andon system brings immediate attention to problems as they occur in the process, this was followed by a score of 16(24.6%) who agreed and the score was lowest at 5(7.7%) who were neutral. (3) Partial andon system ensures that processes are being carried out efficiently and productively had a mean of 3.28 and a standard deviation of 1.398. This results indicate that majority 18(27.7%) of respondents agreed Partial andon system ensures that processes are being carried out efficiently and productively, this was followed by a score of 15(23.1%) who strongly agreed and the score was lowest at 4(6.2%) who strongly disagreed.

This result indicate that 19(29.2%) of the respondents agreed that No andon system makes the condition of manufacturing process readily and easily visible to employees, this was followed by statement 2(Full andon system brings immediate attention to problems as they occur in the process) with a score of 3.35 and the standard deviation was 1.473. This result indicate that the majority 20(30.8%) of the respondents strongly agreed that Full andon system brings immediate attention to problems as they occur in the process. Statement 3 sought the opinion of the respondents whether (Partial andon system ensures that processes are being carried out efficiently and

productively), the score was lowest at 3.25 with a standard deviation 1.398, this implies that majority 18(27.7%) of the respondents agreed that (Partial andon system ensures that processes are being carried out efficiently and productively). Variability among the Board of management was higher ($\sigma= 1.473$) on statement 2, and lower ($\sigma= 1.269$) for statement 1.

Liker (2004), implementing Andon is one of the approaches used to “build a culture of stopping to fix problems, to get quality right the first time”, and to “use visual control so no problems are hidden”. As such, the andon production system may be an appropriate precursor to effective detection of problems in the production line. Further andon production system may serve to make manufacturing process readily and easily visible to employee, however, Inman et al. (2003) have recognized the study of Andon systems as an important research opportunity to address the tradeoffs between quality and throughput.

Hypothesis Testing Results

One hypotheses was formulated to test the effect of andon as a lean manufacturing practice on organizational performance a case of Sony Sugar Company Awendo Kenya. The multiple regressions model was used to test the hypotheses by assuming that regression coefficients attributed to the identified lean manufacturing not zero and therefore a function of the form $Y = \beta_0 + \beta_1 X_1 + \epsilon$ could be used to model the relationship between lean manufacturing and organizational performance profitability and cost of extension services.

An examination of correlations revealed that there were significant correlations among the various andon indicators and organizational performance (Table 3). This clearly paved way for use of regression to establish causation.

Table 3: Correlation Analysis – Lean manufacturing indicators and organizational performance

	Andon	Organizational performance
Andon	1	
Organizational performance	.967	1

Source (Researcher 2018)

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4: Model summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.991 ^a	.980	.209	1.921

a. Predictors: (Constant), Andon

b. Dependent Variable: Organizational performance

From table 4, R value was 0.991 showing a positive direction of R is the correlation between the observed and predicted values of the dependent variable. The values of R range from -1 to 1 (Saunders et al, 2012). The sign of R indicates the direction of the relationship (positive or negative). The absolute value of R indicates the strength, with larger absolute values indicating stronger relationships. Thus the R value at 0.991 shows a stronger relationship between observed and predicted values in a positive direction.

The coefficient of determination R^2 value was 0.98. This shows that 98 % of the variance in dependent variable (organizational performance) was explained and predicted by independent variables (elimination of waste, intellectual knowledge, andon, technology adoption and organizational culture as the moderation variable).

Table 5: ANOVA

ANOVA ^b						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	113.741	5	22.748	20.733	0.000 ^a
	Residual	0.647	59	0.011		
	Total	114.388	64			

a. Predictors: (Constant), Andon

b. Dependent Variable: Organizational performance

The ANOVA in table 5 illustrates whether the model can predict organizational performance using the independent variables. The F statistic (F=20.733) was significant at a 95% confidence level (Sig. F < 0.05). This means that the model has predictive power. There exists a statistically significant relationship between elimination of waste, intellectual knowledge, andon, technology adoption and organizational culture as the moderation variable and organizational performance.

Table 6: Regression Coefficient

Model	Coefficients ^a				Sig.
	Unstandardized Coefficients		Standardized	t	
	B	Std. Error	Beta		
(Constant)	4.924	0.724	1.572	3.537	0.020
Andon	0.761	0.761	0.768	4.168	0.006
Organizational culture	0.612	0.138	0.672	4.919	0.037

Table 6 gives the results for the regression coefficient for the multiple linear equation. $Y = \beta_0 + \beta_1 X_1 + \epsilon$ which by supplying the coefficients becomes:

$$Y = 4.924 + 0.761X_1$$

Where:

Y = Organization performance

The t-value of constant produced (t = 4.537) was significant at 95 per cent level (Sig. F < 0.05), thus confirming the fitness of the model. Therefore, there is statistically significant relationship between andon and organizational performance.

Ho There is no significant relationship between Andon and organizational performance in Sony Sugar Company, Awendo, Kenya.

Hypothesis postulated a lack of significant effect of andon on organizational performance. Results of the regression analysis reported in Table 4.15 show that andon was positive and significant predictor of organizational performance ($\beta = 0.768, p < 0.05$). Consequently, an application of and

is likely to lead to increase in organizational performance. The hypothesis that null hypothesis was rejected

The correlation output table 4.15 shows that all the andon characteristics were statistically significant (P-values under significant 2-tailed were all less than $\alpha=0.05$) against the three indicators of organizational performance, (no andon, full andon and partial andon) similarly there was relatively high degree of positive correlation exhibited between the various bivariate variables implying that the more the Sony Sugar employ andon practices the more the organizational performance was realized and were operational in production of high quality products through utilization of inputs at least cost and within the stipulated time. The small p-values under significant (2-tailed) indicated in Table 4.15 were all less than the threshold $\alpha=0.05$, implying that there is a significant relationship among the variables leading to rejection of the null hypothesis (Ho3 There is no significant relationship between Andon and organizational performance in Sony Sugar Company, Awendo, Kenya) and acceptance of the alternative hypothesis, and hence the research findings conclude that there is a significant relationship between andon and organizational. This is in agreement with Liker (2004), implementing Andon is one of the approaches used to “build a culture of stopping to fix problems, to get quality right the first time”, and to “use visual control so no problems are hidden”.

This finding concur with deduction of Li & Blumenfeld, (2006) who observed that purpose of Andon is to detect defects as they appear, find the root cause of the defect, fix the defect and to make things right the first time by stopping production as defects are detected. The more the organization adopts andon to utilize inputs, they result to production of defect free goods and cost saving practice. Additionally, Raturi and Evans (2005), explains the possibilities of lower production cost which in its turn could create lower selling prices to the customer by decreasing product defects in the manufacturing process. Moreover, Subramaniam et al. (2009) shows how andon display data can be used to improved production performance.

4. SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summatively statement 1 (No andon system makes the condition of manufacturing process readily and easily visible to employees) had the highest mean (3.37) and standard deviation (1.269). The results indicate that 19.2% of the respondents agreed that No andon system makes the condition of manufacturing process readily and easily visible to employees. In hypothesis testing, Ho3 There is no significant relationship between Andon and organizational performance in Sony Sugar Company, Awendo, Kenya was accepted. This meant that there is no significant relationship between Andon and organizational performance in Sony Sugar Company, Awendo, Kenya. It was concluded that the strength of the relationship between intellectual knowledge and organizational performance depend on lean manufacturing (t-value of 4.168 and p-value of 0.006).

Conclusions and Recommendations:

Andon as a lean manufacturing indicator has a positive and significant effect on organizational performance. The andon system makes the condition of manufacturing process readily and easily visible to employees. With the application of the andon system, it brings immediate attention to problems as they occur in the process and it ensures that processes are being carried out efficiently and productively and this results to a realization of organizational performance.

Andon involves all aspects of immediate attention to problems as they occur in the production line, including re to alert operators and managers about current problems in manufacturing with capability of impacting positively on organizational performance. This study established that andon statistically and significantly influences the performance of organizations; $p < 0.05$ ($P=006$) with an explanatory power of mean 3.37 and standard deviation. It is therefore recommended in

this study that manufacturing firms should impress andon systems such no adon system, full andon system and partial andon system ensuring production of defect free products resulting managing their cost of production and creation of customer loyalty.

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