Maintenance Cost Threshold and Return on Investment in Nigerian Cement Manufacturing Industry

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Abstract

The study examined maintenance cost threshold and return on investment of manufacturing firms. It focused on the impact of direct maintenance cost on return on investment of firms in the Nigerian cement manufacturing industry. The study employed a simple linear auto regression approach to assess the predictor and response variables of the study and adopted ex-post facto research design in its investigation. Longitudinal data of 15 years (2005-2019) observations were obtained from listed cement manufacturing firms in the Nigerian Stock Exchange (NSE) and analyzed with ordinary least squares regression (system-OLS). The results of the study showed Coefficient value of 11.10 that is >0, Prob.-value of 0 that is < 0.05 and t-Statistic value of 6.11 that is absolutely ≥ 2. The analysis results indicated that maintenance has significant positive effect on return on investment. Based on these results, the study suggested that maintenance is cost-profit centre and recommends among others for top management support and commitment to the use of appropriate maintenance strategies over a given machine condition at the right time, with the right parts and right maintenance personnel as the key drivers of cost effective maintenance.

Keywords:
Maintenance Cost (MC), Return on Investment (ROI), Cost Centre, Profit Centre, Cost-Profit Centre.

1. Introduction

In the new industrial age, modern industrial societies rely on capital intensive technology to produce goods and services to meet customers' needs. The nature of capital investment on heavy duty equipment by manufacturing firms emphasizes the need for organizational development of maintenance culture over production machines and equipment to be able to synergize. To meet the challenges of World Class Manufacturing Performance (WCMP) in today's global economy, every manufacturing firm is required to have cost effective and continuous improvement maintenance. Manufacturing firms that do not adequately maintain their production facilities cannot operate at installed production capacity and will stand at a disadvantage in a market that requires availability of high quality products at low cost and on-time delivery.

In a market based economy, a key driver of manufacturing performance is functional production machines and equipment, which play vital role for business success and when these machines fail to perform due to downtime, heavy losses are incurred. The physical condition of production facilities determines the extent at which installed production capacity, production cost advantage, product quality, on-time delivery, flexibility in manufacturing operations and quality of customer service are achieved. Fore & Zuze (2010) assert that maintenance is the key to optimization of overall equipment effectiveness. Poor maintenance culture affects process continuity of manufacturing operations and organizational corporate performance (Schuman & Brent, 2005).

With the increasing technological developments in industrial plants and integrated manufacturing systems, many manufacturing firms across the globe now adopt the use of modern manufacturing techniques such as just-in-time, lean system, agile manufacturing, total quality management in creating value for customers and in achieving corporate performance. Due to the new developments in production and manufacturing operations, industrial and process manufacturing, many industrialists and the organizations' management in today's manufacturing is focusing on maintenance cost threshold towards improving equipment effectiveness, machine availability, plant reliability, overall plant productivity and performance efficiency for competitive priorities on the basis of cost, product quality, productivity target, on-time delivery and flexible manufacturing.

In the move towards world class manufacturing, the dynamic relationship between maintenance cost threshold and return on investment profitability index of manufacturing organizations across different industries in the developed and emerging economies is gaining unprecedented attention. Automation in today's manufacturing requires maintenance cost threshold aimed at achieving competitive priorities and organizational goals while creating value for the customers. In the current era of competitive manufacturing, manufacturing firms are faced with the challenges of optimizing their production systems at low cost to remain highly competitive. Maintenance cost threshold is a key factor in addressing this challenge. Campbell & Jardine (2001) note that maintenance cost is one of the manufacturing key performance indicators while Dimitris, Christos, Andy & Joseph (2010) opine that in capital-intensive manufacturing, maintenance cost and production downtime are key areas that affect manufacturing performance.

This research adopts a simple linear auto regression approach, using fifteen (15) year data sets to assess the pattern of dynamic correlation that exist between maintenance cost threshold and return on investment profitability index of listed Nigerian cement manufacturing firms in the Nigerian Stock Exchange (NSE).

This study is in five sections. Section one of the study is the introduction. Section two focuses on review of related literature. Section three presents the methodology and model specification of the study. Section four shows the data description and empirical results of the variables in the linear auto regression model while section five is conclusion, recommendations and contributions to knowledge.

2. Review of Related Literature

The literature for this present study covers theoretical and empirical studies, which has gained wide debate across the globe. Kris (2008) observes that some studies lent support that maintenance of manufacturing facilities is "cost centre" and "necessary evil". Maletic, Matjaz & Gomiscek (2013) in their study note that within the manufacturing industry, maintenance is often regarded as a cost driving necessity rather than a competitive resource. These researchers express that in today highly competitive manufacturing environment, cost effective maintenance is critical and essentially a service function that is profit centre. Maintenance cost varies considerably across industries and manufacturing firms in the same industry.

Maintenance cost is an aspect of manufacturing key performance indicators (Campbell & Jardine, 2001). It is the costs incurred to keep an item in good condition and or good working order; it is the monetary inputs for restoring a failed or breakdown system (Szumbah & Richard, 2014). Asaria, Griffin & Cookson (2016) see maintenance cost from the perspective of economic analysis that compares the relative costs of maintenance and outcomes of different courses of maintenance action.

Studies by Kris (2008) & Maletic et al (2013) classify maintenance cost into direct and indirect cost. The direct cost of maintenance is the exclusive cost of keeping a system continue to function or for restoring a failed system to its operational state (Kris, 2008). Maletic et al. (2013) refer to direct maintenance cost as cost directly related to maintenance decisions such as costs of inspecting, oiling and lubrication, spare parts, labour, maintenance education and training cost and other costs related to maintenance activities. These authors also describe indirect maintenance cost as the aftermath results of ineffective maintenance, the invisible cost of maintenance actions, the implied cost of poor maintenance function, resultant cost, burden cost and opportunity cost of poor maintenance activities such as machine or equipment depreciation, production loss, poor product quality, late delivery time, poor customer satisfaction, loss of customers and markets, loss of market share, revenue and profit.

Tsang (2002) observes that today manufacturing organizations are under pressure to enhance continuously their capabilities to create values on the basis of choice, cost, product, quality, safety and on-time delivery and also to improve the cost effectiveness of their operations. In another related study, Kumar, Soni, & Geeta (2013) point out that maintenance of large-investment equipment which was once thought to be "necessary evil" is now considered key to improving cost effectiveness of an organization, creating additional value by delivering more innovative services to customers.

Production facilities maintenance is not only about ensuring proper function of machines but also plays a key role in achieving company's goals and objectives by improving productivity and profitability. Heinz & Fred (2006) posit that in many manufacturing organizations, middle and corporate level management see maintenance as 'necessary evil'. Alsyouf (2007) observes that not until recently, most organizations' executives or stakeholders had blurred perception about maintenance towards attaining organizational goals and objectives. To them, maintenance function is a less important activity that only cost money rather than generating profit. The change from a labour-intensive to technology-intensive manufacturing and the intense competition in the business environment has set a platform for manufacturing companies to continue to maintain their production assets to remain competitive (Al-Najjar, 2007).

Effective maintenance extends equipment life, improves equipment availability, equipment reliability, equipment capacity utilization, retains equipment in proper condition and contributes to a firm's corporate performance (Swanson, 2001). Kutucuoglu, Hamali, Iran & Sharp (2001), Pinjala, Pintelon & Vereecke (2006) aver that effective integration of maintenance function into corporate business objectives contributes to return on investment. Study by Al-Najjar (2007) confirms that a manufacturing firm's internal effectiveness is strongly influenced by the maintenance role and impact. Alsyouf (2007), Maletic, Matjaz, Al-Najjar & Gomiscek (2014) hold that effective maintenance influences the productivity and profitability of a manufacturing process and it offers manufacturing firms significant potential of improving efficiency, productivity and profitability.

Manufacturing companies can turn maintenance into profit centre through overall equipment effectiveness, which defines the percentage of time that machine is available for production, rate of performance efficiency and rate of product quality. In this context, high rate of overall equipment effectiveness means high production machine capacity, which in turn means high output leading to increased sales capacity.

Maletic, Matjaz & Gomiscek (2012) in their studies, emphasize the role of maintenance in improving performance and profitability of manufacturing processes. Komonen (2002) posits that effective maintenance is associated with low maintenance cost. This however suggests that effective maintenance is profit centre. Thus, a good maintenance policy aims at cost effective maintenance for overall equipment effectiveness, production cost effectiveness, high return on investment and competitiveness in a firm's manufacturing operations.

Appropriate maintenance policy has cost advantage (Liptrot & Palarchio, 2000). Different maintenance strategies such as predictive, preventive and reactive and continuous improvement maintenance have different cost elements. The net results of reactive type of maintenance are higher maintenance cost, lower availability of process machinery and other associated cost such as lost production, lost sales and lost revenue (Campbell & Jardine, 2001; Sharma, Kumar & Kumar, 2005). Blischke & Murthy (2003) contend that it is more costly to carry out maintenance on a failed system than to prevent the system from failing.

Maintenance is an integral part of production, a core support function to manufacturing and an element of manufacturing business strategy that ensures smooth running of production at operational cost leadership advantage and competitiveness in manufacturing. Capital-intensive manufacturing firms achieve world class maintenance via strategic approach to maintenance management that is essential in minimizing maintenance's negative potentials. Improvement in maintenance aims at reducing operating costs and improving product quality and the cost effectiveness of improvement action could be examined by assessing the relevant cost parameters before and after improvement.

Empirical studies on the subject conducted at different environment over the years have showed different results. Alsyouf (2004) conducted a study on "Cost effectiveness maintenance for competitive advantage". The study was carried out in Sweden with reference to Swedish industries. Descriptive survey research was adopted for the study. The study highlighted maintenance practices and policies adopted by firms in the different industries in Sweden and their influence on the operational and financial performance of the industries. The finding of the study indicated that 70% of Swedish manufacturing companies still consider maintenance as cost centre, cost driving necessity, non-profit generating function, non-value adding function in production and manufacturing and 'necessary evil' that only add to the cost of manufacturing business operations rather than increasing profit.

Alsyouf (2009) carried out a study in Sweden on "Maintenance practice in Swedish industries: Survey results". The study was performed by conducting a cross sectional survey within Swedish firms that have at least one hundred (100) employees. One of the results gotten from the study showed that greater percentage of Swedish manufacturing firms had poor maintenance culture and they had traditional view of maintenance function as cost driving necessity, which affected their profit maximization objective function. The finding of Alsyouf (2009) revealed significant negative relationship between maintenance cost allocation and operating profit.

Andre, Luiz, Luiz & Guilherme (2011) examined "Operational practices and financial performance: An empirical analysis of Brazilian manufacturing companies". A descriptive survey research design was adopted for the study. A total number of fourteen industries that were into manufacturing of different products were studied. The study's regression model used the dependent variable profitability to determine how much of the variation of the profit variable could explained the firm's production variables. The result of the model analysis indicated that maintenance service outsourcing had negative effect on profitability and revenue growth rate by 6.7% profit variation. The negative coefficient (-0125) showed that maintenance service outsourcing was costly and was associated with negative and weak revenue growth rate and profitability.

Bartz & Julio (2011) carried out a study in Brazil on the "Evaluation of maintenance performance in a metalworking company: A case study and proposal of new indicators". The work was a descriptive case study of a metal working company for a sixteen (16) years period (1995-2009). Data on maintenance indicators and manufacturing performance for the period studied were analyzed to appraise the relationship between maintenance cost and revenue growth level. The finding of the study provided that cost of maintenance had significant inverse relationship with the firm's revenue growth level. From the empirical analysis, the study indicated that the cost of maintenance to revenue growth level was 4.26% in 1995, 4.39% in 1997, 3.56% in 1999, 4.47 in 2001, 4.27% in 2003, 4.10% in 2005, 3.89% in 2007 and 4.14% in 2009. This result suggested that high cost of maintenance had negative effect on the firm's net operating profit.

Donca (2011) examined the "Impact of maintenance on profitability in a food package company in Romania". In determining the level of relationship between maintenance cost and return on capital, a simulation model was designed and data collected from the simulation was calculated and statistically compared by the analysis of variance technique. The result of the analysis revealed that changes in maintenance cost impacted on profit and return on capital. The study also highlighted that maintenance policy was a strong intervening factor, which mediated on the relationship between maintenance cost and profit.

Maletic et al. (2014) investigated "The role of maintenance in improving company's competitiveness and profitability: A case study of a textile company". In establishing the relationship between maintenance cost and profitability, a descriptive case study research design was adopted, where a textile company in Slovenia was studied. The result of the investigation revealed that 3% of additional profit could be generated from the firm's weaving machines if all unplanned stoppages and loss of product quality due to poor maintenance of machines could be prevented.

Szumbah & Richard (2014) carried out an empirical investigation on the "Assessment of relationship between plant and equipment maintenance strategies and factory performance of Kenya sugar firms" The relationship between cost effective maintenance and manufacturing performance at Likert-scale weighted average score of 3.47 showed that high maintenance cost had significant negative correlation with economic operations and return on investment.

Significant linear relationship existed between maintenance cost and manufacturing performance of the sugar companies studied in Kenya, as increase in the cost of maintenance was associated with increase in the cost of production, which had the propensity of leading to uneconomic operations, thereby making the objective functions of their business operations unrealizable.

3. Methodology and Model Specification

The study adopted ex-post facto research design in conducting empirical investigation in the estimation of dynamic relationship between maintenance cost threshold and ROI. The study used 15-year period (2005-2019) panel data derived from annual financial reports and maintenance scorecards of listed Nigerian cement manufacturing firms in the Nigerian Stock Exchange as at December 2019. The Ordinary Least Squares (OLS) estimator was adopted for the regression analysis of the study.

For the purpose of this study, we derived a simple linear auto regression model from the linear equation of Y = f(X) that address the dynamic relationship of multiple time series data of the study variables. The functional equation that addresses the regressor and regressand variables of the present study is presented in the order below.

$$ROI = f(MC) \quad \text{...} (1)$$

We re-write the equation (1) in a model as thus

$$ROI_{it} = e_0 + e_1MC_{it} + \mu_{it} \quad \text{...} (2)$$

Where:

ROI	=	Return on investment as a proxy for corporate performance and dependent variable (Y)
MC	=	Maintenance cost as the independent variable (X)
e_0	=	Autonomous variable (constant or intercept)
e_1	=	Coefficient of the explanatory (independent) variable of the model
μ	=	Error term
$_I$	=	Individual dimension
$_t$	=	Time dimension

4. Data Description and Empirical Results

The study considers multiple time series data of average annual maintenance cost and return on investment of WAPCO, CCNN, Ashakacem and Dangotecem from 2005 to 2019. The data sets were derived from financial reports and maintenance scorecards of these listed companies in the Nigerian cement industry and the data were subjected to statistical stationarity test/unit root test to validate the stationarity and non-stationarity trend of the statistical properties over time.

Augmented Dickey-Fuller (ADF) unit root test was carried out to estimate the statistical stationarity of the data and order of integration, following the testing procedure below:

$$\Delta KF_t = \lambda_0 + \beta t + \gamma KF_{t-1} + \partial_1 \Delta KF_{t-1} + ... + \partial_p \Delta KF_{t-p} + \mu_t$$

………………………….................(3)

Where,

λ_0 is a constant,

βt is the coefficient on a time trend,

p is lag order of the autoregressive process, and

Δ is difference operator.

The unit root test was carried out under the null hypothesis $\gamma = 0$ against the alternative hypothesis of $\gamma < 0$, where we compared the value of the test statistic with the relevant critical value for the Dickey-Fuller Test to either accept or reject the null hypothesis.

Literature on Augmented Dickey-Fuller unit root test is widely recognized. Dickey & Fuller (1981), Engle & Granger (1987), Enders (1995), Pindyck & Rubinfeld (1998) observe that most times, longitudinal data or cross sectional time series pooled data tend to contain infinite variances that lie on the unit circle, which can make equations estimated from such series to result in spurious regression. In classical linear regression model (CLRM), statistical properties such as mean, variance and correlation are assumed to be constant over time (stationary) for regression results to be significant. The ADF unit root test is used to test whether variables in the regression model are stationary or not. The underlying hypothesis for the ADF unit root test (statistical stationarity) which defines the equations for their tests are given as:

H_o: The variable has unit root (non-stationary/not significant)

H_a: The variable has no unit root (stationary/significant)

Table 1: Augmented-Dickey-Fuller (ADF) Unit Root Test of MC

Null Hypothesis: D(MC) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=3)

		t-Statistic	'rob.*
Augmented Dickey-Fuller test statistic		- 4.036185*	)051
Test critical values:	1% level	-4.057910	
	5% level	-3.119910	
	10% level	-2.701103	

* Significant at 5% & 10% level (stationary/has no unit root)

The results of Augmented-Dickey-Fuller (ADF) unit root test of MC in table 1 above indicate that at 5% and 10% significant level, MC has no unit root, meaning that it is stationary or constant over time.

In classical linear regression model (CLRM), error terms are assumed to have the same variance, which means that variance is assumed to be constant. This assumption makes regression model to be valid. The underlying hypothesis for the heteroskedasticity test is given as:

H_o: There is no heteroskedasticity (homoskedasticity)

H_a: There is heteroskedasticity

Also, in conducting this empirical investigation, error variance of the variables employed in the linear auto regression model was tested with white heteroskedasticity test to determine if all the errors have the same variance or not. The presence of heteroskedasticity in a longitudinal, time series, cross sectional pooled or panel data causes errors in regression analysis, which leads to spurious and biased regression results (Jeffrey, 2013). Maddala & Lahiri (2009) posit that in a classical linear regression model (CLRM), error terms is assumed to be independent and identically distributed with expected value to be zero and variance to be constant (i.e all errors are assumed to have the same variance).

Heteroskedasticity is a violation of this assumption. It occurs if different observed errors have different variances. Gujarati & Porter (2009) refers to heteroskedasticity as error variance that is caused by model misspecification, measurement errors, misspecification of data, manipulation of

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data before receipt and after receipt, extrapolation of data, interpolation of data and sub-population differences.

In linear regression model, this assumption makes regression model to be valid (Maddala & Lahiri, 2009; Jeffrey 2013). Thus, the underlying hypothesis for the heteroskedasticity test of this study is given as:

H_o: There is no heteroskedasticity (homoskedasticity)

H_a: There is heteroskedasticity

Table 2: Heteroskedasticity Test of MC

Null Hypothesis: MC has no heteroskedasticity

Heteroskedasticity Test: White

F-statistic	4.388188	Prob. F(2,12)	0.371
Obs*R-squared	6.336314	Prob. Chi-Square(2)	0.0421
Scaled explained SS	11.50491	Prob. Chi-Square(2)	0.0032

** No significant heteroskedasticity (homoskedasticity)

Critical chi-square at 5% level of significant (5.991)

Table 2 above is the heteroskedasticity test results of MC. The F-statistic value of 4.388 is less than the critical chi-square value of 5.991 at 5% level of significance when compared. This signifies that the error terms have the same variance as MC has no significant heteroskedasticity.

Table 3: Regression Test

Dependent Variable: ROI

Method: Least Squares

Sample: 2005 2019

Included observations: 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.156281	7.281150	-0.421034	0.6800
MC	11.10041	1.890346	6.116274	0.0000

R-squared	0.733450	Mean dependent var	41.90373
Adjusted R-squared	0.713308	S.D. dependent var	9.940725
S.E. of regression	5.231901	Akaike info criterion	6.234841
Sum squared resid	351.2079	Schwarz criterion	6.319268
Log likelihood	-45.06139	Hannan-Quinn criter.	6.113306
F-statistic	37.25234	Durbin-Watson stat	1.525080
Prob(F-statistic)	0.000000		

Table 4: Summary of Regression Results

Analysis Criteria	**Variable: MC**
R-square *	0.73
Adjusted R-square*	0.71
D-Watson*	1.53
F-statistic*	37.25
Prob (F-statistic)*	0.00
Coefficient*	11.10
t-Statistics*	6.11
P-value*	0.00

* Significant in the estimation of relationship

Table 3 and 4 above present the detailed regression results and summary of regression results of maintenance cost and return on investment profitability index of manufacturing firms in the Nigerian cement manufacturing industry respectively. The coefficient value of 11.10 explains the effect maintenance cost has on return on investment of firms in the industry. The coefficient value being > 0 implies that cost effective maintenance of production facilities is significantly associated with 11.10% improvement on return on investment.

The Durbin-Watson statistic value of 1.52 signifies positive relationship between the dependent variable (ROI) and the independent variable (MC). Also, the R-squared value of 73% and the Adjusted R-squared value of 71% are clear indication that there is a strong evidence of goodness of fit of the study's regression model. The F-statistic value of 37.25 and the Prob(F-statistic) of 0.00 means that the estimated model is significant. The p-value (0.00) of the independent variable indicates statistical significance of the hypothetical test result.

With the coefficient value > 0, prob-value < 0.05 and t-statistic value of ≥ 2 in the regression results in table 3 and 4 above, maintenance activities of firms in the industry is cost effective. Based on these findings, direct cost of maintenance of heavy duty equipment has significant positive effect on return on investment of firms in the Nigerian cement manufacturing industry. The result of this study hinges on the implications of opportunity cost of maintenance, which direct cost of maintenance mitigates or minimizes to the barest minimum for improved production, improved product quality, on time delivery, customer satisfaction, high market share, revenue and profit. The study observed direct proportional significant effect of the regressor variable (MC) on the regressand variable (ROI). This finding corresponds with the empirical findings of Alsyouf (2007), Donca (2011), Maletic et al. (2014), Szumbah & Richard (2014) that cost effective maintenance has significant positive effect on the operating profit.

5. Conclusion, Recommendations and Contributions to Knowledge

The study has been able to examine the effect of maintenance cost threshold on return on investment of manufacturing firms in the Nigerian cement industry. Result indicates that cost effective maintenance significantly impact on ROI of operating firms in the industry. Based on the finding result, the study concludes that the ability of a manufacturing firm to effectively use the different maintenance strategies at different machine conditions is the platform for maintenance cost effectiveness and that any manufacturing firm that avoid maintenance due to cost, stands the risk of opportunity cost (burden/indirect cost) of maintenance.

Arising from the above, the study therefore recommends for top management support and commitment to the use of appropriate maintenance strategies over a given machine condition at the right time, with the right parts and right maintenance personnel as the key drivers of cost

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effective maintenance. Further research should focus on the invisible cost of production facilities maintenance on the corporate performance of firms in the industry.

This study has contributed to knowledge in two ways. First, it has bridged gap between maintenance cost centre and maintenance profit centre by providing a pragmatic knowledge that maintenance is cost-profit centre, which is a paradigm shift in knowledge from the traditional (classical) view that direct cost of maintenance is solely cost centre and the neo-classical view that only emphasize the benefits of maintenance (profit centre) without considering cost. The pragmatic knowledge which the study offers is a hybrid view that emphasizes both cost and profit centre via maintenance cost-profit model.

Secondly, the study has been able to provide a graph of inverse relationship between maintenance cost and return on investment in figure 5.1 below.

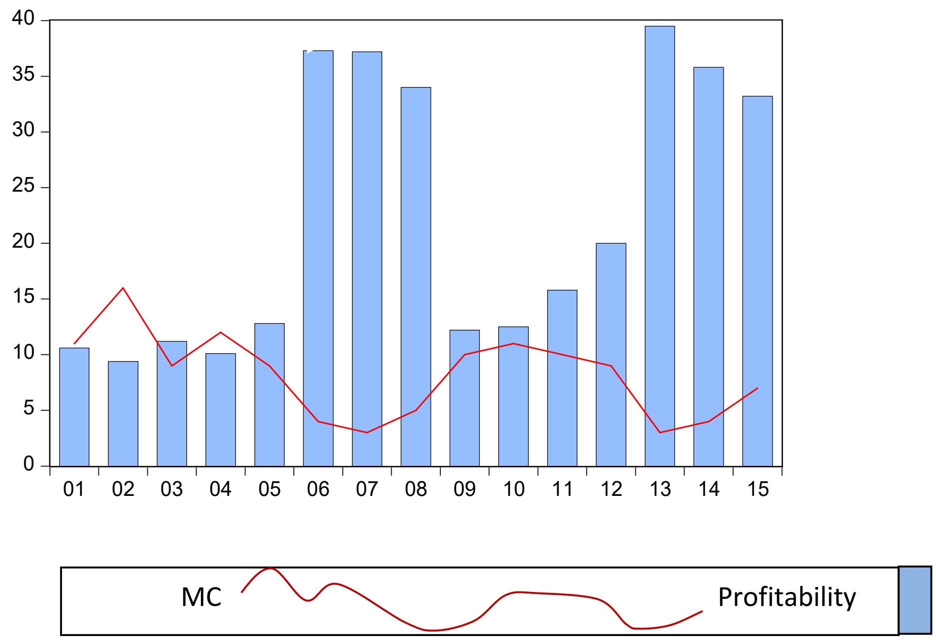

Figure 5.1: MC-ROI Stochastic Graph

The MC-ROI stochastic graph can be used to estimate outcome of MC on ROI. As presented in the graph, inverse correlation exists between MC and ROI profitability index. As the curve which represents MC fluctuates, the bar chart that represents ROI inversely fluctuates. The implication arising from this is that MC determines the extent of ROI growth and with this, manufacturing companies that use heavy duty equipment can apply this knowledge to make stochastic forecast

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of trend of MC and ROI in maximizing their corporate goals. Also, maintenance actions that can give rise to MC have to be minimized through cost effective maintenance strategies by every manufacturing firm since an increase in the value of MC results in a decrease in the value of profitability index and vice verse.

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