International Journal of Advances in Engineering and Management (IJAEM)
Volume 6, Issue 05 May 2024, pp: 832-839 www.ijaem.net ISSN: 2395-5252

Impact of Maintenance on Defective Product Output from Mikap Nigeria Limited

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Date of Submission: 18-05-2024 Date of Acceptance: 28-05-2024

ABSTRACT
Effective maintenance is a guarantee for quality output product from a production system. Mikap Nigeria Limited, Producer of Miva rice in Makurdi produces outputs of whole and defective kernels as outputs. The defects called broken kernel. What then is the relationship between maintenance and defective output? To investigate this problem, data was collected from the industry through questionnaire and records of maintenance hours and the amount of whole and broken kernel as output for thirteen months, for study. The three basic aspects of maintenance were captured in the average number of hours allotted for maintenance per month. Analysis used regressions in Microsoft excel; it established that the relationship between broken kernel and hours of maintenance was negative and linear relationship, which implies as the number of maintenance hours increased, the machinery becomes more efficient and reduces the amount of broken kernel. Thus, the study recommends more hours of effective machinery maintenance reduce the amount of broken kernelin the output.

Key words: Broken kernel, Machinery, Mikap, Maintenance, Output, Production

I. INTRODUCTION

The term maintenance comprise of routine, preventive, corrective etc maintenance. It is a wide field that includes all activities carried out to keep production machinery in optimal working condition and esthetic qualities. A machine that receives effective maintenance is sure to maintain the quality of output. Industries produce goods and services to have a particular quality and the machines that carry out production need to maintain that quality. Any alteration in the quality is pointer to a defect in the machine other things been equal.

However, most executives lack the knowledge of maintenance and soconsider it a waste of time, money and resources. In standard industrial settings, management of enterprises spell out the aims of maintenance in their policy document to conform to the organization's objectives and benefits related to other aspects of the business like, production, marketing and accounting [1]. These guidelines put in place to give direction towards achieving standard performance andbacked up with genuine actions. Sustainable industrial growth depends on clearmaintenance objectives enshrined in the policy of the organization, which gives maintenance its proper place [2].

The process of maintenance involves all efforts and actions geared towards keeping a machine or system in its optimal performance state, good appearanceand serviceability [1], [2]. Apart from regular maintenance activities of routine, preventive, corrective, there are other maintenance functions, which are not immediately obvious but no doubt important. They include activities like; training of maintenance staff and operators, testing of parts for suitability, planning of service schedules, improvement and modification of plant, protective painting and procurement of spare parts [3]. These activities share common objectives namely,maintaining assets in good shape, appearance and efficient working condition within the service life of the equipment. Therefore, time waste is not of a major essence in maintenance [4]. Professional maintenance workers take time to do a good job because a job done in haste to please the boss or save time of a customer in the end is done poorly. It cost more by repeating the same work; it wastes more time and materials. Even when correct tools are available caution, produces a better job than hasty work [6].

For maintenance to provide the needed results enough time goes into it therefore, delay or stoppage of other activities becomes necessary in serious cases. In addition, genuine spare parts must always be available, which may mean increase in production costs. Maintenance workers must undergo regular training to handle jobs professionally rather than learning on the job [7]. Learning on the job is the position favored by most chief executives of enterprises and unknown to them; this translates to increased cost in the end [6], [7].However, to hire professional outside to handle some aspects of the job like new installations, engine overhauls etc cost more to the organization.

It appears that a defined maintenance objective isdifficultto formulate and runs counter to production even when formulated. However, good maintenance is actually the one that prevents time waste due to downtime, ensures more production, and guarantees better quality output. On the contrary, managers of industries have defined objectives for production and quantify it in terms of figures and predict market trends but ignore maintenance [8].

Maintenance goals may disagree with normal production goals in the short term but well support it in the long term. Production efforts are concentrated on producing more, reducing cost, time and purchasing only the needed items. Maintenance objective seems to divert attention from production goals, reduces achievement, waste time, and support purchase of spare parts not needed presently. Nevertheless, store of spare parts supports machine or systems for continuous operation even when emergency breakdown occurs, without waste of time finding the needed parts. Spare parts are necessary because functionality of any machine depends on their availability [9].

Another serious problem that faces maintenance is the difficulty of specifying the exact amount of money and time required. During normal routine service, a component not suspected to be faulty may be on dismantling for services. In such a case, replacement becomes necessary before assembly. This action was not initiallyplanned for and other such unforeseen breakdowns similarly be repaired. Thus, appropriate money for spare parts, lubricants, personnel training and provision of labor are not easy to budget. Again, it is not quite simple to quantify many other unforeseen events for instance, accidents, parts that may malfunction during operation, time of system shut down or unserviceable periods, in terms of figures or money before they occur. Such expenditures are undefined and limitless yet essential, as the probability of occurrence exists [4],[9]. It is not enough simply to lump them in the miscellaneous expenditures because it simply makes it vague. The performance history of the machines or systems and the actual money that goes into them as maintenance cost and second hand value cannot be determined fairly. Therefore, all expenditures should be specified per each machine in other to determine their serviceable life and secondhand value [10].

During planned service, detailed instructions are followed so that chances of failure in operation are minimized before the next service. This action reduces the events of accidental breakdowns. To obtain the greatest benefits from the system, workers must document actions carried out. In addition, workers training should be regular to deepen their knowledge and equip them with knowledge on new technologies. As the organization grows and equipments become sophisticated, operators update knowledge to face new challenges without recourse to professionals outside that cost higher [5], [7], [11].

1.1 TIME

Maintenance figures alone might not show a decrease in the frequency of breakdowns or in their severity. Other factors external to it might be responsible for instance, the latest operator-training program or recent improvement in supervision. Therefore, the cause of reduction or increase in any one trend may be results of other events not captured in the data collection [8], [11].

Executives of most enterprises face dwindling productivity because they have no workable maintenance guideline so that the actual trend of equipments performance is not known. Some chief executives make maintenance an ad-hoc business with no records kept to enable quantitative assessment of the state of equipments. The outcome is poor quality products shortly after business start off. Sometimes, machines are disposed-of as scraps with very low second hand value. This situation is commonplace in government and most privately owned industries or homes [12].

In attempt to reduce time waste for troubleshooting, manufacturers of some modern equipment builds self-regulating devices or gauges that assist in thetask ofperformance assessment. In this way, regular inspection and reading of these gauges reduce time waste for trouble shooting and such data show a pattern of functionality of the machine. The records also show if the machine or system is in good condition or not by displaying regular or irregular patterns. In another way, outputs pattern may assist to determine the effectiveness of the machinery [13].

1.2 BUDGETING

Effective maintenance budgeting does not only mean provision of adequate funds to carry out the planned activities. It also demands provision of adequate time to carry out quality work without interference. The organization in its policy should make available sufficient money and time for maintenance. If time for a round of routine service should take two hours, management should allot double this time in the budget to take care of any eventuality[10].

The qualities of outputs as goods or services are a direct function of the efficiency of the processing machinery. The cost of maintenance calculated alongside with other variables costs like raw material, fuel, labor etc, and properly budgeted for regarding the market value of suchmaterials or services. In addition, a percentage of the profit ploughed back into maintenance as a policy of the organization without waiting for breakdowns to occur [12].

Mikap Nigeria Limited, Producers of Miva rice in Makurdi, processes parboiled rice for local consumption and export. Processing activities carried out through four stages namely: pre-cleaning, parboiling, drying, milling, and packaging. Each of these units has assembly of machines that carry out operations. Milling and packaging unit has many other sub-units like whitening, polishing, sorting etc, before packaging, which is the final operation. Each of these units have array of machines for specific activity.

1.3 OPERATIONS OF PROCESSING UNITS

i. **Pre-cleaning Unit-** The machines in this section blow off dust and remove foreign particles from the grains. Improper cleaning and extraction of these hard particles interfere with the structure of the grains during milling. The hard particles breakdown the kernels in the mill. Thus, these machines must be efficient in the cleaning activity.
ii. **Parboiling Unit-** The machines in this unit provide hot water to sock the grains to the appropriate moisture level before parboiling to the required degree of temperature. Improper heat application through prolonged period of socking tempers with the grain structure and negatively affects the grain during milling and leads to breakages.
iii. **Drying Unit**- The machines here blow hot air across the grains. This reduces the moisture content of the grains to required level necessary for milling. Malfunction of machines in this unit will cause imbalance in the moisture levels of grains resulting to high amount of breakages at the milling unit due to uneven moisture levels of the grains.
iv. **Milling unit**-This unit has multiplesubunits attach to it namely, hulling, polishing, whitening, sorting, and packaging. After the paddy is milled and every other process is completed, the kernels are sorted out. Machines remove the broken kernels from whole kernels. The whole kernels sent to packaging subunit for packaging into, 5 kg, 10 kg, 25 kg and 50 kg depending on demands in the market. While broken kernels are packaged into 50 kg bags only. The husk and bran are outputs too but not considered in this study.

Some factors may also affect the kernel production negatively;they include the nature and type of grains. If grains harvested immaturely, or different sizes or types of grains mixed and treated in the same well, even optimal machinery will give out high breakages because the machines are not sensitive to mixture of rice grains. For this reason, the grade of rice in commercial market is allowed to have 5-25% of broken kernels [12].

A batch of raw rice undergoing processing passes through all the units mentioned before the final output. Therefore, this study does not consider the output from any one section, rather assessment is considered holistically to determine optimality of the processing system. It is worthy of note that the malfunction of any unit renders low quality output from the system.

Composition rice is; husk-20 %, bran-11 % and processed kernel- 69 %. Depending on the type of milling process, yield could be; 20 %-husk, 8-12 %-bran and 68-72 %, both whole and broken kernels. The international standard states that optimal processing equipments produce less than 6 % (> 6 %) of broken kernel per batch [13]. However, the probability of mix grains in the commercial paddy rice is high therefore; this study adopts the commercial classification of 50-60 % whole kernels and 5-10 % broken kernel from efficient processing system.

The problem investigated is the quantity of broken kernel that comes out from the system. It is a technical fact that if adequate attention is given to effective maintenance of production machinery, output thereof will be of accepted standard. It appears maintenance of production machinery has become an ad-hoc activity done when breakdowns occur, it is observed from the amount of broken kernel as output.This study investigates level of

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Volume 6, Issue 05 May 2024, pp: 832-839 www.ijaem.net ISSN: 2395-5252

impact machinery maintenance has on the broken kernel in production.

The significance of the study is for management of industries to understand that product output is a direct function of effectiveness of the maintenance equipment quantified in the number of hours attention was given to such maintenance issues.

The objective of this study is to assess the impact of maintenance on broken kernels as output inMikap Nigeria Limited, producer of Miva rice. The specific objective is to establish a relationship between hours of effective maintenance and the amount of broken kernel in the output from product output.

II. DATA COLLECTION

This study collected data, with permission of chief executive, from production records of Mikap Nigeria Limited Producer of Miva rice in Makurdi within a period of thirteen months.The amount of whole kernel in various sizes of bags; 5 kg, 10 kg, 25 kg and 50 kg were collected while, the amount of broken kernels in 50 kg bags only. In addition, maintenance time in hours for each month and recorded in Table 1. The industry did not keep records of type and frequency of any form maintenance. The only available records were number of hours used for maintenance. It was observed that management used the number of maintenance hours to pay ad-hoc workers who were part of maintenance team, so maintenance hours were recorded as criteria for payments at the end of the month.

III. RESULTS

The numbers of bags were converted to kilogram (kg) to enable addition of the monthly output in kilogram or tons (t) Table 2. Table 3 shows the detail regression statistics for the relationship in the model. Fig. 1 shows the negative linear relationship between broken kernel and maintenance hours. Fig. 2 shows the distribution of percentage broken kernel in the residual plot.

IV. DISCUSSION

Fig. 1 shows the negative linearrelationship between maintenance hours and broken kernel in outputs.It shows the strength (R^2) of the relationship as 89 %. It implies the empirical model is 89 % accurate to determine the broken grains given the number of maintenancehours. The relationship is negative and linear, indicating that as the time of maintenance increases the amount of broken kernel decreases. Assumption was made that the number of hours for maintenance was devoted for effective maintenance to improve machinery performance. Therefore, increasing effective hours of maintenance reduces output of broken kernels. .

Table 3: shows the quantitative determine of the two variables: maintenance time and broken kernel output. How good is the model? This question is answered using the strength of the relationship (Multiple R) of the correlation between the variables. The value of Multiple R equal 0.95 (95%). This is the strength of the negative linear relationship between variables. Where the coefficient of determination (R^2) that indicates, the ability of the model to predict the dependent variable (y) given the independent variable (x). That means given quantity of broken kernel, this model predict 89 % of the state of the production machinery. That means only 11 % may be unaccountable and could be due to factors of poor quality raw materials and in effective operators. Alternatively, other factors account only for 11 % of breakages in the output.

Further examination shows that the overall significance (F- significance), which indicate the probability of been wrong is 0.001, which is much less than 5% (0. 05) level of significance. This proofs further that the model is significant to predict the effective hours of maintenance given true amount of broken kernel output from production. The model included a significant error in the intercept (y) of 1.03 and broken kernel (x) of 0.1 in the output. Table 3 also shows, P (0.05) > P (0.004) this implies that the model is significant at 5% level since, that is the calculated value of “P” is less than the critical value of “P.” This explains that any change of broken kernel in output is associated with a change in the efficiency of the production machinery that requires maintenance.

Fig.1 the negative gradient showed that broken must exist in production no matter the number of hours assigned to maintenance. It is because even the best of machines must give out broken kernel in the output, that internationally the allowable percentages of broken kernel in the output is less than six percent (> 6%), because there is no perfect machine [5]. This concept is shown in Fig 1 where the trend line did not touch the “y” or “x” axes.

Fig. 2 shows the distribution of the broken kernel within the period under review on a residual plot. The points below the horizontal line (0-line) show the months the average value of broken kernel fall within acceptable level 5-12 % [11]. This is an indication that the processing machinery received adequate maintenance. However, the points above the 0-line show that the output in broken kernel exceeded acceptable value. This further showed that the processing machinery operated without adequate maintenance, which resulted to high amount of broken kernel in the output during the month.

Available literature shows that commercially, the acceptable broken kernel as output from production should fall between 5-12 %. The lower value representing broken kernel output from very efficient system while the higher value of broken kernel indicate that the processing machinery is in dare need of maintenance [7]. The acceptable value of broken kernel from production should average at 8.5 % however, the internationally accepted value is less than 6 % (>6%) [11], for the industry to maintain acceptable level of 6% broken kernel in the output the industry must allocate more than 11-hours to effective maintenance of its machinery.

It was noted earlier that other hidden factors might also influence the quality of output, for instance; the type and nature of raw material used and unskilled operators. These factors adversely affect the quality of output too if not properly controlled however, the study did not consider them.

The fluctuations in amount of broken kernel inthe output some months consideredcould be pressure from customersand the desire to meet up supply, the executive, impressed on the operators not to shut down for maintenance to increase production. In so doing, the processing machinery was subjected to longer hours of operation without rest. This action stressed the mechanical parts and resulted to breaking more kernels.

Secondary, even operators, may sleep off on duty and the machinery worked without appropriate regulation; this too could result to more broken kernels shown in the distribution plot Fig. 2 above the horizontal line. For a machine, the period of rest is important; it allows the stressed parts to recuperate, before next operation.Without this action, the moving parts may become over stressed resulting broken kernel in output. For this reason,most manufacturers specifies effective time a machine may be subjected to work with optimal results but outside of this, good output can no longer be guaranteed [4]. Machine rest period is also a period for lubrication, greasing, changing filters etc. This is a surety for standard performance and quality outputs devoid of defects.

Some faults occurbecause management considers them minor and direct work to continue, since such minor faults cannot stop production. For instance, a leakage occurs in compressed air or steam pipe used for drying parboiled paddy. This reduces the expected intensity of pressure and heat required to dry wet rice to required moisture level in the drying unit. The result is uneven drying of the paddy in the dryer. When such batch goesfor milling, most of the kernels come out broken because they did not have equal moisture content. Therefore, a little malfunction like leakage in a steam pipe can cause improper drying, which caused more defects in the output. Thus, there is no small fault, fault is fault and rectify immediately to guarantee high quality output with little defeats.

V. CONCLUSIONS/RECOMMENDATIONS

This study has shown that maintenance has positive impact the product output. Effective maintenance reduces defects in the outputs conversely, poor maintenance leads to poor output or more defects in the output. Industry will analyze defects to estimate the number of hours needed for maintenance using the model established. At the end of study the following recommendations are made;

Executives of industries should always budget adequate time for maintenance.

For every batch of production analysis be made on the output to determine the state of the production machinery.

ACKNOWLEDGEMENT

Our appreciation goes to Tertiary Education Trust Fund (TETFUND) for sponsoring this research work

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Appendix 1

Table 1: Products outputs and Maintenance hours

S/No.	Monthly Avg. Prod. Hours (h1)	Monthly Avg. Maint. Hours (h2)	Monthly Whole Kernel (t1)	Monthly Broken Kernel (t2)	Total Output (T)	Broken Kernel (%)
1	466	03	80	45	125	15.80
2	514	14	350	15	365	5.60
3	424	11	284	25	309	5.60
4	542	09	250	28	278	6.90
5	436	12	279	18	297	4.20
6	424	12	290	24	314	5.30
7	424	03	190	41	231	12.20
8	424	10	210	29	239	8.40
9	424	06	143	40	183	12.01
10	432	11	220	24	244	6.80
11	512	07	140	35	175	9.80
12	442	14	305	09	314	2.00
13	324	14	310	18	328	3.80

Table 2: Output converted to tons of Whole and Broken Kernel

Date	Production Hours (h)	Maint. Hours (h)	**5kg** Whole Kernel	**10kg** Whole Kernel	**25kg** Whole Kernel	**50kg** Whole Kernel	**50 kg** Broken Kernel
June 2016	466	6	174	391	1705	4491	900
July	514	14	203	1037	912	3847	28
Aug.	424	11	112	431	3236	3962	500
Sept.	542	9	1	263	2185	4237	565
Oct.	436	12	4	112	1885	4616	350
Nov.	424	12	194	1510	1820	5535	411
Dec.	424	9	300	1038	3986	2339	817
Jan. 2017	424	10	104	119	1048	2158	588
Feb.	424	8	0	128	711	2445	798
March	432	11	2	765	2174	1621	489
April	512	7	0	0	3161	1217	493
May	442	14	20	281	2002	1491	290
June	324	14	24	117	1526	3918	352

Rice grain contains [12]: Husk, 20%, Bran and 11 % and Kernel 69%

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Volume 6, Issue 05 May 2024, pp: 832-839 www.ijaem.net ISSN: 2395-5252

Table 3: Relationship between percentage Broken Kernels and Maintenance Time

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.946097							
R Square	0.895099							
Adjusted R Square	0.885562							
Standard Error	1.328597							
Observations	13							
ANOVA								
	df	**SS**	**MS**	**F**	**Significance F**			
Regression	1	165.6795	165.6795	93.86045	1.01E-03			
Residual	11	19.41686	1.765169					
Total	12	185.0964						
	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**	**Lower 95.0%**	**Upper 95.0%**
Intercept	16.84896	1.026203	16.41874	4.39E-03	14.5903	19.10762	14.5903	19.10762
X Variable 1	-0.95735	0.098817	-9.68816	1.01E-06	-1.17485	-0.73986	-1.17485	-0.73986

Fig. 1: Relationship between maintenance time and broken kernel

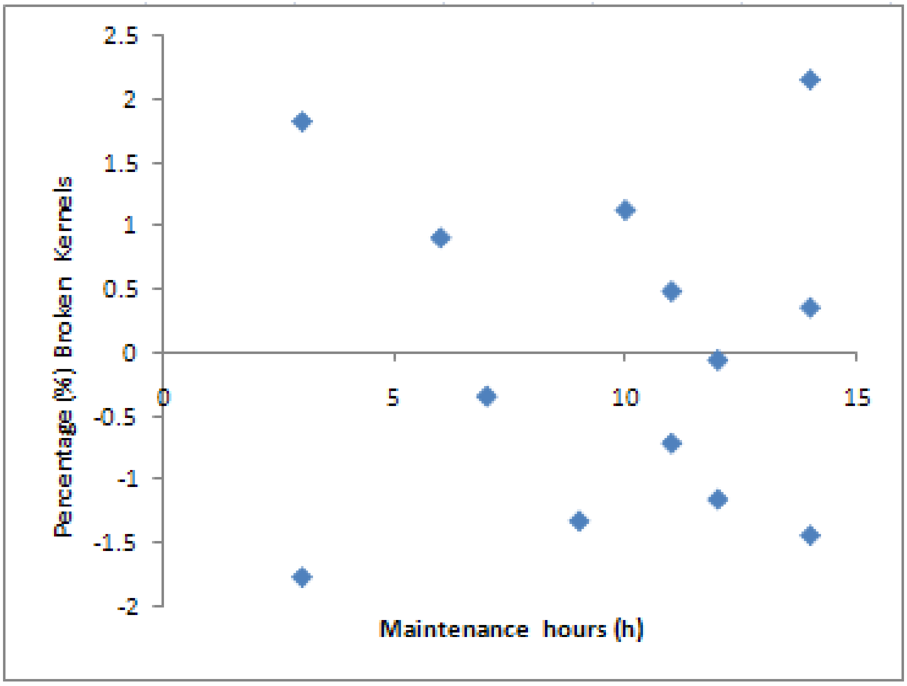

Fig 2: The distribution of percentage broken kernel in the Residual plot