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Performance of Trucks Working in Sugarcane Transportation

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ABSTRACT: *This study was conducted at Kenana Sugar Estate with the objective of the evaluation of the failures and downtime of trucks operating in sugarcane transportation. Results showed that there was no significant difference between seasons within the same type of trucks. There was significant difference between the different types of trucks in the frequencies of failures. The transmission system and clutches have the most failures in sugarcane transporting due to the harsh conditions of operation. Radiator failures also are affected by the condition of operations. Accidents contributed to about 60% 0f the total downtime.*

Keywords: *sugarcane; truck; failure; downtime; repair and maintenance.*

INTRODUCTION

One of the major cost component of sugarcane production is the transport of sugarcane from the field to the mill. Sugarcane transport has undergone many changes and has been streamlined to reduce cost as well as to accommodate the harsh field roads.

Sugarcane is transported by tractor/trailer and trucks. Most of the tractors used for sugarcane transportation are of the standard type tractors. Trucks that transport sugarcane ranged from single to double drive axle, rigid to articulated trucks with capacity up to 24 tons. It is fitted with an engine developing between 260-330kw. Although the use of large capacity trailer has increased significantly, especially for transporting sugarcane directly from the field to the mill, the use of self-propelled trucks is popular and cost effective.

Parson *et al.* (1981) stated that the importance of timeliness is well accepted concept when considering efficient machinery selection. Leading farmers generally recognize the importance of being in time. They understood the relationship between timeliness and machine reliability long before agronomists, engineers, and economists developed the coefficients and analytical tools now commonly used for machinery systems analysis. Harris and Bender (1973) defined timely operation as the "ability to perform an activity at such a time that quantity and quality of a product are optimized". The penalty of not carrying out an operation within the optimum time will be a reduction in yield, a loss of quality or both.

Time efficiency is defined as a percentage reporting the ratio of the time a machine is effectively operating to the total time the machine is committed to the operation. Timeliness is defined as the ability of the machine to perform a given operation at the specified time when the field and crop is at its suitable condition in quality and quantity. It is impossible to predict when some part of a machine will fail, but many breakdowns in the field can be avoided by scheduled inspection during operation.

Breakdowns are field stoppages due to sudden failure of a part. The expected repair time for breakdowns is not usually included in the calculation of predicted field efficiency, but such time losses do interfere with machine performance. The probability for the lost time due to breakdowns can be considerable. A probability number is the decimal ratio of the number of times a breakdown is observed to the total number of observations (Hunt, 1977). Green and Bournce (1981) stated that the concept of reliability becomes important when failures lead to some finite length associated with repairing, restoring or replacing the failed item.

For mechanical power technology, reliability indices in developing countries will rarely exceed 60%for engine powered machinery and 80% for implements. On the other hand, in developed

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countries, with sophisticated service networks and easy access to replacement parts and, therefore, reduced downtime, the indices may be 10-20% higher.

Bohm (1995) found that the two most common causes of breakdown were overloading and poor maintenance, particularly the oil and filters. On the other hand Monge (1994) stated that about 25% of tractor breakdowns are attributed to effects in the cooling system.

Hunt (1971) stated that the breakdowns were considered to be unpredictable events which may be caused by one or more of the followings:

1. Accidents, such as striking hidden object, storms, fires, etc.
2. Improper service or maintenance, such as lack of lubrication.
3. Improper machine operation such as overloading, overturning and running too fast.
4. Improper set-up such as omission of parts, foreign objects, objects left in the machine and improper bolt-tightening torques.
5. Improper design such as underestimation of loads and service factors, and the deliberate under design to gain a price advantage.

Clyde *et al.* (1979), in studying skidder downtime found that the weather factor has the greatest severity on unscheduled downtime. He found that there were 1.4 failures per machine weekly. He determined 38 classes of failure. He found that for both types of skidders under investigation the total downtime was 23%. For grapple type skidder it was 30.8% and 18.4 % for choker skidder. By neglecting the non-machine failure (labor, weather …etc) the downtime for all skidders was 16.5 % with 15% for the grapple machine and 17.2 % for choker skidders.

Frequent machinery unscheduled downtime was due to failures of hydraulic hoses and fittings. While engine repairs or replacement were the main causes for long time breaks.

The objective of this paper is to:

1. Determine the specific failures of trucks operating in sugarcane transportation.
2. Determine the downtime associated with these failures.

MATERIAL AND METHODS

Experimental site

This study was conducted at Kenana Sugar Company. In Kenana sugarcane is transported using trucks. Kenana's current fleet consists of three types of trucks referred to in the study as A, B and C to hide the make and model. The numbers of these trucks were 100, 29 and 67 respectively.

Data Collection

The type of failure and the time required for repair were registered for each implement on daily basis. The frequency of failure, total time lost and the range of repair time was determined. The mean and the standard deviation were obtained as well as the percent of downtime.

RESULTS AND DISCUSSION

First season

Table (1) shows the results of the first season. For trucks A, the reported individual failures resulted in a total of 1963 failure incidents, with an average of about 20 failure per machine per season. These were 37 different types of failures. The total time lost for repair was found to be 10950.18 hours. The average time to repair the failure was found to be about 5.6 hours.

For trucks B, the reported individual failures totaled of 1005 incidents. These were 30 different types of failures. There was an average of 34.66 failures per truck per season. The mean time required for repair of failure is 7.67 hours.

For trucks C, the reported individual failures resulted in a total of 1022 failure. These were 27 different types of failures. The mean repair time was found to be 5.7 hours per failure. There were 14.25 failures per truck during the season.

The transmission system and clutches have the most failures in sugarcane transporting due to the harsh conditions of operation. Radiator failures also are affected by the condition of operations.

Table 1
Expected and observed frequencies of failures of the first season:

Truck type	*Observed frequency*	*Expected frequency*
A	19	23
B	35	23
C	15	23
Total	69	69

There is a significant difference between the three types of trucks. Trucks B have the highest frequency of failures although the trucks A are the eldest. To show the difference between trucks C and trucks A, further calculation of Chi-squire test was made and it showed that there was no significant difference between the two types of trucks.

Second season

Table (2) shows the comparison between the three types of trucks in the incidence of downtime in the second season. This difference in the above calculation was due to the high frequency of trucks B. Also further analysis showed that there was no difference in frequency of failures between trucks A and C.

For trucks A, the season reports when analyzed by individual occurrences resulted in a total of 1269 failure listings. By sorting the 1269 listings 30 different classes of failures were determined. The average number of failures per truck was found to be 12.69. The average time for repair was 5.66 hours. The total time lost per truck was 71.82 hours.

For truck B the season reports when analyzed by individual occurrences resulted in a total of 877 failure listings, or an average of 30.24 failures per machine per season. By sorting the 877 listings 24 different classes of failures were determined. The mean time for failure is 9.16 hours. In this season the truck B lost on average 277.13 hours.

For trucks C, the season reports when analyzed by individual occurrences resulted in a total of 509 failure listings. By sorting the 509 listings 20 different classes of failures were determined.

Table 2
Expected and observed frequencies of failures of the second season

Truck type	*Observed frequency*	*Expected frequency*
A	13	17
B	30	17
C	8	17
Total	51	51

Third season

The results indicated that there was no significant difference between the three types of trucks. Further analysis was made to show if there is any significant difference between the trucks A and C. It showed that there is no significant difference between them.

Table 3
Expected and observed frequencies of failures of the third season

Truck type	*Observed frequency*	*Expected frequency*
A	9	11.67
B	18	11.67
C	8	11.67
Total	35	35

Further analysis of the incidents of failure within the same types of trucks over the three seasons showed no significant difference. From the above discussion it can be concluded that although the trucks A were the oldest of fleet in Kenana, it showed good performance compared to the other two types. It also showed the lowest repair time per failure this may be attributed to the fact that the mechanics have acquired a good experience in repairing and maintaining this brand of machines.

Figure (1) shows the percentages of different types of transportation trucks in the total downtime. From the Figure it can be shown that the trucks B had the highest downtime (1362.6 hours per truck per season). This means that a truck spend 2.5 hours per day in the workshop for repairing breakdowns and failures. This time is more than 10% of its operating time. The main problems of the trucks B were the accidents (938 hours) radiator (64.5 hours) and the clutch system (58.1 hours).

The main problem of trucks C was found to be the accidents (34.5 hours), radiator (13.1 hours), air system (12.4 hours) and fuel system (11.9 hours).While the main problems of truck A were the engine and clutch which were 29.9 and 29.8 hours per season respectively.

Figure (2) showed the percentage of different types of failures from the total downtime. Accidents are the major problems of Kenana transportation fleet, followed by the gearbox and the clutch system. Figure (3) shows the time lost per each type of failure and for the three types of trucks.

For trucks B the failure classes causing % of total downtime in excess of 5%in decreasing order were accidents (16.1.24%), steering (14.4%), electrical (7.60%), radiator (8.80%) and bearings (5.30%).

The failure classes causing % of total downtime in excess of 5%in decreasing order for trucks C were engine overheating (12%), exhaust (10.8%) radiator (9%), fan (7.3%), air system (6.2%) and 5th wheel (5.3%).

For trucks A the failure classes causing % of total downtime in excess of 5%in decreasing order were accidents (22.2%) engine (18.%), gearbox (8.3%), clutch (6.3%), pp shaft (6.3%) and spring (6.3%).

Exploration of failures

Failures were further analyzed with respect to total downtime and number of occurrences. It worth mentioning that during this research work it was observed that for the three seasons no day passed without failure or breakdown in all types of transportation units.

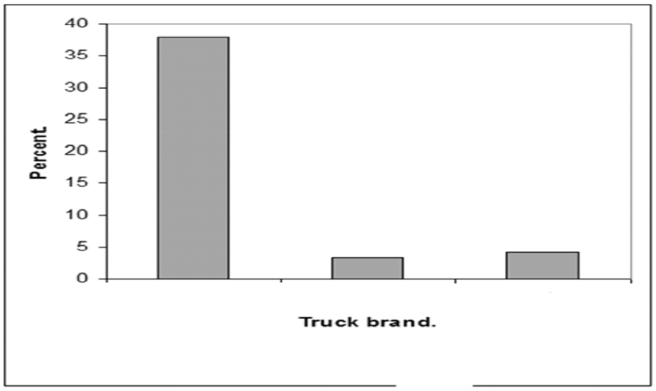

Figure 1: Percentage of downtime

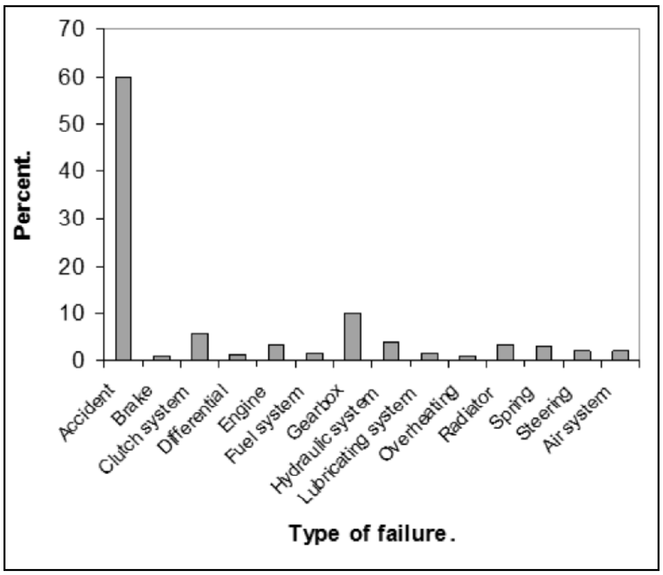

Figure 2: Percentage of different types of failures

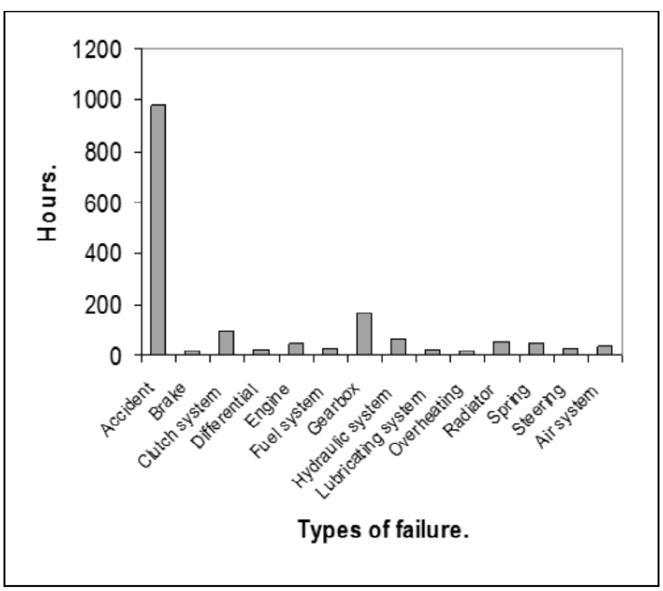

Figure 3: Time lost per failures

Engine: Frequent problems were engine overheating, engine replacement and/or major overhauls. The total number of engine failures was 329 with an average of 11.86 hours per failure.

Transmission: Reported observation of transmission system failures (clutch, differential and gearbox) occurred 1546 times. The corresponding time lost was 13024.8 hours, with mean time failure of 8.42 hours. scheduled transmission maintenance includes checking transmission lobe every 100 hours, and changing oil and filter element every 100 hours. Thus transmissions require a minimum of routine maintenance.

Radiator: Radiator failures occurred (487) times. The total time of radiator defect was found to be 2110.5 hours with a mean time per failure of 4.3 hours. Radiator punctures were noted to be a frequent cause of failure, as well as removal of radiator for "rodding" coolant passages to reduce the severity of overheating. Radiator problems were mainly in Volvo and Man trucks and of minor effect in trucks A. Other cooling system failures were related to water hose and pump bearings. Fan belt, fan bearing were also reported as common sources of cooling system failures.

Brakes: Brake failures occurred 196 times, with the mean time per failure of 4.31 hours. Brake pad replacement was noted to be the most frequent cause of failure. This type of failure reflects the harsh working conditions which force operators to use the brakes to avoid the bad field terrain.

Fuel system: The typical causes of failures were air and water in lines and leaking high pressure injector, fuel lines, fuel transfer pump and fuel tank. Probably most of these problems could have been avoided if more care had been given in handling of fuel and scheduling fuel filter changes.

Tires and wheels: In Kenana Sugar Company tire repair/replacement was done at the tower while waiting for unloading. There are many spare tires at the unloading site and at the field with the mechanical team, so there was no tire failures reported in the workshop files.

Hydraulic hose and fittings: Hydraulic failures occurred 118 times with a total time lost of 1966 hours and a mean of 16.66 hours. Main problems were hydraulic control and fittings, hydraulic valve, O' rings as well as hydraulic pumps and hose failures.

Suspension system: The number of occurrence was 518 times with a mean of 5.52 hours. A major problem was the spring main-leaf breakage due to the higher load and bad terrain.

Steering system: Steering mechanism problems accounts for only 2.2% of the total downtime with a total hours lost of 1057.05. The total number of occurrence was found to be 300 times with a mean time of 3.52 hours. This problem is mainly in trucks A and B and occurred once in trucks C during the three seasons.

Lubricating system: The components frequently failed were the oil pump and oil seals for all types of trucks. This type of failure contributed to 3.77% of the total downtime and it took about 1810 hours.

CONCLUSION

Unscheduled downtime was registered on daily basis for the transportation units. Results showed that for the three seasons there was no difference between the same types of trucks under study. There was significant difference between the different trucks in the frequencies of downtime. Radiator is the major problem of trucks B and the service (air system) was the major failure for A and C trucks. Accidents contributed to about 60% of the total time lost in Kenana Sugar Estate.

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