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Asessment of Vehicle Maintenance Culture and Its Cost Effectiveness: Case of University for Development Studies

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Doi: 10.19044/esipreprint.10.2022.p300

Approved: 17 October 2022
Posted: 19 October 2022

Cite As:
Seniwoliba J.A. (2022). *Asessment of Vehicle Maintenance Culture and Its Cost Effectiveness: Case of University for Development Studies*. ESI Preprints.
https://doi.org/10.19044/esipreprint.10.2022.p300

Abstract

The study assessed the maintenance culture of vehicles and the associated costs in the University for Development Studies at the Central Administration, Tamale Campus in order to provide solutions to maintenance problems facing the University with the associated high cost of maintenance. The study considered all 55 vehicles and drivers at the Central Administration used by various offices, directorates and general use (pool). However, data on 34 vehicles were available which is far more than the needed representation. Ten drivers were sampled to participate in the study using the simple random sampling approach. Face-to-face interviews with one-on-one respondents were conducted with the selected drivers. The researcher used open ended questions to gather relevant data from the respondents. The secondary data was obtained from mechanics and technicians who had presented their bills for payment at the Transport Office. Both the qualitative and quantitative methods were used in analyzing the data collected. The Grounded Theory and excel sheets were employed for the data analysis. The study revealed that that the poor maintenance culture is as a result of poor funding, delay in the release of funds for maintenance, inflation of the cost of spare parts, design errors, use of sub-standard materials, age of vehicles, insufficient knowledge and skills of mechanics and technicians were factors identified as those contributing to problems of effective maintenance culture. It is therefore recommended that a formalized maintenance department should be established with well qualified and experienced personnel with practical knowledge and skills in vehicle

maintenance and with a well-equipped workshop with the necessary tools and spare parts. This will allow fast and quick response to vehicle maintenance issues.

Keywords: Maintenance culture, cost effectiveness, vehicles, central administration, mechanics and technicians

Introduction

Like most African countries and indeed developing nations, state owned organisations in Ghana have very poor maintenance culture which is responsible for the terrible state of many of the national monuments, institutional vehicles, infrastructure, and administrative buildings today. However, the growth and development of every higher educational institution depends greatly on its infrastructural development which includes buildings, vehicles, workshops, laboratories, libraries and laboratory equipment. For these infrastructures to stand the test of time and to perform their intended function to contribute to the development of the institution there must be the culture of maintenance.

Maintenance culture has been acknowledged as a significant facet to improve the quality of maintenance work. Despite being unique to each organisation, culture within organisations need to evolve to suit the ever-changing market demands and trends. The habit of maintenance culture should start with the change of mindsets and attitudes to the promotion of continuous knowledge and skill enhancement, and performance improvement in maintenance activities. Maintenance is usually carried out in order to restore or keep a facility such as machinery or equipment to an acceptable standard. Without proper maintenance of resources, there can be stoppage or loss in production which could greatly affect profit, gains and reputation of the institution.

Maintenance is necessarily not only to maintain the function of the vehicle, but to minimize maintenance costs and to ensure a safe environment to vehicle occupants. The issue of maintenance is often highlighted in the educational sector of Ghana with respect to weaknesses in managing and maintaining vehicles. This item in most studies is associated with lack of management commitment to respond promptly for dexterous and responsive maintenance work. The problems occur because of low quality maintenance work, lack of ethics in maintenance effectiveness, ignorance of maintenance work, inexperienced and unskilled workers and manpower, lack of proper supervision from supervisors, delays in repairing and replacing assets, failure of management to provide clear policies and standard guides to maintenance processes, insufficient information on maintenance, and lack of commitment to maintenance plan (Okoro and Anichebe, 2020)

The United Nations Industrial Development Organisation's Report (2016) on maintenance and repairs in developing countries indicated that one of the strongest factors responsible for poor utilization of installed machines and equipment was using the machinery for a very long time without maintenance resulting to breakdowns and stoppages. The poor maintenance of these physical facilities hastened the deterioration and shortened their useful life. The report also noted that improving maintenance culture in developing nations would be one of the most important and effective methods of stimulating industrial development (World Bank, 1995). According to Kans and Galar (2017), poor maintenance culture is partly one of the reasons for breakdown of machinery and partly due to the absence of an appropriate work standard.

The Transport Office which is a unit under the General Administration section of the University mandated to ensure the effective maintenance and management of the fleet of the university. The Transport Unit is also responsible for the movement of both people and goods of the University. This helps speed up the business operations and processes. In other words, the pressure to deliver faster and cheaper goods and services of the University makes it eminent in effective vehicle maintenance and management (Uforo, et.al., 2022). The pivotal role played by the Transport Unit has prompted most organisations to embrace fleet management which include a range of management functions such as vehicle maintenance, vehicle financing, vehicle telemetric (tracking and diagnostic), driver management, fuel management, health and safety management (Choudhary and Vithayathil, 2013)

Problem Statement

A visit to the mechanic shops in Tamale where the University maintains its vehicles revealed that most of the vehicles were packed and left unattended to. The Transport Officer (TO) reported to the 9th Transport Committee meeting that a number of the University's vehicles were involved in accidents while others had broken down. Similarly, reports from the Assistant Transport Officers (ATO) indicated that most of the vehicles had broken down and were packed on stones in the campuses whilst some have been left at the mercy of the weather at mechanics shops. The Assistant Transport Officers reported the following: six vehicles had broken down at Wa Campus and nearly all the other vehicles need replacement of tyres; nine vehicles had broken down at Navrongo, five needed tyres and batteries, one needed a steering motor; and eight vehicles had broken down at Nyankpala, four needed tyres. This phenomenon questions the maintenance culture of the University for Development Studies. In one mechanic shop, one of the vehicles had been packed there for nearly seven years though the owner of

the shop has passed on and yet the vehicle was still left there. However, the cost of maintenance of the vehicles continues to increase though the maintenance does not meet the required standards. This has therefore challenged the researcher to assess the maintenance culture of vehicles and its associated costs in the University for Development Studies at the Central Administration, Tamale Campus in order to propose solutions to maintenance problems facing the University with the associated high cost of maintenance.

Review of related literature

Concept of Maintenance

The universal definition of maintenance is based on minimum principle of conservation and long-life cycle on structure, systems and equipment. The structure refers to something constructed such as a building; the system consists of the components installed on the equipment and structure such as civil system, mechanical system and electrical equipment. These are referred to as devices, machines, tools, and vehicles. Therefore, all these items are tangible assets and have a life cycle that is required to be maintained and protected properly. The word maintenance is a noun derived from the verb "to maintain" that mean process of keeping something in good condition (Okoro and Anichebe, 2020). The process of maintenance is concerned with tasks or activities to restore the equipment in its standard operating condition, at minimum cost throughout their life cycle.

According to British Standard 3811:1984, maintenance can be classified as a combination of all technical, administrative and managerial actions during the life cycle of an item intended to retain it in, or to restore it to a state in which it can perform the appropriate function (Wordsworth, 2001). A combination of any action comprising of technical, administrative and managerial that conjoins with each other is maintenance work. While 'to retain' and 'to restore' this item is a process of work accomplished in anticipation of failure(retain) and work carried out after failure (restore). Meanwhile, the required function or acceptable condition is referred to the acceptability of the person who is paying for the work to the person receiving benefit or to some outside body with responsibility for enforcing minimum standards (Tubis and Werninska-Wojciechowska, 2015). In other words, maintenance is defined as an action carried out by a group of persons to protect, preserve and maintain the systems, equipment and structures to ensure the asset is capable to function effectively. Thoben, et. al. (2017) stated that the aims of maintenance from the automobile perspective are:

1) increase the maximum benefit, especially to owners;
2) get maximum performance at a lower cost, especially public owned vehicles; and

3) provide comfort and peace building, especially to vehicle occupants

According to Okoro and Anichebe (2020), maintenance is the vital work to keep the body, equipment and machines in proper and required standard operating conditions. Therefore, maintenance is considered as a vital part and a necessity in human and non-human resource management if they are to be continuously functional. Maintenance can be summed up as the repair and upkeep of existing equipment, buildings and facilities to keep them in a safe, effective as designed condition so that they can meet their intended purpose (Mong et al., 2018). Every equipment or facility has a predetermined expected standard of performance, and maintenance supports for the equipment or facility to meet this performance standard. Effective maintenance denotes how the maintenance objectives are met with regards the approval of both internal and external and customer requirements (Vilarinhoa, et. al., 2017).

Okoro and Anichebe (2020), classified maintenance into two groups consisting of preventive and corrective maintenance. Maintenance that is carried out at a predetermined interval in order to reduce the likelihood of an item not to meet acceptable condition is referred to as preventive maintenance. This category of maintenance is necessary for the extension of the lifespan of an equipment and improve the overall readiness to perform its functions (Sharma and Bahadoorsingh, 2005). It includes a number of component tasks that could be broadly classified either as performance monitoring or maintenance tasks. The performance monitoring tasks include inspection and non-destructive testing (NDT) while maintenance tasks include lubrication, routine cleaning, adjusting of machines and minor components replacement (Quatrini, et. al., 2020).

According to Vilarinhoa, et. al., (2017) preventive maintenance is any planned maintenance activity designed to improve equipment life and avoid any unplanned/unscheduled maintenance activities. It is a systematic approach to a regular inspection carried out at a predetermined interval or in accordance to prescribed criterion, intended to reduce or preferably eliminate probability of failure or performance of degradation of an item/equipment. The aim of preventive maintenance is to reduce the number of failures and their financial expenditure by performing maintenance at a predetermined point of time without considering the component/equipment condition. Preventive maintenance involves inspection, testing, repairing and replacement of equipment before failure occurs, and is in most cases applied to complex systems in order to avoid operational failure especially when the consequences of the failures are critical, with regards to environment, economy or safety (Otoo and Transport Section, 2018).

Corrective maintenance can be defined as the maintenance carried out to restore (including adjustment and repair) an item which has ceased to

meet an acceptable condition (Igboanugo and Aigbe, 2003). Corrective maintenance is usually associated with terms like overhauling, refurbishing and turn-around-maintenance (TAM). According to Al-Najjar (2007)), corrective maintenance may consist of maintenance activity which includes repair, restoration or replacement of components that have undergone failure or that has totally broken down. The challenges as explained by Mobley (2002) is to detect problems that are beginning to develop, before they lead to total failure and to correct the faults at the lowest possible cost. One of the advantages of adopting corrective maintenance is that the machines are not over maintained and machine condition is not monitored. However, its disadvantages lie in the increase of production downtime, overtime labour, high cost of spare parts as well as risk of secondary failures. Preventive maintenance is normally planned while corrective maintenance may or may not be planned.

Maintenance has been grouped as follows: routine, planned, preventive, predictive, breakdown, predictive, corrective, design out maintenance, total productive maintenance and contracted out maintenance (Al-Najjar, 2007). The type of maintenance to be employed by any industry depends on the maintenance objectives of the industry. Also, the specific and operational objectives of maintenance are determined by the nature of the organisation's business. Therefore, in order to ensure effectiveness, the objectives of maintenance must be clearly defined to be understood by all stakeholders in the organisation. Maintenance is primarily to:

1) sustain equipment and facilities as designed, in a safe, effective operating condition;
2) ensure production targets are met economically and on time;
3) prevent unexpected breakdown of machinery and equipment;
4) extend the useful life of equipment; and
5) ensure the safety of personnel using the system.

The need for reliability and dependability of equipment as well as compulsion to save cost in all areas are satisfied by these objectives.

Concept of Culture

Culture is difficult to define because it has multitude dimensions, each with its own slight variation depending on the focus of the study. According to the Advanced Learner's Dictionary, culture is a way of life which consists of language, arts and thought, spiritually, social activity and interaction. Generally, culture is about inherited ideas, beliefs, values and knowledge that contribute to the shared bases of social actions (Tijani, et. al., 2016). Culture is the key that influences behaviour of getting things done the right way without which goals would have been hindered from being achieved (Brendan, 2006). Culture is shaped by the interaction between

individuals and groups who share the value, perception and goals they have learned from previous generations. The context of culture has been used in organisations when culture is created in the organisation of social relationship among members through the way of thinking, behaviour and belief.

According to Kportufe (2015) culture is a social and collective phenomenon which refers to the ideas and values of a social group and how it is influences their actions without noticing it explicitly. According to him, the cultural elements are value, knowledge, beliefs, legislation and rituals. Other researchers, Okoro and Anichebe (2020) defines culture as a mental coding which allows acting coherently. In general, culture is defined as the overall activity of human behaviour, the arts, beliefs, values, attitudes, practices and all human works and ideas that influences each member in the organisation.

The Role of Culture in Maintenance

Culture of maintenance is important to elevate maintenance performance which would directly lead to enhanced facilities performance. It is an alternative for improving maintenance commitment and creating maintenance awareness among all parties in maintenance management. Culture is not something that can be described only by the treatment and the actions of each member of the group as they interact with one another. These actions and behaviours relate to the things to do and what we want to achieve for an organisation (Diaz- Cabrera et al., 2007). Therefore, culture is an important element of acting in creating individual behaviour and then transmiting it to the whole group or organisation. It has also been referred to as the conventional way of how the group members think and act, understand and appreciate the reality and identify problem solving in organisations. The aim of developing maintenance culture is to build general awareness of the importance of maintenance concerning maintenance work.

The definition of maintenance culture has not been described in detail by the literature. However, the scope of the definition has similarities with the culture in other fields. The concept of maintenance culture is the internal environment between management and staff in managing maintenance effectively through the sharing of ideas, beliefs and values for each member in the organisation (Mark et al., 2006).

Maintenance culture is a way of thinking and behaviour that can be drawn based on the actions taken by each individual in maintaining, preserving and protecting a system, equipment and structures. Cultural beliefs, values, norms, practices and attitudes related to maintenance work should be embedded in every individual organisation carrying out maintenance services activities based on human resource development.

The phrase maintenance culture could therefore be seen as an important one that should be defined to have a proper understanding of what it stands for in the process of sustainable development. Ajibola (2009) defines culture as "the shared belief and values of a group; the beliefs, customs, practices and social behaviour of a particular nation or people". He defined maintenance as "the work that is done regularly to keep a machine, building or a piece of equipment in good conditions". He expatiated further that maintenance is a combination of actions carried out to retain an item in or to restore the item to an acceptable condition. Adeleye (2009) sees maintenance as involving keeping equipment and mechanized infrastructure in operational conditions for continual use. The word maintenance to Eti et al., (2006) means preserving and keeping in good order as near as possible in their original state. By implication, maintenance means keeping in good order and shape all projects of development that are of benefit to the people. Maintenance as defined by Federal Ministry of Works and Housing (FMW&H in the Central Bank of Nigeria Document, 2003) is a means of correcting deficiencies that have developed as a result of age and use.

The concept of maintenance culture focuses on the design and implementation of a technical procedure that supports the prevention or correction of premature failure of engineering systems with least cost and time without compromising the system performance and safety parameters. Developing good maintenance culture in industries requires a human resource organisational framework. The strategies would be based on definite corporate focus and objectives while the functionality of the human element depends on factors like qualification, motivation, inter-personal relationships, training and retraining. It has been found that a good production system is usually backed up by an effective maintenance system; evaluating maintenance culture is an important ingredient in the effort to enhance profitability in the manufacturing industries (Thoben, et. al. 2017).

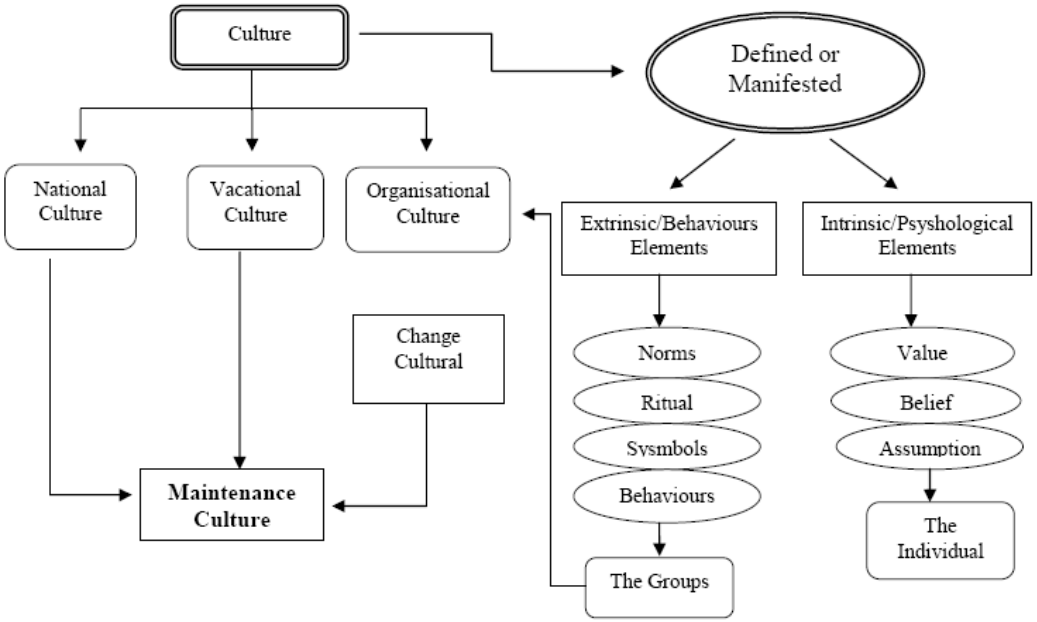

Figure 1. Framework of maintenance culture development: (Mohd Saidin 2008)

Cost-effective maintenance

According to Marais and Saleh (2009) cost-effective maintenance is the measure of how much of the considered maintenance policy is economically beneficial in the long run whereby two situations (before and after maintenance improvement) is compared with the use of a dimension less ratio. Generally, the improvement of a maintenance policy performance aims to reduce production cost while increasing profitability and competitiveness of the company through enhancing process availability, performance efficiency and quality rate (Marais and Saleh, 2009).

The author further expressed that in order to give a good account of maintenance investment, the cost-effective (Ce) of the invested money and the generated improvement (as a result of the investment) can be accessed via the proportion of the difference between (Cb) before and that after the improvement (Ca) to the (Cb) i.e.

Cost-effective maintenance (Ce) = 1 - Ca/Cb

Where (Ca) = after improvement

(Cb) = before improvement

It is possible that at the beginning, $Ce \geq 0$, i.e. ($Cb \geq Ca$) due to extra expenses incurred during or because of the learning period. However, outside this

period, Ce should be greater than zero, (i.e. Cb > Ca) so as to consider improvement as cost-effective action.

Maintenance Planning and Scheduling Tools

Maintenance planning is a structure process to achieve the efficient and effective delivery of maintenance task/schedules, it consists of management activities focused on meeting the organization's objectives and achieving service delivery outcomes through an effective maintenance planning. Maintenance planning involves the collection and analysis of all relevant data, strategy and available resources the deploy a process to develop a plan for the short, medium- and long-term maintenance practices.

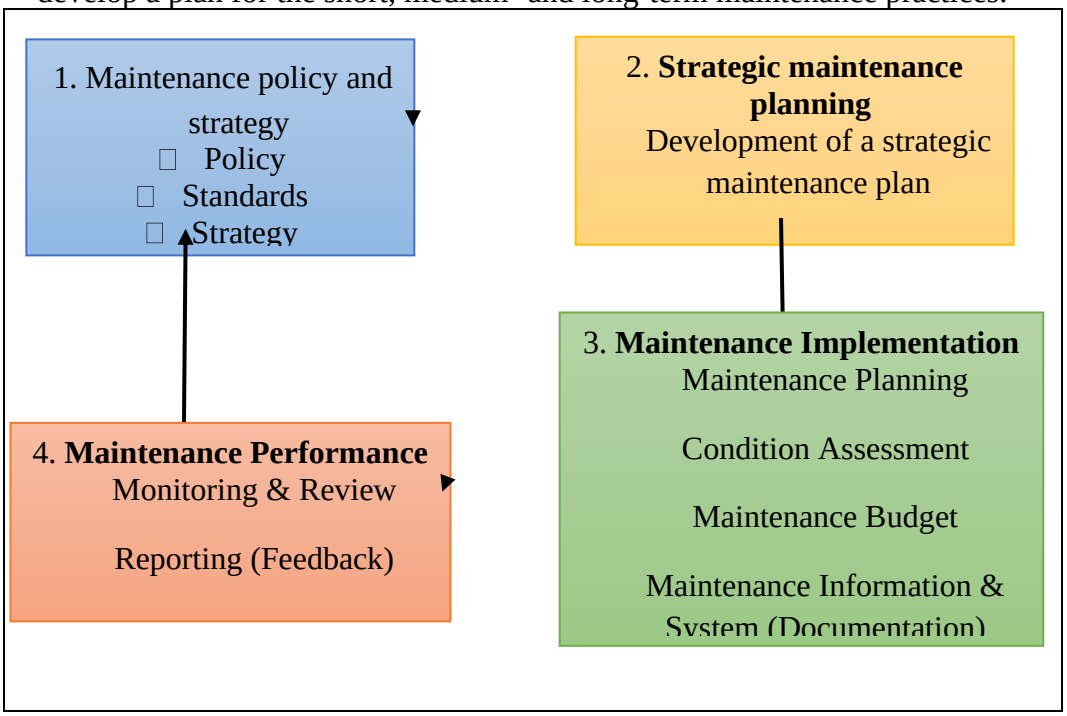

Figure 2. Maintenance Management Process chart:
Sourced: Chanter (2005)

Maintenance planning starts from a clear understanding and review of the company's corporate policy, strategies and service delivery plans to develop effective equipment and building plans to ensure maintenance priorities and strategies are relevant and align with business directions. Maintenance planning provides appropriate maintenance programme and procedures for execution of tasks based on frequent basis (daily, weekly, monthly, yearly etc), depending on available maintenance policy, whereas, planning standard and procedures shall also be laid down.

Strategic maintenance plans affect the implementation of maintenance planning practices and equipment condition assessment.

Maintenance budget is a significant tool as in all maintenance operations and should not be neglected by any means spares of good quality and skilled manpower are obtained from the available budget. Bowers (2005) commented that manpower planning should reflect and identify needs, establish goals and allocate fund to meet goals, scheduling maintenance and allocating funds for implementation, the act which is of great importance towards best maintenance practices.

Documentation, information processing and handling are very important tools in the maintenance planning and implementation. Vehicle data need to be captured stored, processed, shared and updated accordingly to match with technology and business demands.

Planning schedule maintenance activities is a very difficult issue for the public sector, as it is done and stored manually. Processing and keeping data manually does not provide effective maintenance planning and scheduling (Chanter and Swallow, 2007), for that it becomes very difficult to achieve best maintenance practices.

Methodology

Study Area

The data was collected from the University for Development Studies at its Tamale campus specifically the Central Administration. There are 55 vehicles with 30 drivers at the Central Administration used by various offices, directorates and general use (pool). However, data was obtained from 34 vehicles. The Central Administration is the administrative seat of all the principal officers of the University where most of the vehicles are located.

Data collection and procedure

The population consisted of all drivers from the University for Development Studies. The primary data was collected from a sample of 10 drivers including the Acting Transport Officer. The simple random sampling method was used to select the respondents who use the vehicles. The vehicles are allocated to individual drivers and so they ensure that vehicles due for maintenance are taken to the mechanic shops for servicing. Face-to-face interviews with one-on-one respondents were conducted with the selected drivers. The researcher used open ended questions to gather relevant data from the respondents. The secondary data was obtained from mechanics and technicians who have presented their bills for payment at the Transport Office.

Data Analysis

The study used both the qualitative and quantitative methods in analyzing the data that was collected. According to Yin (2013), combining qualitative and quantitative methods of research provides multiple theoretical perspectives. The data was analyzed by first reading through the transcript several times to transcribe the information into formal headings for easy comprehension. The Grounded Theory was employed for the data analysis. This is an inductive approach used to analyze data systematically. It provides the opportunity to collect data, generate and discover a theory (Creswell, 2007).

Each transcript was read line by line, coded and the findings were summarized. Code is a smaller decorative phase to elaborate and explain data, each unit of data was assigned with different codes (Yin, 2013). The codes were utilized, categorized, and highlighted. After making the categories the themes were identified from the data. At a later stage these themes were re-ordered and properly arranged in clusters. The secondary data was inputted into an excel sheet and analyzed. Finally, the data was organized into tables and graphs.

Results and discussion

Maintenance and Repairs of University Vehicles

At the University for Development Studies, the Transport Unit is entrusted with the responsibility of maintaining and repairing all the vehicles of the University. Every Campus has a Transport Unit headed by an Assistant Transport Officer (ATO) who is responsible for the maintenance and repairs of the vehicle. The Transport Officer is however, located in Tamale at the Central Administration. All the ATOs in principle report directly to the Transport Officer. The vehicles are allocated to drivers in the various Schools, Faculties, Directorates, Departments, Sections and Units and they are responsible for the day-to-day care of the vehicles. Under no circumstances should a university driver operate a vehicle that may be unsafe or ignore an unsafe condition.

In terms of maintenance and repairs of the University's vehicles, the drivers alluded to the fact that, effective and proper maintenance will provide many benefits to the vehicle and the University, including saving fuel and money – mechanical systems of the vehicle will affect fuel efficiency; reducing long-term maintenance costs; minimize harmful exhaust emissions and protect the environment; increase reliability of your vehicle and limit the risk of vehicle breakdown and increase the resale value of your vehicle when no more needed. These views are supported by Bolaji and Adejuyigbe's (2012) study who state that a good maintenance culture ensures that equipment functions effectively even when depreciation is measured. It is the regularly and consistently keeping a building, machine, equipment,

infrastructure etc. in good condition (Tijani et al., 2016). In a similar view, Otoo (2018) posits that maintenance culture is an acquired and sustained habit of taking steps to preserve the equipment and facilities used in any organisation.

UDS Policy on vehicle maintenance

The respondents were interrogated to find out if they were aware if a transport policy existed in the University. All respondents responded in the affirmative. This is confirmed in section 10 of the University Transport Policy on maintenance of motor vehicles. It is clearly stated in the policy that all University motor vehicles shall receive the best maintenance practices as recommended by the manufacturers. To this effect: only recognized automobile workshops shall be contracted to service and repair University motor vehicles; and the University shall operate Maintenance Workshops for the purpose of motor vehicle servicing, repairs, and maintenance of its fleet (UDS Transport Policy 2018). This finding is contrary to Mkilania (2016) study which revealed that, lack of a maintenance policy and strategy factor is a very important factor and it ranks number one with Relative Importance Index (RII) of 0.83, since most of the public business objectives, maintenance operational strategies have not been integrated to meet business requirements.

Section 8 of the policy also sets the minimum replacement criteria. The policy underpins that a Minimum Replacement Criteria (MRC) for replacement of University motor vehicles shall be considered as 10 years or a mileage of 250,000 km for station wagons, pick-ups, buses whilst saloon cars will be considered at age 10 years or 200,000 km but with motor cycles attaining age 6 or 150,000 km mileage. It further indicates that the University shall procure only durable motor vehicles that have readily available spare parts on the Ghanaian market, to ease the maintenance of its fleet. To achieve this, the University intends to: limit (where possible) the number of models of motor vehicles purchased; ensure all motor vehicles procured conform with and are adaptable to tropical weather conditions; and ensure that the procurement procedure for University motor vehicles are consistent with the provisions of the Procurement Act 663 (as amended), and the Public Financial Management Act 921, Act 2016, (UDS Statutes, 2017). These underlying statements confirm the study of Wilson (2002) which recommends that an effective maintenance system should have a maintenance policy.

Factors militating against regular maintenance

In response to the factors militating against the regular and effective maintenance system, respondents indicated inadequate finance; access to

qualified mechanics; lack of genuine parts; and late release of funds for maintenance. Mkilania's (2016) study on factors affecting best maintenance practices in Tanzania Public Sector revealed that planning and scheduling, materials management, maintenance task execution, and budgeting were very important on the Relative Importance Index (RII) of 0.81, most significant at 0.79, significant at 0.73, and significant at 0.70. this implies that the identification of the various factors is in line with the study of (Mkilania, 2016).

The role of the Transport Committee

According to the (UDS Statues, 2017), the University Transport Committee is responsible for the development of a procedure for the acquisition and use of University vehicles; develop a mechanism for the inspection of University vehicles; develop a cost-effective fueling and maintenance system in addition to other expert considerations connected with the use and maintenance of the University's vehicles; recommend a sanctions system for persons who may be found culpable in the misuse of University vehicles. It is mandated to meet at least thrice a week. Irrespective of the powers vested in this committee, Management does not adhere to the advice of the committee. The information gathered from the respondents indicates that, in maintenance organisation, a decentralized structure would probably experience a lower utilization than a centralized one but would be able to respond quickly to breakdowns and would achieve higher plant availability (Levitte, 1997). On that basis, there is the need to encourage the decentralization of maintenance activities in the university.

Cost of Maintenance

The study analyzed the cost of maintenance of 34 vehicles at the Central Administration of the University for the fiscal year 2018 and 2019 and found that in 2018, the lowest cost of maintaining one vehicle was GH₵ 1,150.19 and the highest was GH₵ 13,920.29 with a cost variance of GH₵ 12,770.10 between the lowest serviced vehicle and the highest. Similarly, in 2019, the lowest maintenance cost of one vehicle was GH₵ 434.75 and the highest was GH₵ 55,337.54 with a cost variance of GH₵ 54,902.79. Table 1 provides a pictorial illustration of the analysis.

Table 1. Lowest and Highest Cost of Vehicle Maintenance

	2018		2019	
Vehicle No	**Cost Per Annum**	**Vehicle No**	**Cost Per Annum**	**Remarks**
NR 362-12	1,150.19	GE 2425-11	434.75	Lowest Cost
GN 3090-10	13,920.29	NR 362-12	55,337.54	Highest Cost

Source: Field survey, October, 2020

The cost variances are rather very high at both the lowest maintenance level and highest maintenance level. This could be attributed to the fact that the vehicle had problems at the design stage because two of the same brands of vehicles were purchased at the same time and managed by the same institution. It is therefore in line with Omotehinshe, et. al (2015a) assertion that most maintenance and operational cost of physical assets are linked to the decisions taken at the early stage of the machine design. Therefore, it is easier to reduce future maintenance cost at the design stage than the operational stage. This assertion confirms the findings of this study because from all indications that particular vehicle had major problems from its design stage other than the operational stage.

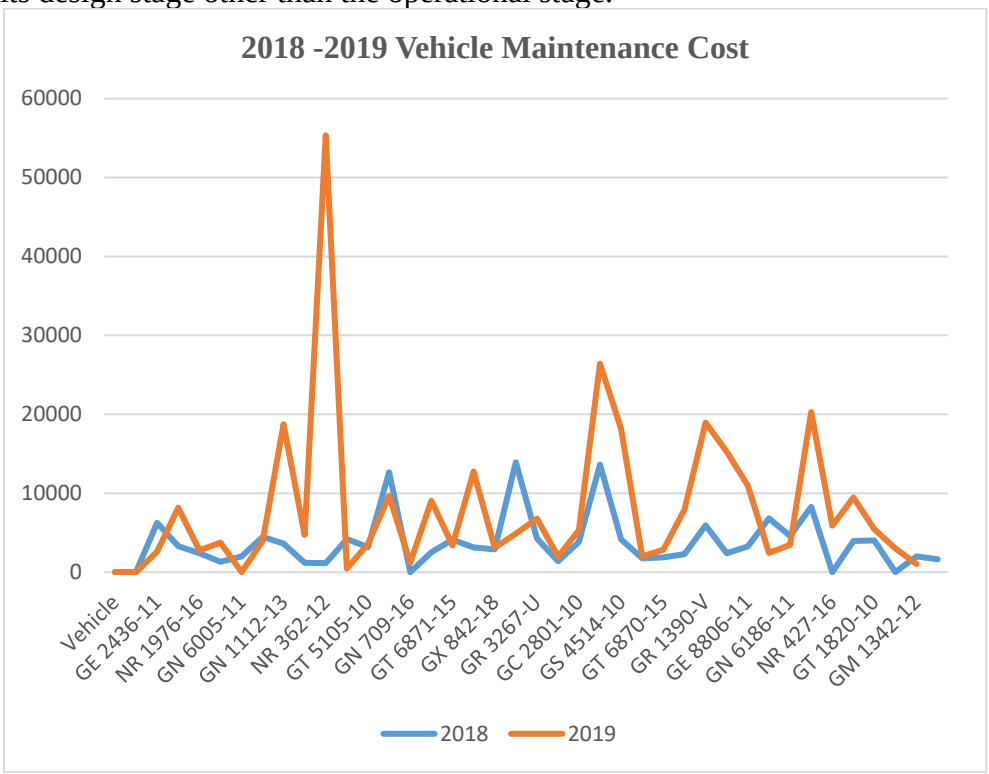

Figure 3. Comparative analysis of 2018 and 2019 maintenance cost.
Source: Field study October, 2020

The study also revealed that two vehicles of the same brand bought the same day had a wider variation pertaining to cost of maintenance. In 2018 GR 294-12 incurred a maintenance cost of GH₵ 1,311.56 and in 2019, GH₵ 3,744.76 was used in maintaining the vehicle while in 2018 NR 362-12 incurred a cost of GH₵1,150.19 and 2019 the maintenance cost

escalated to GH₵ 55,337.54. This supports Omotehinshe, et. al., (2015a) study that high maintenance cost of physical assets is linked to the decisions taken at the early stage of the machine design. The high cost of maintenance is also as a result of poor maintenance. Poor maintenance can be defined as a kind of maintenance that has not been properly done by the mechanic or technician as expected n (Selin and Mahasin, 2016). The poor maintenance of these vehicles accelerated deterioration and shortened their useful life. The report also noted that improving maintenance culture in developing nations would be one of the most important and effective methods of stimulating industrial development (World Bank, 1995). The human factor presented by maintenance technicians and other staff are the backbone of the maintenance system. As such, the effectiveness of the different facets of the performance system is very much dependent on the competency, training, and motivation of the overall human factor in charge of the maintenance system (Ljungberg, 1998). In this context, factors such as years of relevant working experience on the machine, personal disposition, operational reliability, work environment, motivational management, training and continuous education are relevant factors which tend to impact effectiveness of the performance of maintenance systems (Cabahug, Edwards, & Nicholas, 2004). Drivers are in direct contact with maintenance, and are generally able to judge the quality of the service they receive. Below in Table 2 is the maintenance cost of 38 vehicles in 2018 and 2019 at the Central Administration.

Table 2. Analysis of cost of maintenance for 2018 and 2019

	2018	**2019**
Vehicle Number	**Cost Per Annum**	**Cost Per Annum**
GX 842-18	2,874.11	3,084.91
NR 348-17	1,183.43	4,707.54
GW 6671-16	3,122.51	12,745.62
NR 1976-16	2,417.27	2,747.16
GT 6870-15	1,861.23	2,859.60
GT 6871-15	4,108.3	3,360.00
GX 9630-14	3,299.06	8,155.65
GN 1112-13	3,615.37	18,751.90
NR 362-12	1,150.19	55,337.54
GR 294-12	1,311.56	3,744.76
GM 1356-12	1,761.42	1,990.93
GM 1342-12	2008.58	1,032.41
GE 2436-11	6,243.94	2,598.77
GS 1549-11	4,478.75	3,964.59

GE 2425-11	4,191.2	434.75
GE 2426-11	12,656.63	9,653.80
GT 2052-11	1,399.53	1,938.27
GN 8464-11	2408.55	15,238.20
GE 8806-11	3262.35	10,951.53
GN 6186-11	4574.2	3,456.10
GN 8463-11	3933.5	9,445.28
GT 5105-10	3,179.75	3,568.38
GN 3090-10	13,920.29	4,853.32
GC 2801-10	3,812.9	5,299.55
GS 4514-10	4,134.65	18,136.24
GS 5379-10	8265.99	20,275.55
GT 1820-10	4000.55	5,446.80
GT 6632-Z	13,622.74	26,405.63
GR 3194-Y	2,279.5	7,905.25
GT 8584-Y	6809.15	2,456.30
GR 1390-V	5911	18,941.70
GE 4455-V	2,530.72	9,051.39
GR 3267-U	4,257.75	6,767.15
Total	**148, 190.42**	**315, 354.93**

Source: Review of receipts from mechanics

A comparative analysis of the cost of maintenance of 2018 and 2019 indicated that the cost of maintenance is increasing at a geometric rate. In 2018, a total of GH₵ 148,190.42 and in 2019, cost of maintenance of the same number of vehicles amounted to GH₵ 315,354.93 with a cost variance of GH₵ 167,164.51. This is an increase of maintenance cost of 53% within one year. The older vehicles had the probability of experiencing one or more downtimes per year. This finding is also in consonance with the United Nations Industrial Development Organisation's Report on maintenance and repairs in developing countries which indicated that one of the strongest factors responsible for poor utilization of installed machines and equipment was considerable downtime of machinery resulting from breakdowns and stoppages.

Age of Vehicle and cost of maintenance

The newest vehicle was one-year-old and the oldest was sixteen years old. From table 2, the cost of maintenance of the latest vehicles was far cheaper than the older ones. According to international literature it has been proven that older vehicles have more probabilities to increase repair cost

than the younger generation. For example, in Europe vehicles aged 1 -5 years had a 20 to 30 percent likelihood of incurring repair cost in a year. The vehicles 13 to 15 years had likelihood closer to 68 percent. The lowest probabilities range from around 10 percent in their early years to around 50 percent year 14 (Pint, et al., 2008).

Table 3. Age of vehicle and cost of maintenance

		2018	2019
Vehicle No	**Age of vehicle (years)**	**Cost per annum**	**Cost per annum**
GX 842-18	1	2,874.11	3,084.91
GR 3267-U	16	4,257.75	6,767.15

Comparing the performance and cost effectiveness of vehicles age between 15 to 20 years, Pint, et al, (2008) remarks that new vehicles below 5 years old are more cost effective than those 10 years and above. The study revealed that if institutions and organisations adhere to the manufacturer's service standards of 150, 000km, the vehicle can be driven between 15 to 20 years without engine repairs irrespective of the make. But in other manufacturer's literature, after 150,000km there is the probability to incur costs on engine repairs and on major components such as gear box, differential, power steering system, brake system, suspension system and electrical system. In review of the cost of maintenance it is very clear from table 2 how money has been expended on unnecessary repairs.

Conclusion

The study identified that the poor maintenance culture is as a result of poor funding, delay in the release of funds for maintenance, inflation of the cost of spare parts, design errors, use of sub-standard materials, age of vehicles, insufficient knowledge and skills of mechanics and technicians were factors identified as those contributing to problems of effective maintenance culture. The analysis has also shown that the cost elements should be discussed to correspond with the concept of poor maintenance based on the analysis. So that reducing this cost aspect will not only increase the value of maintenance activities, but will also mitigate the risk of having poor maintenance. The study therefore, concludes that the factors identified should be handled effectively to ensure regular servicing of the vehicles is carried out at all times. This will aid better fuel economy, safety, engine reliability at all times and guaranteeing comfortability while driving. Above all the vehicle will last longer. A lot of vehicle operators do risk their lives on the road by managing the vehicle when there is a fault forgetting that it is a risk to manage a faulty vehicle as long as the vehicle is still in motion. This can be dangerous to the driver as well as other road users.

Recommendations

A formalized maintenance department should be established with well qualified and experienced with practical knowledge and skills in vehicle maintenance with a well-equipped workshop with the necessary tools and spare parts. This will allow fast and quick response to vehicle maintenance issues.

As part of the annual budget for the university, the vehicle maintenance budget should be used solely for vehicle maintenance. This will avoid any shortfalls in budget constraints.

Regular maintenance must be conducted on vehicles as such Management should develop continuous training programmes for drivers to upgrade their knowledge and skills as a pillar for proper maintenance culture development. Investing on driver mechanics will be an efficient approach, even though the cost of training will increase, the value of maintenance will surplus this cost in the long term.

Over-aged vehicles should be withdrawn from the fleet of vehicles and be replaced with new ones to reduce frequent breakdowns, high maintenance cost and high fuel consumption.

Design, purchase and new installation should be meticulously evaluated before decisions on such issues are made to forestall inadequacy of maintenance personnel skills and spare parts.

Maintenance personal should undertake repair and servicing of vehicles and must be aware of the importance of preventive maintenance to reduce vehicle breakdown

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