ESJ Humanities

Assessment of Vehicle Maintenance Culture and Its Cost-Effectiveness: The Case of the University for Development Studies

Seniwoliba, A. J.
Faculty of Agriculture, Food and Consumer Sciences,
University for Development Studies, Ghana
Awuni, A. M.
Directorate of Works and Physical Development,
University for Development Studies, Ghana

Doi:10.19044/esj.2023.v19n2p18

Submitted: 05 October 2022
Accepted: 10 January 2023
Published: 31 January 2023

Cite As:
Seniwoliba A.J. & Awuni A.M. (2023). *Assessment of Vehicle Maintenance Culture and Its Cost-Effectiveness: The Case of the University for Development Studies*. European Scientific Journal, ESJ, 19 (2), 18. https://doi.org/10.19044/esj.2023.v19n2p18

Abstract

The University for Development Studies is a public university in Ghana that owns and manages a fleet of vehicles. The university, however, faces numerous challenges in terms of maintaining its fleet of vehicles. Reports from the various campuses of the university indicate that most of the vehicles that broke down were at various mechanic shops and needed urgent attention. In order to propose solutions to the university's problems, the study sought to discover the causes of the university's vehicles' frequent breakdowns, why most of the vehicles were left unattended at the various mechanic shops, and why the cost of vehicle maintenance was so high. The study population comprised 55 vehicles and 30 drivers who use the vehicles in the various offices, directorates, and the pool (general usage) at the Central Administration. However, data on 34 vehicles were available for the study, which was far more than the needed representation. Ten drivers were sampled to participate in the study using a simple random sampling approach. Face-to-face interviews and one-on-one correspondence were conducted with the selected sample (drivers). The researchers used open-ended questions to gather relevant data from the respondents. The secondary data was obtained

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

from mechanics and technicians who presented their bills for payment at the Transport Office of the University. Both qualitative and quantitative methods were used in analyzing the data collected. The data were analyzed using grounded theory and Excel sheets. The study revealed issues such as frequent vehicle breakdowns that went unattended at mechanic shops and high maintenance costs as a result of a poor maintenance culture, insufficient funding, delays in the release of funds for maintenance, inflation of the cost of spare parts, the use of substandard materials, the age of the vehicle, and the insufficient knowledge and skills of mechanics and technicians. It is therefore recommended that a formalized maintenance department be established within the university and sufficiently equipped with tools and spare parts. The department should be staffed with well-qualified and experienced mechanics with the requisite practical knowledge and skills in vehicle maintenance. This will allow fast and quick responses to vehicle maintenance issues.

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

Introduction

Ghana, like most African nations and indeed most developing nations, has state-owned organizations with very poor maintenance cultures, which is responsible for the deplorable state of many of the nation's monuments, institutional vehicles, infrastructure, and administrative buildings today. However, the growth and development of higher educational institutions depend greatly on their infrastructural development, which includes buildings, vehicles, workshops, laboratories, libraries, and laboratory equipment. For these infrastructures to stand the test of time and perform their intended function and contribute to institutional development, there must be a culture of maintenance.

Maintenance cultures have been acknowledged as a significant barrier to improving the quality of maintenance work on vehicles. Despite being unique to each organization, the culture within organizations needs to evolve to suit the ever-changing market dynamics, demands, and trends. The habit of maintenance culture should start with a change of mindsets and attitudes toward 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 a machinery or equipment, to an appreciable and acceptable standard. Without proper maintenance, there can be losses in production that could greatly affect profit, gains, and the reputation of the institution.

Maintenance is necessary not only to maintain the function of the vehicle but to minimize maintenance costs and to ensure a safe environment for vehicle

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

occupants. The issue of maintenance often confronts educational institutions in Ghana, especially with respect to weaknesses in managing and maintaining vehicles. This item is associated in most studies with a lack of management commitment to respond promptly to dexterous and responsive maintenance work. These issues arise as a result of poor maintenance work, a lack of maintenance ethics, ignorance of the fundamentals of maintenance schedules, inexperienced unskilled workers, a lack of proper supervision from supervisors, delays in repairing and replacing parts, management's failure to provide clear policies and standard guidelines to maintenance processes, insufficient maintenance information, and a lack of commitment to the maintenance plan (Okoro and Anichebe, 2020).

The United Nations Industrial Development Organization Report (2016) on maintenance and repairs in developing nations 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 in breakdowns and stoppages. The poor maintenance of these physical facilities hastens their deterioration and shortens their useful lives. 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 one of the causes of machinery breakdowns, as is the absence of an appropriate work standard.

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

Problem Statement

The University for Development Studies owns and manages a fleet of vehicles. These vehicles frequently break down; some are packed at mechanic shops unattended, leading to transportation inadequacies within the work environment, and the maintenance cost is becoming increasingly high. These challenges were confirmed when the Transport Officer (TO) reported to the

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

9th Transport Committee meeting that a number of the university's vehicles were involved in accidents while others had broken down and were at different mechanic shops. Similarly, reports from Assistant Transport Officers (ATO) from the university's various campuses indicated that most of the vehicles had broken down and were packed on stones on the campuses, while others had been abandoned to the elements at mechanics' shops. According to the reports, some of the vehicles required new tires, batteries, and steering motors. It was also reported that in one of the mechanic shops, one of the vehicles had been packed there for nearly seven years, even though the owner of the shop had passed on to glory, the vehicle was still left there unattended. This phenomenon triggers questions about the maintenance culture at the university. These issues prompted the researchers to investigate the causes of the vehicles' frequent breakdowns, why most of the vehicles were left unattended at the various mechanic shops, and why the cost of vehicle maintenance was extremely high in order to provide solutions to the university's maintenance challenges.

Review of Related Literature

Concept of Maintenance

The universal definition of maintenance is based on the minimum principles of conservation and long-life cycles for structures, systems, and equipment. The structure refers to something constructed, such as a building, and the system consists of the components installed on the equipment and structure, such as the civil system, mechanical system, and electrical equipment. These are referred to as devices, machines, tools, and vehicles. Therefore, all these items are tangible assets with life cycles that are required to be maintained and protected properly. The word "maintenance" is a noun derived from the verb "to maintain" which means a 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 to its standard operating condition at a minimum cost throughout its 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 restore it to a state in which it can perform the appropriate function (Wordsworth, 2001). Maintenance work consists of any combination of technical, administrative, and managerial actions. While "to retain" and "to restore" this item are processes of work accomplished in anticipation of failure (retain) and work carried out after failure (restore), the required function or acceptable condition is referred to as the acceptability of the person who is paying for the work to the person receiving benefits or to some outside body with responsibility for enforcing minimum standards (Tubis and Werninska-Wojciechowska, 2015). In other

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

words, maintenance is defined as an action carried out by a group of persons to protect, preserve, and maintain the systems, equipment, and structure to ensure the asset is capable of functioning effectively. Thoben et al. (2017) stated that the aims of maintenance from the automobile perspective are:

- increase the maximum benefit, especially for owners;
- get maximum performance at a lower cost, especially public-owned vehicles, and
- provide comfort and peacebuilding, especially to vehicle occupants.

According to Okoro and Anichebe (2020), maintenance is the vital work needed to keep the body, equipment, and machines in proper and required standard operating conditions. Therefore, maintenance is considered 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, and designed condition so they can meet their intended purpose (Mong et al., 2018). Every piece of equipment or facility has a predetermined standard of performance, and maintenance support is provided to ensure that this standard is met. Effective maintenance denotes how the maintenance objectives are met with regard to the approval of both internal and external customer requirements (Vilarinhoa et al., 2017).

Okoro and Anichebe (2020) classified maintenance into two groups consisting of preventive and corrective maintenance. Preventive maintenance is maintenance performed at predetermined intervals to reduce the likelihood of an item failing to meet acceptable standards. This type of maintenance is required to extend the equipment's lifespan and improve its 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. Performance monitoring tasks include inspection and non-destructive testing (NDT), while maintenance tasks include lubrication, routine cleaning, adjusting of machines, and minor component 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 or unscheduled maintenance activities. It is a systematic approach to a regular inspection performed at predetermined intervals or in accordance with prescribed criteria, with the goal of reducing or, preferably, eliminating the likelihood of failure or performance degradation of an item or piece of equipment. The aim of preventive maintenance is to reduce the number of failures and their financial expenditure by performing maintenance at a predetermined point in time without considering the component or equipment condition. Preventive maintenance entails inspecting, testing,

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

repairing and replacing equipment before failure occurs and is typically applied to complex systems to avoid operational failure, particularly when the consequences of the failures are critical in terms of the environment, economy, or safety (Otoo and Transport Section, 2018).

Corrective maintenance is maintenance carried out to restore (including adjustment and repair) an item that 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 that includes repair, restoration, or replacement of components that have failed or have totally broken down. The challenges, as explained by Mobley (2002), are to detect problems that are beginning to develop before they lead to total failure and 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 their conditions are not monitored. However, its disadvantages lie in the increase in production downtime, overtime labor, high cost of spare parts, and 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, corrective, designed-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 industry's maintenance objectives. Also, the specific and operational objectives of maintenance are determined by the nature of the organization's business. Therefore, in order to ensure effectiveness, the objectives of maintenance must be clearly defined and understood by all stakeholders in the organization. Maintenance is primarily for

- sustain equipment and facilities as designed in a safe and effective operating condition;
- ensure production targets are met economically and on time;
- prevent unexpected breakdowns of machinery and equipment;
- extend the useful life of equipment; and
- ensure the safety of personnel using the system.

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

Concept of Culture

Culture is difficult to define because it has a multitude of 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

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

that consists of language, arts and thought, spirituality, social activity, and interaction. Culture, in general, refers to inherited ideas, beliefs, values, and knowledge that contribute to the shared foundations of social actions (Tijani et al., 2016). Culture influences behavior in getting things done correctly, and without it, goals are hampered (Brendan, 2006). Culture is shaped by the interactions between individuals and groups that share the values, perceptions, and goals they have learned from previous generations. The context of "culture" has been used in organizations when culture is created in the organization through social relationships among members through ways of thinking, behaving, and believing.

According to Kportufe (2015), "culture" is a social and collective phenomenon that refers to the ideas and values of a social group and how they influence their actions without noticing it explicitly. According to him, the cultural elements are values, knowledge, beliefs, legislation, and rituals. Other researchers, Okoro and Anichebe (2020), define culture as a mental coding that allows coherent behavior. Culture is defined broadly as the overall activity of human behavior, which includes the arts, beliefs, values, attitudes, practices, and all human works and ideas that influence each member of the organization.

The Role of Culture in Maintenance

A culture of maintenance is important to elevate maintenance performance, which would directly lead to enhanced facility 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 actions of each member of the group as they interact with one another. These actions and behaviors relate to what to do and what we want to achieve for an organization (Diaz-Cabrera et al., 2007). Therefore, culture is an important element of action in creating individual behavior and then transmitting it to the whole group or organization. It has also been referred to as the "traditional way" in which group members think and act, understand and appreciate reality, and identify and solve problems in the organization. The aim of developing a maintenance culture is to build general awareness of the importance of maintenance work.

The definition of maintenance culture has not been described in detail in the literature. However, the scope of the definition has similarities with the culture in other fields. The concept of "maintenance culture" refers to the internal environment created by management and staff to effectively manage maintenance by sharing ideas, beliefs, and values with each member of the organization (Mark et al., 2006).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Maintenance culture is a way of thinking and behaving that can be drawn based on the actions taken by each individual in maintaining, preserving, and protecting a system, equipment, and structure. Cultural beliefs, values, norms, practices, and attitudes related to maintenance work should be embedded in every individual organization carrying out maintenance services and 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 beliefs and values of a group; the beliefs, customs, practices, and social behavior of a particular nation or people." He defined maintenance as "the work that is done regularly to keep a machine, building, or piece of equipment in good condition." He goes on to say that maintenance is a collection of actions taken to keep or restore an item to an acceptable condition. Adeleye (2009) sees maintenance as involving keeping equipment and mechanized infrastructure in operational condition for continual use. According to Eti et al. (2006), the term "maintenance" means preserving and keeping in good order as close to their original state as possible. By implication, maintenance means keeping in good order and shaping all projects of development that are of benefit to the people. Maintenance, as defined by the Federal Ministry of Works and Housing (FMW&H) in the 2003 Central Bank of Nigeria document, is a means of correcting deficiencies that have developed as a result of age and use.

The concept of "maintenance culture," as shown in Figure 1, focuses on the design and implementation of a technical procedure that supports the prevention or correction of premature failure of engineering systems with the least amount of cost and time without compromising the system's performance and safety parameters. Developing a good maintenance culture in industries requires a human resources organizational 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, interpersonal 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).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

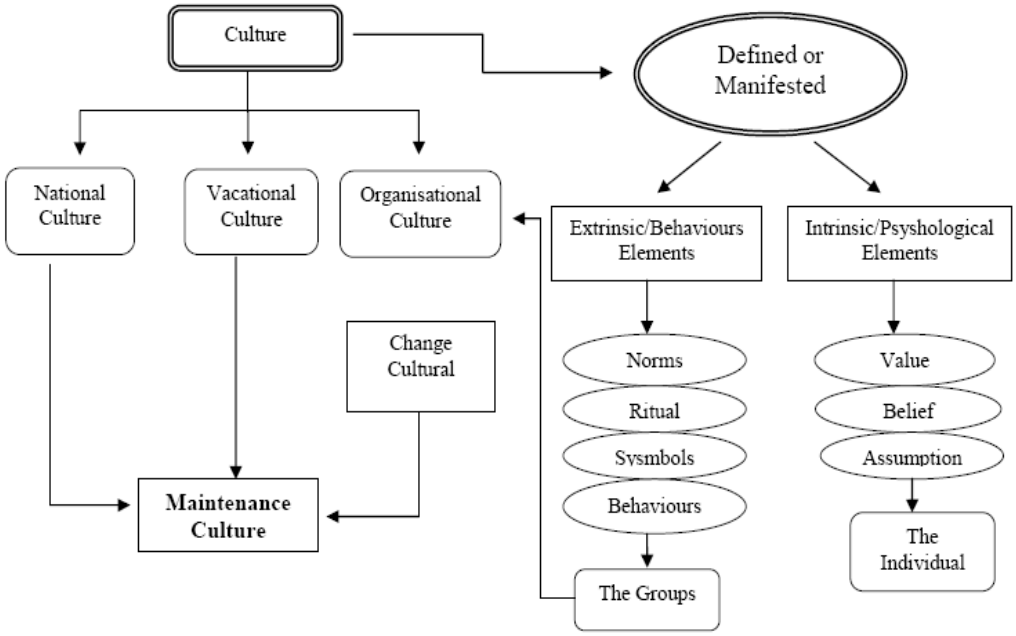

Figure 1. Framework for Maintenance Culture Development (Mohd Saidin, 2008)

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) are compared with the use of a dimensionless ratio. In general, improving the performance of a maintenance policy aims to reduce production costs while increasing the company's profitability and competitiveness through improved process availability, performance efficiency, and quality rate (Marais and Saleh, 2009).

The cost-effectiveness (Ce) of the invested money and the generated improvement (as a result of the investment), according to the author, can be accessed via the proportion of the difference between (Cb) before and after the improvement (Ca) to the (Cb), i.e.

Cost-effective maintenance (Ce) = Ca/Cb

Ca denotes after improvement.

(Cb) = before improvement

It is possible that at the beginning, Ce ≥ 0, i.e., Cb ≥ Ca, is 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 a cost−effective action.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Maintenance Planning and Scheduling Tools

Maintenance planning is a structured process to achieve the efficient and effective delivery of maintenance tasks and schedules. It consists of management activities focused on meeting the organization's objectives and achieving service delivery outcomes through effective maintenance planning. Maintenance planning involves the collection and analysis of all relevant data, strategies, and available resources, followed by the deployment of a process to develop a plan for the short-, medium-, and long-term maintenance practices.

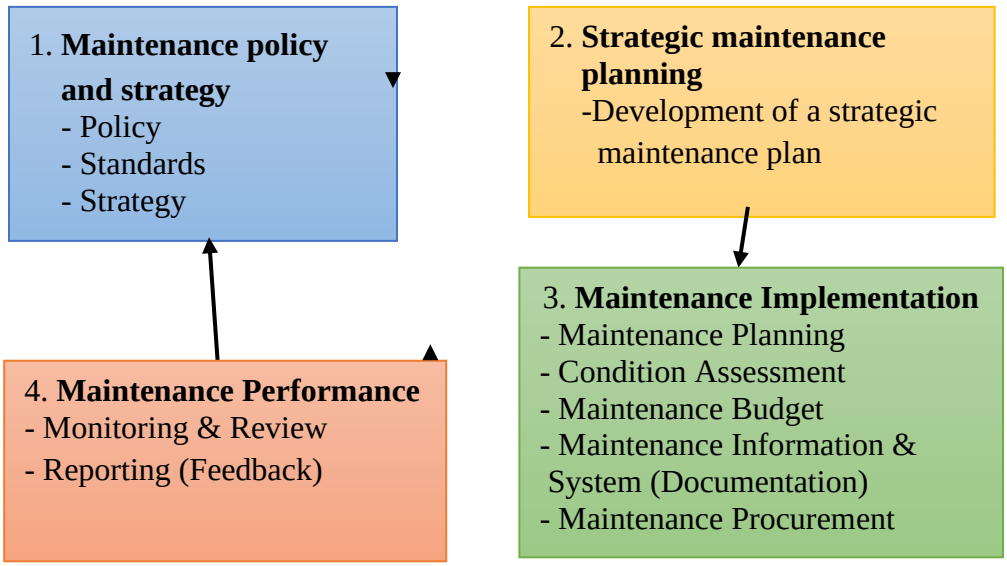

Figure 2. Maintenance Management Process Chart
Source: Adopted from Mkilania (2016)

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

Strategic maintenance plans, as indicated in Figure 2, affect the implementation of maintenance planning practices and equipment condition assessment. A maintenance budget is a significant tool in all maintenance operations and should not be neglected by any means. Spares of good quality

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

and skilled manpower are obtained from the available budget. Mkilania (2016) commented that manpower planning should reflect and identify needs, establish goals, and allocate funds to meet those goals, including scheduling maintenance and allocating funds for implementation, an act of great importance towards best maintenance practices.

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

Scheduling 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), so it becomes very difficult to achieve best maintenance practices.

Methodology

Study Area

The data was collected from the University for Development Studies at its Central Administration, Tamale Campus. There were 55 vehicles at the Central Administration, used by various offices and directorates and for general use (the pool) by 30 drivers. However, data were 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 respondents who use vehicles were chosen using a simple random sampling method. The vehicles were 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 and one-on-one correspondence were conducted with the selected drivers. The researchers 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 data were analyzed using both qualitative and quantitative methods. 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. A grounded theory

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

was employed for the data analysis. This is an inductive approach used to analyze data systematically. It provides the opportunity to collect data, generate theories, and discover a theory (Creswell, 2007). It is often viewed as both a process and a product of social research. The grounded theory has been argued to be the most utilized contemporary qualitative research methodology (Guetterman et al., 2017), but is not limited solely to the collection and analysis of qualitative data, having been employed in both quantitative and mixed research methods (Glaser, 2008; Holton and Walsh, 2017; Johnson and Walsh, 2019). Because of its positivist and post-positivist epistemological roots, as well as the systematic and rigorous foundational aspects advanced by its co-founders, it is likely to be a particularly appealing "transition methodology" for quantitatively trained scholars interested in adopting qualitative methodologies for their research or incorporating it into mixed methods designs (Guetterman et al., 2017).

Each transcript was read line by line, coded, and the findings were summarized. Coding is a smaller decorative phase to elaborate and explain data such that each unit of data is assigned a different code (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

The study discovered that the Transport Unit was entrusted with the responsibility of maintaining and repairing all the vehicles of the university. It was also observed that every campus had a transport unit headed by an assistant transport officer (ATO) who was responsible for the maintenance and repairs of the vehicles. The transport officer was, however, located in Tamale at the Central Administration. In principle, all the ATOs report directly to the Transport Officer. The vehicles were allocated to drivers in the various schools, faculties, directorates, departments, sections, and units, and they were responsible for the day-to-day care of the vehicles. Under no circumstances should a university driver operate a vehicle that might have been classified as unsafe or ignore its unsafe conditions while using it.

The study sought to find out the benefits of effectively maintaining vehicles at the university. The drivers alluded to the fact that effective and proper maintenance will provide many benefits to the vehicles and the university, including saving fuel and money. They contended that when the mechanical systems of the vehicles are working effectively, it will improve fuel efficiency, reduce long-term maintenance costs, minimize harmful

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

exhaust emissions, protect the environment, increase reliability of the vehicle, limit the risk of vehicle breakdown, and increase the resale value of the vehicle when no more is needed. These views are supported by Bolaji and Adejuyigbe's (2012) study, which posits that a good maintenance culture ensures that equipment functions effectively even when depreciation is measured. A building, machine, equipment, infrastructure, etc. has a long life span because it is regularly and consistently maintained in good condition (Tijani et al., 2016). In a similar view, Otoo and Transport Section (2018) posit that "maintenance culture" is an acquired and sustained habit of taking steps to preserve the equipment and facilities used in any organization.

UDS Policy on Vehicle Maintenance

The purpose of policy formulation is to provide guidance and direction for organizations and institutions. The study interrogated respondents to find out if they were aware there was a transport policy at the university. All respondents replied in the affirmative. This is confirmed in Section 10 of the University Transport Policy on the 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 in conformity with the Mkilania (2016) study, which revealed that the lack of a maintenance policy and strategy factor is a very important factor, and it ranks number one with a Relative Importance Index (RII) of 0.83 since most of the public business objectives have not been integrated to meet business requirements.

The study also observed that, though Section 8 of the transport policy sets the minimum replacement criteria for university motor vehicles at 10 years or a distance coverage of 250,000 km for station wagons, pick-ups, and buses, while sedans are considered at age 10 or 200,000 km and motorcycles at age 6 or 150,000 km mileage, yet management does not adhere to these principles. The policy also makes it clear that the university shall procure durable motor vehicles that have available spare parts on the Ghanaian market in order to ease the maintenance of the fleet. As a result, the university decided to limit the number of motor vehicle models purchased (as much as possible).Furthermore, while ensuring all motor vehicles procured conform to and are adaptable to tropical weather conditions, and while ensuring that the procurement procedure for university motor vehicles is 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

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

statements confirm the study of Wilson (2002), which recommends that an effective maintenance system should be guided by a maintenance policy.

Factors militate against regular maintenance.

The prime objective of the study was to find out the causes of the frequent breakdowns of university vehicles. To ascertain the facts prevailing, a question was formulated to find out the factors militating against the regular and effective maintenance system of the university. In reaction, the respondents mentioned inadequate finance, poor knowledge and skills of mechanics, the use of cheap and fake spare parts, failure to adhere to planned maintenance systems, and management's delay in the release of funds for maintenance. Mkilania's (2016) study on factors affecting best maintenance practices in the Tanzanian public sector revealed that planning and scheduling, materials management, maintenance task execution, and budgeting were very important on an 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 consistent with the study of Mkilania (2016).

The Role of the Transportation Committee

The study discovered from the UDS Statutes (2017) that there existed a University Transport Committee responsible for the development of plans and procedures for the acquisition and use of University vehicles; the development of mechanisms for the inspection of the University vehicles; the development of a cost-effective fueling and maintenance system in addition to other expert considerations connected with the use and maintenance of the University's vehicles; and the recommendation of disciplinary procedures for persons who may be found culpable in the misuse of University vehicles. The committee was mandated to meet at least three times a year. Irrespective of the powers vested in this committee, management does not adhere to the policy advice of the committee. The information gathered from the respondents indicates that, in maintenance organizations, a decentralized structure would probably experience lower utilization than a centralized one but would be able to respond quickly to breakdowns and would achieve higher plant availability (Otoo and Transport, 2018). On that basis, there is a need to encourage the decentralization of university maintenance activities.

Cost of Maintenance

The study analyzed the cost of maintenance for 34 vehicles at the Central Administration of the University for the fiscal years 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

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

highest was GH 55,337.54 with a cost variance of GH 54,902.79. Table 1 provides an illustration of the analysis.

Table 1. Lowest and Highest Costs of Vehicle Maintenance

	2018		2019	
Vehicle No	**Annual Price**	**Vehicle No**	**Annual Price**	**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 high at both the lowest maintenance level and the highest maintenance level in both years. This could be attributed to the fact that the vehicles had problems at the design stage because two vehicles of the same brand were purchased on the same day and managed by the same institution, yet the cost variances of maintenance were vast. It is therefore in line with Omotehinshe et al.'s (2015a) assertion that most maintenance and operational costs of physical assets are linked to the decisions taken at the early stage of the machine's design. Therefore, it is easier to reduce future maintenance costs at the design stage than at the operational stage. This assertion confirms the findings of this study because, from all indications, that particular vehicle, which had a higher cost of maintenance, had major problems from its design stage other than the operational stage. The differences in the cost of maintenance could also be partly attributed to the users.

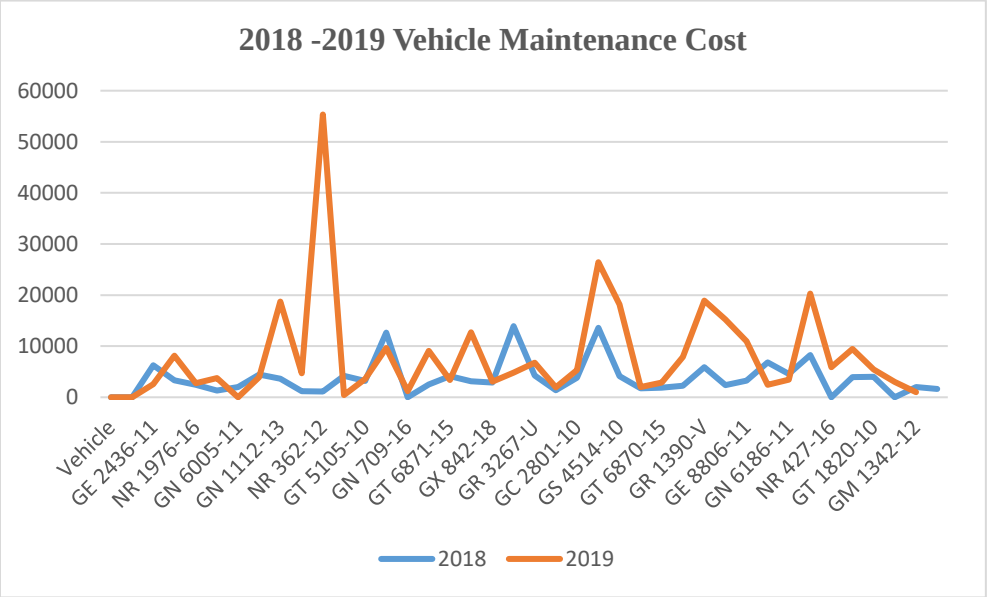

Figure 3. Comparative analysis of 2018 and 2019 maintenance costs
Source: Field Study October, 2020

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

The high variation in the cost of maintenance indicated in Table 3 could also be a result of the inflation of the spare parts of the vehicles, a refusal to adhere to maintenance standards or a delay in releasing funds to maintain the vehicles. The mechanics are of the view that by the time the university refunds their money, the same amount could not purchase the spare parts used earlier; hence, they tend to inflate the prices, thereby leading to the high cost. These attitudes accelerate the deterioration and shorten the useful life of the vehicles. The study 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 is 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, prompt release of funds, 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 that tend to impact the effectiveness of the performance of maintenance systems (Cabahug et al., 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 34 vehicles in 2018 and 2019 at the Central Administration of the University.

Table 2. Analysis of maintenance costs for 2018 and 2019

	2018	**2019**
Vehicle Number	**Annual Price**	**Annual Price**
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

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

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, 2018 and 2019

A comparative analysis of the cost of maintenance in 2018 and 2019 indicated that the cost of maintenance was increasing at a geometric rate. In 2018, a total of GH 148,190.42 was used to maintain the university's vehicles, while in 2019, the cost of maintaining the same number of vehicles amounted to GH 315,354.93 with a cost variance of GH 167,164.51. This is an astronomical increase of 53% in maintenance costs within one year. The older vehicles had a higher probability of experiencing one or more downtimes per year. This finding is also in consonance with the United Nations Industrial Development Organization Report (2016) 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 interruption of machinery resulting from breakdowns and stoppages.

Age of the vehicle and cost of maintenance

The newest vehicle in the fleet was one-year-old, and the oldest was sixteen years old. From Table 3, the cost of maintenance for the latest vehicles was far cheaper than that for the older ones. According to international literature, older vehicles have a higher likelihood of increasing repair costs than newer ones. For example, in Europe, vehicles aged 1–5 years had a 20–30 percent likelihood of incurring repair costs in a year. The likelihood was closer to 68 percent for vehicles aged 13 to 15. The lowest probabilities range from around 10 percent in their early years to around 50 percent by age 14 (Pint et al., 2008).

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

Table 3. Age of vehicle and cost of maintenance

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

Source: Field survey, October 2020

Comparing the performance and cost-effectiveness of vehicles aged 15 to 20 years, Pint et al. (2008) note that new vehicles under 5 years old are more cost-effective than those aged 10 years and above. The study revealed that if institutions and organizations adhere to the manufacturer's service standards of 150, 000 km, the vehicle can be driven for 15 to 20 years without engine repairs, irrespective of the make. But in other manufacturers' literature, after 150,000 km there is the probability of incurring costs on engine repairs and on major components such as the gearbox, differential, power steering system, brake system, suspension system, and electrical system. With the review of the cost of maintenance of the university's vehicles, it is abundantly clear from Table 2 how money has been expended on unnecessary repairs to the detriment of the university as a result of poor supervision and regular monitoring.

Conclusion

The study concludes that the frequent breakdown of the university's vehicles is a result of poor maintenance culture, a refusal to adhere to maintenance management plans, inadequate funding, a delay in the release of funds for maintenance, inflation of the cost of spare parts, design errors, the use of sub-standard materials, the age of the vehicles, and the insufficient knowledge and skills of mechanics and technicians, which were some of the factors identified as contributing to the frequent breakdown of the vehicles. The analysis has also shown that the cost elements should be discussed with the mechanics based on the public standard charges for the cost of maintenance at the engagement stage so as to reduce the cost aspect, which will invariably not only increase the value of maintenance activities but will also mitigate the risk of having poor maintenance.

Recommendations

A formalized maintenance department should be established with well-qualified and experienced staff with practical knowledge and skills in vehicle maintenance. The workshop should also be well-equipped with the necessary tools and appropriate spare parts. This will allow fast and quick responses 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 allocations.

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

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

Designs, purchases, and new installations should be meticulously evaluated before decisions are made on such issues to forestall the inadequacy of maintenance personnel skills and spare parts.

Maintenance Vehicle repair and servicing should be performed by individuals who understand the importance of preventive maintenance in order to reduce vehicle breakdowns.

The study concludes that the factors identified as causing frequent vehicle breakdowns should be dealt with effectively to ensure that regular vehicle servicing is carried out at all times. This will aid in better fuel economy, safety, and engine reliability at all times, while also guaranteeing comfort while driving. Above all, standard operating procedures should be outlined for all users of vehicles at the university.

References:

1. Adeleye, S. I. (2009). Maintenance practice in Nigeria includes policy, budgeting, and legislative issues. a paper presented at "Sensitization Campaign or Maintenance Culture," organized by the National Orientation Agency, Oyo State Directorate, Ibadan.
2. Al-Najjar, B. (2007). "The lack of maintenance, not the maintenance that costs: A model to describe and quantify the impact of vibration-based maintenance on a company's business," Al-Najjar, International Journal of Production Economics, 107(1), pp. 260-273, 2007.
3. Bolaji, B. O., & Adejuyigbe, S. B. (2012). Evaluation of maintenance culture in manufacturing industries in Akure Metropolitan, Nigeria, *2(3), 37–44, Journal of Information Engineering and Applications*
4. Brendan, J. S. (2006). Optimizing the maintenance function is as much about people as it is about technology. paper number 095 at WCEAM 2006.

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

5. British Standard Institution (BS 3811) (1984). A glossary of general terms used in maintenance organizations *Blackwell Science Ltd., Oxford, U.K.*
6. Cabahug, R. R., Edwards, D. J., & Nicholas, J. (2004). Classifying plant operator maintenance proficiency: examining personal variables *Building Research & Information, 32*(2), 119–127.
7. Central Bank of Nigeria, 2003, "Highway maintenance in Nigeria: lessons from other countries," Central Bank of Nigeria, April 2003. Occasional Research Department, p. 27
8. Chanter, B., and Swallow, P. (2007). building maintenance management. *Oxford: Blackwell Publishing.*
9. Choudhary, V., and Vithayathil, J. (2013). The impact of cloud computing: Should the IT department be organized as a cost center or a profit center? *30: 67–100 in the Journal of Management Information Systems.*
10. Creswell, J. W. (2007). Research design: qualitative, quantitative, and mixed methods approaches (2nd ed.). Thousand Oaks, CA: *Sage.*
11. Eti, M. C., Ogoji, S. O. T., & Probert, D. (2006). Strategic maintenance management in Nigerian *industries in applied energy, 83 (3*), 211-227.
12. Eti, M. C., Ogaji, S. O. T., and Probert, S. D. (2004). Impact of corporate culture on plant maintenance in the Nigerian electric-power industry (pp. 299–310 in Applied Energy, 83(4))
13. Igboanugo, A. C., and Aigbe, S. O. (2003). A Markovian study of maintenance practice in production firms: a case study *1–7 in the Nigeria Journal of Industrial and System Studies*
14. Kans, M., & Galar, D. (2017). The impact of maintenance 4.0 and big data analytics within strategic asset management is examined in Maintenance Performance and Measurement and Management 2016 (MPMM 2016). November 28, Lule, Sweden (pp. 96–104). Lule Technical University
15. Kportufe, S. G. (2015). Accra, Ghana's capital city, suffers from a lack of a maintenance culture for public buildings. Journal of Culture, Society, and Development: An International Peer-Reviewed Journal. 12, 94–103.
16. Mark, C. E., Ogaji, S. O. T., and Probert, S. D. (2006). Strategic maintenance management in Nigerian industries, 83(3), 211-277, Journal Applied Energy
17. Mkilania, J. N. (2016). Factors affecting the best maintenance practice in the Tanzanian public sector, *7(3), 139–149, International Journal of Mechanical Engineering and Technology* http://www.iaeme.com/currentissue.asp?JType=IJMET&VType=7&IType=3

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

18. Mobley, R. K. (2002). An introduction to predictive maintenance, 2nd Ed., *Elsevier Butterworth Heinemann*
19. Mong, G. S., Mohamed, F. S., and Misnan, S. M. (2018). Maintenance management model: an identification of key elements for local-authority value based maintenance managegement by Local Authority. *International Journal of Engineering & Technology*, 7 (3.25, 35–43).
20. Okoro, C. K., & Anichebe, O. (2020). Maintenance culture and sustainable development in Africa, *International Journal of Management, Social Sciences, Peace, and Conflict Studies* (IJMSSPCS), 3(4), 79–84.
21. Omotehinshe, O. J., Dabara, I. D., & Guyimu, J. (2015a). design inadequacies and the maintenance of university buildings in Ile Ife, Nigeria. *Environment and Earth Science, 5(2), pp. 175–187.* accessible at http://iiste.org/Journals/index.php/JEES/article/view/19478.
22. Otoo, A., and Transport, S. (2018). Challenges of vehicle fleet management and control at the University of Education, Winneba, Ghana, *6(5), 1–15, International Journal of Engineering and Advanced Technology Studies*
23. Quatrini, E., Costantino, F., Di Gravio, G., & Patriarca, R. (2020). Condition-based maintenance: an extensive literature review, 8, 31, 1–28; doi:10.3390/machines.80.20031. www.mdpi.com/journal/machines.
24. Pint, E. M., Pelled-Colabella, L., Adams, J. L., and Sleep, S. (2008). Improving recapitalization planning: Toward a fleet management model for the high-mobility multipurpose wheeled vehicle, *Rand Corporation, USA*
25. Thoben, K.-D., Wiesner, S., & Wuest, T. (2017). "Industrie 4.0" and Smart Manufacturing: A Review of Research Issues and Application Examples, *4-19, in International Journal of Automation Technology, 11(1).*
26. Tijani, S. A., Adeyemi, A. O., and Omotehinshe, O. J. (2016). Lack of maintenance culture in Nigeria: The cane of national development *International Institute for Science, Technology, and Education (IISTE)*. 8(8), 23–30.
27. Tubis, A., and Werninska-Wojciechowska, S. (2015). A Controlling Concept for Maintenance Management Performance: A Passenger Transportation Company Case Study Safety and reliability of complex engineered systems Podofillini et al. (Eds). *Taylor and Francis Group, London,* p. 1055–1063
28. UDS Statutes (2017). University for Development Studies Statutes, January 2017

 ISSN: 1857-7881 (Print) e - ISSN 1857-7431

29. UDS Transport Policy (2018). University for Development Studies, revised Transport Policy, July 2018.
30. Uforo, A. E.; Malachi, U. U.; and Don, B. (2022). Maintenance management and organizational performance in selected manufacturing firms, Akwa Ibom State, *International Journal of Business and Management Review, 37–59.*
31. United Nations Industrial Development Organization Report (2016). The role of technology and innovation in inclusive and sustainable industrial development Vienna.
32. Vilarinhoa, S., Lopesa, I., & Oliveiraa, J. A. (2017). Preventive maintenance decisions through maintenance optimization models: a case study
33. Wilson, A. (2002). Asset maintenance management New York: *Industrial Press*.
34. World Bank. World Development Report (1995) Infrastructure for Development, World Development Indicators, World Bank
35. Wordsworth, P. (2001). Lee's Building Maintenance Management (4th ed.). Oxford: Blackwell Science.
36. Yin, R.K. (2013). Case study research: design and methods, 5th ed., *Sage Publications, Thousand Oaks, CA*