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Effect of Maintenance on Vehicles Headlamps Lighting Intensity in Tanzania (Case Study of Tanzania)

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Abstract: ***Engineering Maintenance Improvement for Head Lamp**: Headlamps are important motor vehicle elements that must balance two conflicting goals: maximizing visibility for the driver and minimizing glare to other drivers, passengers and road users. However, the maintenance of motor vehicle headlamps is not given thorough attention causing road accidents at night and discomfort glare to road users. The main objective of this studywas to develop effective maintenance system for improving motor vehicle headlamps lighting intensity in Tanzania.Factors that affecting motor vehicle headlamps lighting intensity are assessed and maintenance actions for improving motor vehicle headlamps lighting intensity are developed. The experiment/measurement and visual observation were the tools used in the study and data were analyzed multilinear regression analysis. The results show that main seven factors contribute to poor motor vehicle headlamps lighting intensity as identified through experiment/measurement using beam setter with lux meter. Among seven factors; improper alignment of motor vehicle headlamps is the major problem as obtained from the analysis. Maintenance for proper vehicle lightning (Vehicle Maintenance Management)*

1. Introduction

1.1 Background Information

The headlamps are lamps attached to the front of a motor vehicle (MV) to light the road ahead. The headlight refers to the beam of light produced and distributed by the device/headlamp (Anne, 1999). The function of the motor vehicle headlamps is to light the roadway for the driver and increases the appearance/presence of the vehicle, allowing drivers, passengers, pedestrians and other road usersto see the position, vehicle's presence, size, direction of travel, and the driver's intentions regarding direction and speed of travel (Perel, Olson, Sivak& Medlin, 1983). Motor vehicle headlamps must balance two conflicting goals: maximizing visibility for the driver and minimizing glare to other drivers, passengers and road users (Balk, 2010).

The required motor vehicle head lamps must be fixed in right position, be in good condition, installed correctly and must produce or reflect the right colour of light and intensity (Alferdinck&Padmos, 1988). They must be installed in pairs (one per each side of the motor vehicle) and some may be installed in multiple pairs (two per each side, three per each side, etc.), as long as they are symmetrical in number, type, mounting, colour, and operation (Owens & Tyrrell, 1999). The current practice in Tanzania for motor vehicle owners, drivers and mechanics do change, replace or refit the motor vehicle headlamps without using strategies and procedures MV headlamps lighting intensity (Boniface, Museru, Kiloloma&Munthari. 2016). The improper headlamps maintenance and set-up causes dazzle (more darkness) to the eyes during the night drive and its consequence might cause the accident due to unseen road (Stern, 2009).

Drivers in Tanzania are worrying to drive during the night because of the night glare. (Deus, 2006) explained the existing regulations and measures that were enforced in Tanzania. Some of these measures are such as preventing busses from travelling at night, introducing vehicles speed limiters that are installed in the engine of public busses. The motor vehicle headlamps lighting during the night should be friendly to the drivers and as well for the road users if they are maintained properly and producing good intensity. Human eyes have the capability of receiving specific amount of light intensity falling to the eye/retina (Zwahlen&Schnell,1999). If the amount of light intensity falling to the eyes is exceeded, the eye/retina shuts down causing the dark area to be darker (dazzle). The drivers, passengers, pedestrians and all users of the road are facing the problem of night glare and discomfort caused by the motor vehicle head lamps lighting intensity (Bosch, 1978). However, there is very low priority in systematic maintenance of headlamps in Tanzania, the maintenance of motor vehicle head lamps are not given thorough attention and one of its consequences is the night road accidents and discomfort glare to the road users due to poor road visibility caused by improper motor vehicle headlamps lighting intensity. The accidents lead to injuries, property damages, road bridges crashes and drivers fear to drive during the night (Bacelar, 2004; IGP, 2015; TBS, 2011, Mkilania and2016, Easel ,2016;)

Therefore, the researcher seeks to develop effective maintenance plan for improving motor vehicle headlamps lighting intensity in Tanzania.The main objective of this research was to develop effective maintenance plan for improving motor vehicles headlamps lighting intensity in Tanzania.

In order to achieve the main objective of the research, the following are the specific objectives:

a) To identify the factors affecting motor vehicle headlamps lighting intensity.
b) To assess different maintenance actions for improving motor vehicle headlamps lighting intensity.
c) To develop effective maintenance plan to improve motor vehicles headlamps lighting intensity.

2. Literature Review

2.1 Introduction

The researcher reviewed the literature related to the area of the research and focused on the primary sources of literature which includes books, auto data, past researches, journals, published and unpublished articles. Literature review can be on concepts and theories or previous research findings (Kothari, 2014).

2.2 The Review of Concepts and Theories

Seeing and being seen are fundamental pre-requisites for the safety of all road users where inadequate visibility is an important factor that influences the risk of a road crash among all types of road users (Bullough & Skinner, 2009). Furthermore, they describe that many accidents caused during the night drive are the results of improper motor vehicle headlamps lighting intensity even though the most reported incidences relay on drivers' negligence and mechanical problems.

2.3 The Review of Previous Research Findings

The review of previous research findings(Stock, 2012), showed the causes of improper motor vehicle headlamps lighting intensityis caused by weak bulb illumination, dirt reflectors, wrong bulb wattage, wrong position of the bulb or head lamp assembly, wrong set-up or adjustment, poor electric energy, defective body of the vehicle and life span or blown bulb. Many types of beam setting equipment are available and most work on the same principle (Denton, 2006). According to Beamsetter Instructional Manual Hella (2014) shows the allowed range of intensity is between 16 lux to 80 lux for all motor vehicles. 2.2 Factors Affecting Motor Vehicle Headlamps Lighting Intensity.

Different authors explain the factors affecting motor vehicle headlamps in different ways such as:

Dirt reflectors and glasses/lenses
According to Stern (2009), dirt is one of the major sources that cause damage to motor vehicle headlamps. It can damage headlamp by blocking the light needed on the road. The accumulation of dirt can cause corrosion on the mounting parts. Plastic glasses/lenses can become discoloured. This is due to oxidation of the painted-on glass/lens hard-coat by ultraviolet light from the sun and the headlamp bulbs.

Moisture
Furthermore, Stern (2009), Moisture also affects the performance of the reflectors and glass. It greatly contributes to the corrosion of the mountings, reflectors and adjusters. Over time, the headlamp glass/lens can deteriorate and become pitted due to abrasion of road sand and pebbles (impurities) that can cause crack, admitting water into the headlamp(Denton, 2006).

Light colour
According to Society of Automobile Engineers (SAE) standardsHeadlamps are generally required to produce white light, however, some of the MV owners do use coloured bulbs or reflectors and violet SAE standards.

Vibration
The most possible causes of vibrations on the motor vehicle headlamps are due to vehicle running on corrugated roads or potholes and engine operation(Stock, 2012). The vibration causes the headlamps to come out of position as long as the fasteners become loose.

Human error (fittings or adjustments)
Human error is any member of a set of human actions or activities that is not correct or acceptable, it is an out of tolerance action (or failure to act) where the limits of performance are defined by the system (Copenhaver &Jones, 1992). Human action is the observable result (often a bodily action) of a person's intention (IEEE, 1997). A set of human actions comprise of task which was defined as collection of actions carried out by operators in order to achieve an objective or a goal state (Essel, 2016).

Human error is therefore understood as being a deviation from what is wanted to achieve, or a failure to act as required on a task level or an action level. This can be seen for the MV mechanics and panel beaters who deviate to use instruments to correct the lighting intensity when fitting MV headlamps. Additionally, it is stated that a theory capable of predicting human error must combine three elements. These elements are; the nature of the task and its environmental circumstances, the mechanisms governing performance and the nature of the individual. In this case the MV head lamps should be set using proper instruments and drivers with ethical driving.

The human error includes the equipment, tools and instruments used, training of the personnel and type of the maintenance used as shown in figure 2.1 of the causal and effects (Shankar, 2000).

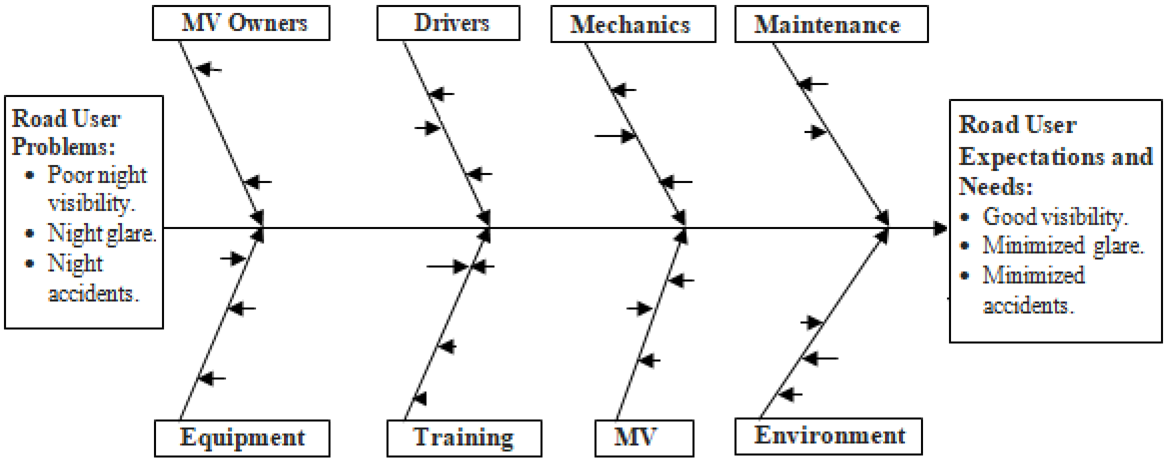


Figure 2.1: Ishikawa fishbone diagram (Source: Shankar, 2000)

2.4 Different Types of Maintenance

According to British Standard Glossary of terms (3811:1993), maintenance is a combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function. The European Standard (13306:2001) takes maintenance as being a combination of all technical, administrative and managerial actions performed during the life cycle of an item, intended to retain it in, or restore it to, a state in which it can perform the required function. According to British Standard Glossary of terms (3811:1993) maintenance is divided into two types namely; planned maintenance and unplanned maintenance. Figure 2.2 depicts the two types of maintenance strategies.

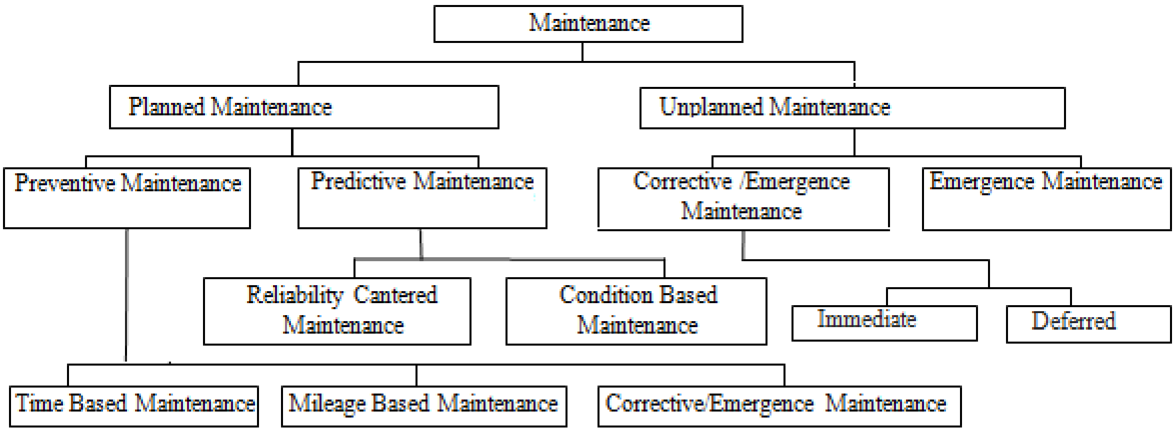


Figure 2.2: Types of maintenance. (Source: BS 3811: 1984)

2.5 Preventive Maintenance (PM)

According to British Standard 3811:1993 glossary of terms, preventive maintenance is the maintenance carried out at predetermined intervals or according to prescribed criteria and intended to reduce the probability of failure of the item; that is a scheduled part of maintaining a whole system. The schedule can be time based, mileage based or corrective/emergence. According to CEN (2001), preventive maintenance is performed on satisfactorily functioning units at regularly scheduled intervals that includes the following actions:

Servicing periodically, such as greasing and lubricating, adjusting, aligning, checking and cleaning surfaces, removing rust deposits, tightening loose units and making routine checks. Inspecting, replacing or repairing failed parts or units.

2.6 Predictive Maintenance (PdM)

This Maintenance is performed before an item or equipment failure using predictive insights hence they can be of Condition based or Reliability centred maintenance(CEN, 2001).

2.7 Condition-Based Maintenance (CBM)

Maintenance based on the equipment performance monitoring and the control of the corrective actions taken as a result (CEN, 2001). The real actual equipment condition is continuously assessed by the on-line detection of significant working device parameters and their automatic comparison with average values and performance. Maintenance is carried out when certain indicators give the signalling that the equipment is deteriorating and the failure probability is increasing. This strategy, in the long term, allows reducing drastically the costs associated with maintenance, thereby minimizing the occurrence of serious faults and optimizing the available economic resources management(British Standard 3811:1993).

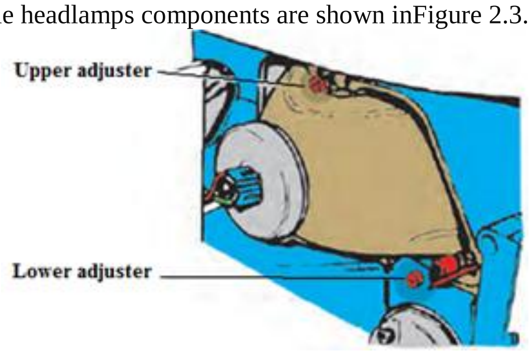
2.8 Reliability Centred Maintenance (RCM)

This is the way of moving toward smart maintenance with the evolution of asset management.

2.9 Corrective Maintenance (CM)

In the British Standard 3811:1993 Glossary of terms, corrective maintenance is defined as, the maintenance carried out after recognition and intended to put an item into a state in which it can perform a required function (CEN, 2001). Maintenance is carried out following detection of an anomaly and aimed at restoring normal operating conditions and the choice can be immediate or deferred (postponed/pended). This approach is based on the firm belief that the costs sustained for downtime and repair in case of fault are lower than the investment required for a maintenance program. This strategy may be cost-effective until catastrophic faults occur (Crotty, 1998).

Figure 2.3 depicts the different parts of motor vehicle headlamp which need to be maintained. The majority of the motor vehicles in Tanzania are not automatic where in developed countries the technologists are trying to introduce the automatic MV headlamps lighting to be common in use (Perel M, *et al*, 1983). In this research the Preventive Maintenance (PM) is the best to be used to develop effective maintenance plan that will be followed to improve motor vehicle headlamps lighting intensity. The typical motor vehicle headlamps components are shown inFigure 2.3.



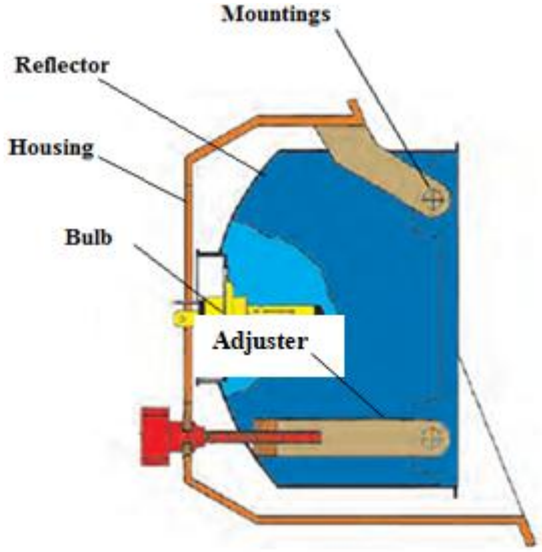


Figure 2.3: A typical motor vehicle headlamp. (Source: Auto technic cars)

The motor vehicle headlamp unit having a lamp housing formed integrally with a front glass/lens and in which a reflector and a lamp bulb as a light source are provided with an aiming adjustment device including pivot mechanisms to tilt the lamp housing on horizontal and vertical axis in relation to the body of a MV. In addition, the lamp housing has provided therein an aiming adjustment aid composed of a level supported tilt-ably in the vertical plane parallel to the optical axis of the reflector and a manual operating member to adjust the tilt angle of the level. At the headlamp unit manufacturer, the posture of the lamp housing with respect to the MV body is pre-adjusted by means of the aiming adjustment device to obtain an optimum luminous intensity distribution pattern (Yamagishi, Ohtusuka, Kikuchi &Isobe, 1991). The circuit of motor vehicle headlamps lighting system is shown below in figure 2.4.

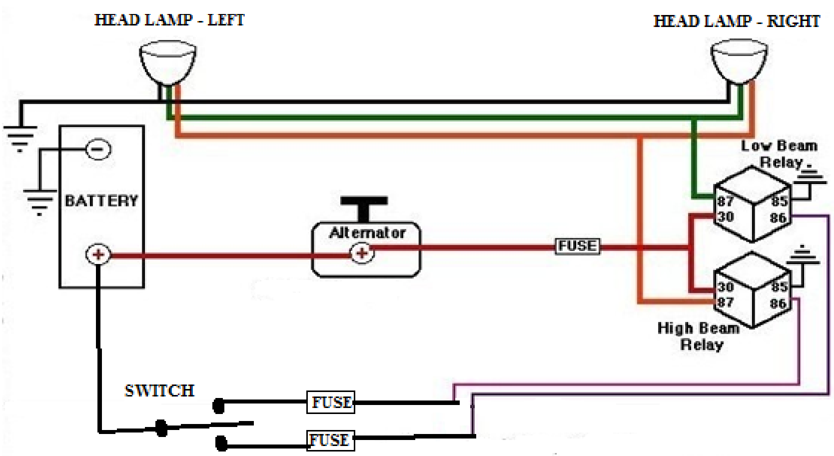


Figure 2.4: Head lamp circuit with relay. (Source: www.jeep.com)

2.10 Other Factors Affecting Motor Vehicle Headlamps Lighting Intensity

According to Alferdinck&Padmos (1988), the following factors were explained:

a) The battery (source of power)
The battery is used as the source of power that provides the quality to the electrical system and improves the strength of the lighting system. If the battery is not producing enough power for the accessories, then the lighting intensity will be poor hence bad visibility. The battery can maintain its power if the charging is an adequate.

b) Switches
The switches are the controls that are used to put "on and off" lighting system. These switches are of main two categories i.e. manual operated switches and electromagnetic switches.

- The manual operated switches are those applied manually by the operator/driver.
- The electromagnetic switches are those operated by electric energy such as relays.

The burnt or dirt switches restrict the electric current to the system that causes improper lighting intensity.

c) Alternator (charging)
An alternator is used in motor vehicle to charge the battery and to power the electrical systems when the engine is running. Whenever the engine is running, the alternator charges the battery and supplies additional electric power for the vehicle's electrical systems. Improper battery charging causes poor battery power hence poor lighting intensity.

d) Head lamps Alignment
The function of the motor vehicle headlamps is to light the roadway for the driver and increases the visibility of the vehicle, allowing drivers, passengers, pedestrians and other road usersto see clearly. MV headlamp comprises of housing, reflector, glass, bulb and adjusters. Wrong alignment of the beam concentration leads to wrong focus of the lighting intensity.

2.11 Development of Maintenance Actions Conceptual Model

The model can be defined in different applications, but in engineering point of view, the English dictionary defines the model as physical representation of an object or activities chain to be explained(Anne, 1999).

2.12 Conceptual Model Development

The conceptual model is the framework in which the activities are carried out i.e. input – process – output. The first and foremost step is that of concept developmentwhich means that the researcher should arrive at an understanding of the major concepts pertaining to study (Kothari, 2014).

This step of concept development is more apparent in theoretical studies than in the practical research, where the fundamental concepts are often already established. Conceptual model is nothing more than an abstraction way to choose, perceive a specific part, function, property or aspect of reality (Creswell, 2009). It is a representation of a 'system' that is intentionally constructed to study some aspects of that system or the system as a whole. Conceptual models have much in common with maps with specific properties (Yin, 2017). Furthermore, it explains that:

- They are framework illustrating (logical) causal relationships between factors that matter (at least in the eyes of its creator).
- They are helping to differentiate between what is important and what is not.
- They serve to direct focus, thus, facilitating (organizational) communication which leads to speedier if not better understanding.

The results for conceptual model of this research led to effective maintenance plan for MV headlamps lighting intensity improvement.

2.13 Development of Effective Maintenance Plan (MP)

Maintenance strategies (MS) is the activities of planning, organizing, coordinating, directing, implementing, monitoring and controlling in order to sustain a certain level of availability and reliability of the system and its components (assets) to have ability to operate to a certain standard level of quality (Lukacks, 2003). Maintenance strategies are explained as process and a framework (Shankar, 2000). Furthermore, strategy in other hand is the plan of actions intended to accomplish a specific goal.

As a framework, they noted that it is the essential supporting structure and the basic system needed to manage maintenance effectively and as a process, it is the course of actions and the series of steps or stages to be followed. According to (CEN. 2001), maintenance covers all the activities of the management that determine the maintenance objectives, strategies, responsibilities and implement them by means such as planning, control, supervision and improvements of methods.

The choice of the maintenance practice applied impacts heavily on the performance of the firm. The main measures of operational performance of a firm are reliability, maintainability, productivity, efficiency, availability and production per unit cost, among others (Shankar, 2000). In this research it is MV headlamps lighting intensity.

2.13.1 Motor Vehicle Headlamps Lighting Maintenance Plan

According to (Anne 1999), the strategy is a plan to achieve the goal, therefore the purpose of successful motor vehicle headlamps lighting maintenance strategies is to improve lighting intensity and reducing night accidents and glare. It consists of particular maintenance strategies designed to aid the maintenance mechanic in motor vehicle headlamps lighting intensity (Stern, 2006).

2.13.2 Faults of Motor Vehicle Headlamps

According to (Stern, 2006), there are several faults as explained below:-

- *Mechanical faults*

Faults under this classification are loose mountings, crashed housing, rusted adjusters and damaged body.

- *Electrical faults*
  Faults under this classification are poor supply voltage or current due to earth fault, overload and fault switches.
- *Lighting faults*
  Faults under this classification are wrong set-up and adjustments, dirt reflector or glass and poor light intensity.

2.14 Summary of Authors on Factors and Maintenance Actions

Literature review on factors and maintenance actions for motor vehicle headlamps lighting intensity have been done in this chapter. The common factors and maintenance actions frequently mentioned by different authors have been summarized and indicated in Table 2.1

Table 2.1: Summary of factors affecting MV headlamps lighting intensity and authors

S/N	Factors Affecting MV Headlamps Lighting Intensity	Author's Name and Year Published
1	Moisture	Stern, (2009) Legg *et al*, (1997)
2	Dirt/Dust	Stern, (2009) Legg, (1997) Stock, (2012)
3	Rust	Danton, (2006) Legg, (1997)
4	Colour	SAE Standards
5	Charging/Battery	Alferdinck&Padmos, (1988) Legg, (1997) Stock, (2012)
6	Vibration	Stock, (2012)
7	Human error	Copenhaver & Jones, (1992) Essel, (2016) Shankar, (2000)
8	Mechanical and electrical faults	Stern, (2006) Stock, (2012)
9	Alignment	Beam setter instrument Stock, (2012)
10	Adjustment	Denton, (2006) Stock, (2012)

3. Methodology

3.1 The Study Area

Arusha district was a picked to be a suitable case study area because it is the major traffic centre, fastest growing city, and is among most the heavily motorized area in the country. According to the 2012 Tanzania national census, the population of Arusha urban district was 416,442 (Census, 2012). According to national link information, Tanzania has 7 motor vehicles per 1,000 people. In calculating this, we get about 2,916 vehicles in Arusha district. Consequently, the testing instruments are easily found at companies, garages and institutions such as Arusha Technical College and Wakulima Engineering Company. The tourist and hunting vehicles are plenty in Arusha region since it is the area which is rich in National parks in Tanzania.

3.2 Research Design/Methods

Research design is the process that involves the overall assumptions of the research to the method of data collection and analysis (Cresswell, 2009). The choice of research design depended on the objectives of the research (Crotty, 1998; Kumar, 1999 and Yin, 2004). The research design for this study was an exploratory experiment that was analysed through quantitative and qualitative methods. Case study research method is in depth study of one or a few of events or cases in order to understand the phenomenon to be studied.

The research design involved the consideration of the activities performed, methods of data collection adopted, source of information, tools for data collection and data analysis. This research employed experiment/measurement method. Methods used to conduct are the literature review observations, measurement of some variable like using beam setter, measurement of light intensity, datalogging, analysis's computer software, such as multilinear regression analysis, cleaning of the lights. Standard recommended were used to compare the lamp performances

3.3 Conceptual Model Diagram

Conceptual Model Diagram is a concept map or a diagram that depicts suggested relationships between concepts. It is a graphical tool that instructional designers, engineers, technical writers, and others use to organize and structure knowledge. The figure 3.3 shows the representation diagram.

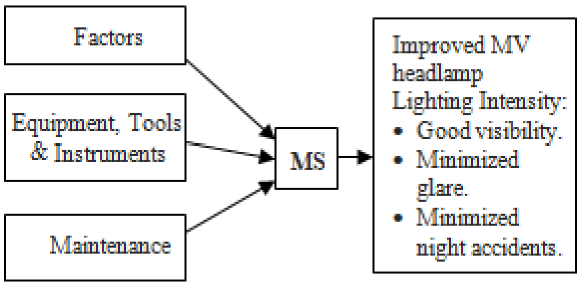


Figure 3.3: Input, process and output diagram

3.4 Data Collection Method

This research used both primary and secondary data. Primary data included both quantitative and qualitative data (Kothari, 2014). The quantitative data was collected through field measurement (experiment) and qualitative data was through review of various literatures related to motor vehicle headlamps maintenance. Hence this research tested and measured different types of motor vehicles headlamps lighting intensity and compare with the standards that is required to be used as indicated in the instrument.

3.5 Sampling

In this research, the sample frame included minibuses (daladala), saloons (taxi), station wagons and pickups. Purposive sampling (non-probability sampling) was used to select motor vehicles that studied to identify causes of improper headlamps lighting intensity and the maintenance practice. The population consists of the public and private motor vehicles which was approximately 2,916 motor vehicles at Arusha district.

3.6 Sampling Techniques

The researcher used stratified sampling techniques, Kothari, (2014). Purposively sampling (non-probability sampling) was used to select different types of the motor vehicles that represent the population. This sampling technique allows the researcher to use cases that have relevant information with respect to the research objectives, time, and available resources. The experiment/measurements were used to answer the research questions on factors affecting the MV headlamps lighting intensity.

3.7 Sample Design

A sample design is a plan for obtaining a sample from a given population. It refers to the technique or the procedure that a researcher would adopt in selecting items for the sample (Kothari, 2014). The stratified sampling technique was used where the population was divided into several sub-populations that are individually more homogeneous than a total population called "strata" (divisions/sections).

Formula for finding the sample size is given by the following equation: -

$$S = \frac{N}{P} \times n \quad (3.1)$$

Where,

- P = Population of MV.
- N = grouped MV population number.
- n = Total number of MV to be tested/measured.
- S = Sample size required from each group.

From the literatures, the population of Arusha district as from census 2012 is about 416,442, meanwhile there is 7 motor vehicles per 1,000 people. Let x be the number of vehicles at Arusha district;

Therefore:

$$x = \frac{416,442}{1,000} = 2,916$$

Therefore, the number of vehicles at Arusha district is approximately 2,916.

From this information the researcher has the follows:

For the number of MV vehicles to be "tested/ measured" on headlamps lighting intensity, the number of the motor vehicles at Arusha district is 2,916 vehicles. The researcher has divided this population in sub-populations of four equal groups as follows: -

- P = Number of vehicles = 2,916.
- N = Size of each group (in this case $N_1 = N_2 = N_3 = N_4 = 729$)
- n = Total number of MV to be tested/Measured) from the population(in this case is 60 vehicles) as the decision of the researcher.
- S = Sample size from each group.

Therefore,

S_1 = Mini buses = $\frac{729}{2916} \times 60 = 15$

But, $S_1 = S_2 = S_3 = S_4 = 15$

Where:

S_1 = Minibuses (daladala).

S_2 = Saloon (taxi).

S_3 = Station wagons.

S_4 = Pick-ups.

Table 3.2: Matrix summary of the sampling procedure

Activity	Description	Number of Vehicles
Test/Measuring MV headlamps intensity	Mini buses (Daladala)	15
	Saloons (Taxi)	15
	Station wagons	15
	Pick-ups	15
TOTAL		60

The decision of the researcher to select 60 motor vehicles has considered the time frame which is six (6) months, special instruments to be used and respondent of the motor vehicles to be tested/measured.

3.8 Research instruments/tools

The measuring instruments/tools which were used are;

1) Optical beam setter with lux-meter.
2) Tools box set.
3) Multi-meter or Voltmeter for voltage measurement.

Data logging sheet was used to record the measured results. The main factors were moisture, dirt, dust, rust, blown bulb, charging and alignment. In order to correct these factors, the strategy methods were performed and thereafter measurements were carried on spot. The performed strategies were sealing of leakage points, cleaning of the reflector/glass, replacing the blown bulb or rust reflector, repairing the charging system and adjusting the headlamps to the required concentration point of the beam, for comparative results. The 3.1 and 3.2 show the results after adjustments and repair respectively. Before the adjustment, the intensity was between 0-16 lux but after correction it becomes to the range between 16-32 lux for this particular MV.

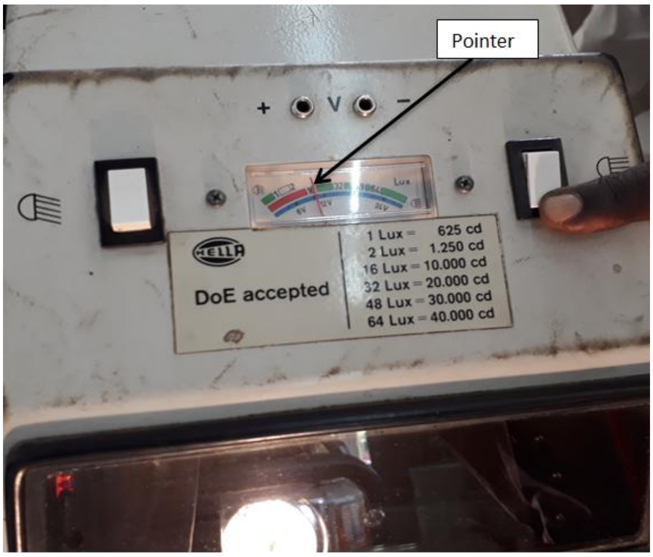


Figure 3-1: Beam setter reading after correction was at "green" between 16-32 lux

Comparing the brightness of the light intensity of Fig. 3-2 and Fig. 3-3, the plate Fig. 3-2 is brighter by normal point of view but it is out of point hence discomfort glare and poor road visibility whileFigure 3-3 has less brightness in point of view but has less discomfort glare and hence good road visibility. In Figure 3-2, the beam concentration is out of the point towards left. By the appearance of the brightness it seems to be good, but in real sense the instrument will indicate low or poor intensity since the concentration is required to be around the centre point of the oval shape of the light. In this case the poor visibility and discomfort glare to road the user is obtained.Before the adjustment, the intensity was between 0-16 lux but after correction it becomes to the range between 16-32 lux for this particular MV.

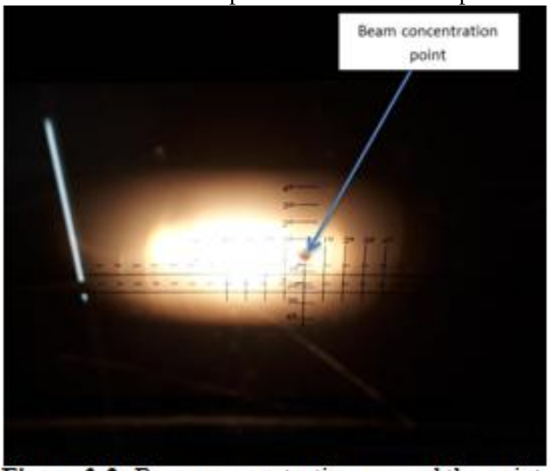


Figure 3-2: Beam concentration around the point before adjustment

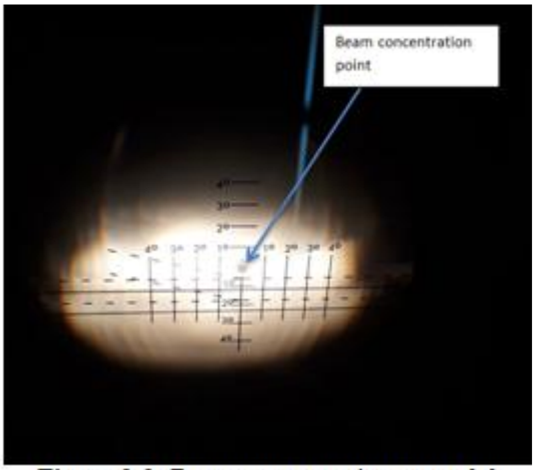


Figure 3-3: Beam concentration around the point after adjustment

3.9 Causes of Poor Intensity Analysis

The frequency table analyses every factor used in the data collection in terms of percent in range of lighting intensity. The researcher used the term "Yes" or "No" to transfer the information from the Data Log Sheet to SPSS.

Yes – represents that the factor affects the lighting intensity for that particular MV measured/tested.
No – represents that not applicable for that particular MV measured/tested.

The six factors that affect the MV lighting intensity are shown in the tables below:

Table 0-1: Frequency Table for Identifying Factors

Statistics								
		Moisture	Dirt/Dust	Rust	Blown bulb	Charging	Adjustment	Alignment
N	Valid	60	60	60	60	60	60	60
	Missing	0	0	0	0	0	0	0
Mean		.40	1.17	.48	.13	.00	1.30	1.65
Median		.00	1.00	.00	.00	.00	1.00	1.00
Mode		0	1	0	0	0	1	1
Std. Deviation		.669	.615	.504	.343	.000	.530	1.071
Variance		.447	.379	.254	.118	.000	.281	1.147

The moisture affects the lighting intensity by 35.0% having the frequency of 21 out of 60. The dirt/dust affects the lighting intensity by 55.0% having the frequency of 33 out of 60. The rust affects the lighting intensity by 31.7% having the frequency of 19 out of 60. The blown bulb affects the lighting intensity by 16.7% having the frequency of 10 out of 60. The charging affects the lighting intensity by 16.7% having the frequency of 10 out of 60. The alignment affects the lighting intensity by 85.0% that corresponds to badand 15% good(Figure 4.1)

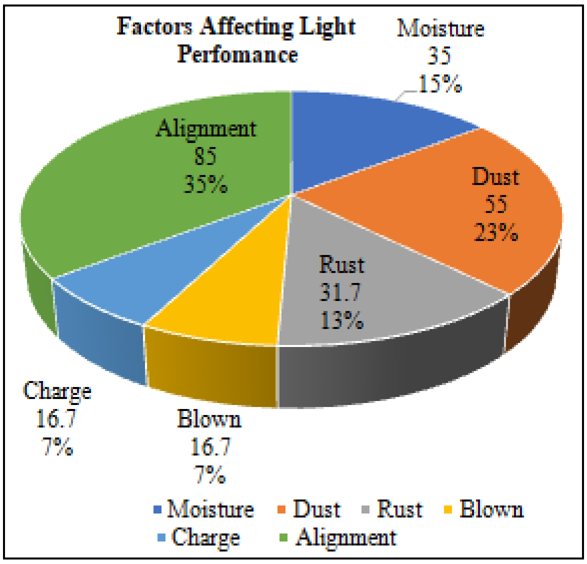


Figure 0-1: Factors Affecting Light Performance

From this analysis, the alignment factor is the major course of poor motor vehicle lighting intensity having frequency of 51 out of 60 MV measured.

4. Conclusion and Recommendations

4.1 Conclusion

Various tools like Ishikawa fishbone analysis and other research methods like interview and the literature review enabled the researcher to identify six factors that highly affect optimal performance for intended uses of vehicle lights namely; moisture affects, dirt/dust, rust, blown bulb, charging system,alignment. Cleaning of the lump inside and outside, checking the lights alignment in the time of maintenance. Replacement of bulbs during maintenance, servicing of the charging systems, all were found to counteract. The major problem for was found to be alignment. Others were the moisture affects the lighting intensity by 35.0% having the frequency of 21 out of 60. The dirt/dust affects the lighting intensity by 55.0% having the frequency of 33 out of 60. The rust affects the lighting intensity by 31.7% having the frequency of 19 out of 60. The blown bulb affects the lighting intensity by 16.7% having the frequency of 10 out of 60. The charging affects the lighting intensity by 16.7% having the frequency of 10 out of 60. The alignment affects the lighting intensity by 85.0% that corresponds to badand 15% good. Generally, the systematic maintenance that shall take care of the six main factors identified shall optimises the reasons for having the headlights in vehicles.

4.2 Recommendations

Noted that, this research concentrated with four wheeled MV vehicles with none automatic MV headlamps lighting system. Also, in this research it was assumed that all drivers are ethical (i.e. those who abide with the road regulations) and not those who violet the principles of road driving.

The measurement analysis carried out on sample motor vehicles indicated that most of motor vehicle has the problem of headlamps alignment that affects the lighting intensity.

Although this research was done on the normal headlamps, there is a need of making a further study on nonstandard lightning systems used in vehicle so as to have a more comprehensive conclusion

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