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**Investigation of the Effects of Gel Cushions on Whole Body Vibrations Transmitted to the Operator during Operation of EMV in Open Cast Mining**

**Research Proposal**

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9. **Introduction** 
   1. Background information

Back pain is one of the main causes of sick leave and even medical retirement among Earth Moving Vehicle (EMV) operators. Earth moving vehicles refer to heavy plant machines or vehicles that are normally used in construction, civil works and mining to clear, dig and haul the earth material. Earth moving vehicle operators usually spend long hours sitting in the cabins and driving in rough terrains. While it is well known that back pain is caused by multiple factors, and it is also common in the general population, it is important to note that over and above what the general population is exposed to, driver operators are exposed to whole body vibration (WBV) which comes through the seat or floor of the machinery being operated. Whole-body vibration (WBV) refers to vibration exerted on a person by a surface supporting their body (Safe Work Australia, 2016). WBV is believed to cause lower back conditions such as degeneration of the lumbar vertebrae and disc hernia. According to SafeWork Australia, from 2000- 2008 there were about 400 workers’ compensation claims per year relating to exposure to WBV and it is stated that the claims amounted to about $ 61million in workers’ compensation payments over the eight-year period.

1.2. Problem Statement

The high prevalence of back pain among the cadre of Heavy Mobile Equipment Operators and in particular among Earth Moving Vehicle Operators is a concern for the industries such as mining, road works and construction. A study conducted by Dupuis and Zerlett (1987) of 352 operators and 315 control group, reported significantly higher spinal discomfort while operating among operators compared to the control (75% vs. 49%) and also higher discomfort in operators compared to the control group after their shifts (59% vs. 45%). This study also demonstrated more disorders of the spine (70% vs. 54%) in operators compared to the control group. Furthermore the operators reported significantly higher discomfort in the lumbar region (69% vs. 42%) than the control group.

One of the cause of back pain in this cadre which is documented in research is exposure to excessive Whole Body Vibration. The EU Directive states an exposure limit of 1.15m/s and vibration dose value of 21m/s1.75 over an eight-hour period making WBV a recognized hazard in the workplace. However due to latency of the health effects of WBV, this risk is usually not well identified and controlled with the same effort as other risks that have instant health impact manifestation.

It is critical to note that, back disorders resulting from WBV, are not only impacting on sick leave absence at work and hence employee productivity but are also very costly to the workers compensation system. In addition to this back pain can be debilitating to an individual and can grossly affect the quality of life.

Back disorders are complex, however where possible and where a contributing factors to the problem are known, effort must be put in controlling such. It is for this reason that effort must be put in controlling WBV exposure of EMV operators. When applying the hierarchy of controls, it is clear that at this stage, most of the industry affected will not be able to eliminate the source or substitute. However, the attempt can be made to engineer the problem by among other things by dampening the vibrations before the reach the operator.

Mining is one of the main industries with high number of Earth Moving Vehicle Operators. In mining, earth moving vehicles are normally involved in digging, grading, loading and hauling earth material in very rough terrains. Machines normally used are haul trucks, loaders, graders drills and dozers. All these machines work in rough areas that cause the vehicle to vibrate. This vibration will then be transmitted to the seat in the cabin, and the seat as a supporting surface to the operator transmits the vibration through the ischial tuberosities which are in contact with the seat to the spine and the rest of the body. The spine has got discs which are natural shock absorbers of any force that the spine is subjected to. However like any other structure in the body, the discs also have limit and they are repeatedly exposed to the shock, they can be affected leading to wear off. A number of research have shown that prolonged exposure of a person to WBV can cause severe injuries of the lower back such as displaced intervertebral discs, vertebra degeneration, osteoarthritis as well as fatigue fractures in the vertebrae (Safe Work Australia, 2016). It therefore follows that if WBV can cause damage to the discs which are primarily for absorbing the shock to the spine and the body as a whole, it can therefore be deduced that WBV can have ripple and vicious cycle impact on the individual’s health.

It is clear that vibration has a role in the high prevalence of back disorders among earth moving vehicle operators. Therefore putting in place strategies or measures to reduce operator exposure to whole body vibration may have an impact on the prevalence of this costly and debilitating condition among earth moving vehicle operators. Also of importance is to note that in order to reduce the health impact of vibration, the vibration could either be eliminated from source or they can be prevented from transmitting to the body. It is therefore possible that reducing whole body vibration transmitted to the operator by the vehicle seat could reduce the prevalence of low back disorders among driver operators to the prevalence in the general population. In A study by Yessirieli etal 2017, the use of lumbar cushion and seat cushion was found to reduce WBV exposure by up to 12%. This means that Lumbar and seat cushions could be used to improve reduce WBV exposure in EMV operators. This phenomena was also witness in Orapa during an in house pilot study in which WBV measurements of one vehicle were compared between a normal seats and when a seat was fitted with jay gel cushion in which the WBV was reduced by 25%.

1.3 Objectives of the Research

The objective of the proposed research, is therefore to establish if the use of jay gel cushions can reduce WBV exposure to earth moving vehicle operators in open cast mining by dampening vibrations transmitted from the vehicle seat to the operator. The second objective is to establish if the jay gel cushion has an impact on operator comfort.

1.4 Research Question

The research questions are therefore as follows:

* 1. Is a jay gel cushion used on the seat of an Earth moving vehicle during mining operation able to reduce whole body vibrations transmitted to the operator?
  2. Is the use of the jay cushion able to alter the comfort of the Mining earth moving vehicle operator?

1.5 Hypothesis

* 1. The use of the jay gel cushions between the seat and the operator will not reduce vibrations transmitted from the seat to the operator.
  2. The jay gel cushions will not dampen the vibrations transmitted from the seat to the operator.

1. **Justification of the study**

Employee health and safety is critical to business sustainability and therefore effort should be put in place to control all hazards that are a threat to employee health and safety. Whole body vibration has proved to be one of the hazards that can result in cumulative trauma to the spine, resulting in chronic low back pain that ranges from mild to debilitating pain. Research has also shown that low back disorders are highly prevalent in EMV operators and this has been linked to among other things, exposures to whole body vibration (Kittusamy 2002).

Research has also shown that back pain accounts for a significant of number sick leave absence which in-turn affects employee productivity. In addition to this low back pain accounts for a significant number of cases for compensation. This study seeks to reduce one of the significant risk factors of low back pain among driver operators.

**Scope and limitation**

* 1. This study will be carried out on driver operators in mining in an open cast mine in Botswana. The study will only confine its self to operators who operate drills,

shovels, loaders, graders and haul trucks in the mine.

1. **Literature Review**

A number of research papers have associated WBV with negative impact on the human body. Among conditions frequently associated with WBV is low back pain. While a lot is not known about the specific effects of WBV on bones, muscles and joints, research has shown that WBV can have negative impacts on the human body. The drivers of earth moving vehicles are known to be exposed to WBV through the seat or floor of the machinery they are operating. Kittusamy (2002) evaluated vibration at the seat/operator interface; transmissibility of vibration in the Z-axis and the results showed that the seat amplified vibration, particularly in the lower frequencies therefore demonstrating that seats may not be sufficient in protecting operators from long-term effects of vibration exposure.

Dupuis and Zerlett (1987) studied 352 operators of earth-moving equipment with at least three years of work experience and compared it with 315 of the control group. Among the 352 operators and 315 referents studied, the operators reported significantly higher spinal discomfort during their work shift (75% vs. 49%) and after their shift (59% vs. 45%), as well as more disorders of the spine (70% vs. 54%). Furthermore the operators reported significantly higher discomfort in the lumbar region (69% vs. 42%) than for the control group. The most frequent (and significant) health impairment among the operators was lumbar syndrome (81%) and was significantly higher than found in the control group. X-ray review of the two groups also showed a statistically higher prevalence of pathological findings among operators compared with the controlled group.

It is very clear that exposure to whole body vibration impact negatively on people’s health leading to compensable conditions. SafeWork Australia, reported that from 2000- 2008 there were about 400 workers’ compensation claims per year relating to exposure to WBV and that the claims amounted to about $ 61million in workers’ compensation payments over the eight-year period.(Safe Work 2016). WBV is clearly very costly to the employer, insurer and individual.

A study conducted by Yassierli N.B and Sutalaksana Z (2017) examined the efficacy of using lumbar cushion and seat cushion in reducing exposure to WBV. The use of lumbar cushion and seat cushion were found to reduce WBV exposure by up to 12%, and the decline was more substantial at higher rotational frequency (i.e., higher speed) and higher rotational amplitude (i.e., rougher road condition).

1. **Methodology**
   1. Research Method

The research method used here will primarily allow the researcher to compare the vibration value measured between the operator and the normal EMV seat when the seat is covered with a Jay gel cushion and when it is not. The philosophy is that when the seat is covered with the cushion, the cushion will attenuate the vibration and hence reducing vibration transmitted to the operator.

* 1. Study Design

The study design will be quasi experimental design. In the study, a number of vehicles will be selected and the vibration transmitted from seat to operator will first be measured without a jay cushion for a cycle job followed by a second cycle with the jay cushion. The vibration values will then be compared for the two cycles to check if there is any impact when the cushion is used.

* 1. Study Location and Population

The study will take place in Orapa Mine pit. This is an open cast pit that is currently over 250 meters deep. The mine has a very good safety record and it is both ISO 14001 certified and OSHAS 18001 certified.

* 1. Study Approach

This study approach will utilise both be quantitative and qualitative approach. The study will have the vibration exposure quantified and also there will be a standardised questionnaire to investigate the comfort and the operator perception and acceptance of the cushions.

The primary source of data will be the accelerometers which will be used to measure the vibrations as well as the questionnaires.

5.5 Sampling Method

Random sampling of machinery will be used and the operators will be by default of the allocation and data for each vehicle will be collected same day with the cycle with cushion immediately following the one with out.

1. **Analysis**

Raw data will then be collected and analysed using Stata statistical analysis package. Once the analysis is done data will be presented using pie charts and histograms.

To ensure that the data is valid only accelerometers recognised by SABS or BOBS being Bureau Standard for South Africa and Botswana respectively. It will also be ensured that the accelerometers have been calibrated as per the standard in use.

1. **Ethics**

Permission for this study will be sought from the National research authority of Botswana as well as from the Orapa Mine management.

1. **References**
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